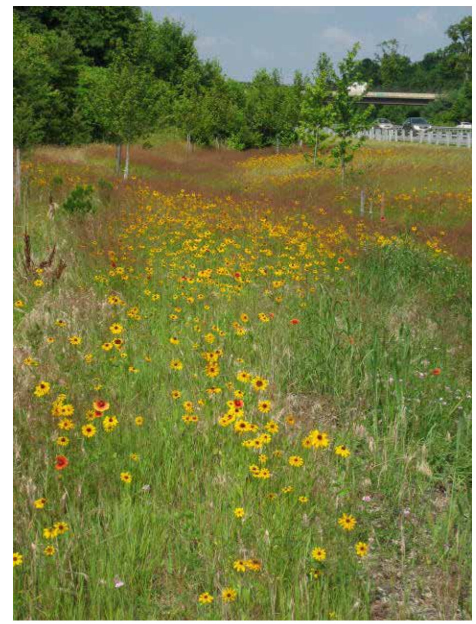
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

Part IV

MDOT SHA Watershed TMDL Implementation Plans



IV. MDOT SHA WATERSHED TMDL IMPLEMENTATION PLANS

A. ANACOSTIA RIVER WATERSHED

A.1. Watershed Description

The Anacostia River watershed encompasses 145 square miles across both Montgomery and Prince George's Counties, Maryland and an additional 31 square miles in Washington, DC. The watershed terminates in Washington, D.C. where the Anacostia River flows into the Potomac River, which ultimately conveys water to the Chesapeake Bay. The watershed is divided into 15 subwatersheds: Briers Mill Run, Fort Dupont Tributary, Hickey Run, Indian Creek, Little Paint Branch, Lower Beaverdam Creek, Northeast Branch, Northwest Branch, Paint Branch, Pope Branch, Sligo Creek, Still Creek, Upper Beaverdam Creek, Watts Branch, and the tidal river.

There are 1,815.3 centerline miles of MDOT SHA roadway located within the Anacostia River watershed. The associated ROW encompasses 4,861.6 acres, of which 2,329.2 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) weigh station, one (1) highway garage or shop, one (1) highway office or lab, three (3) park and ride facilities, and three (3) salt storage facilities. See **Figure 4-1** for a map of the watershed.

A.2. MDOT SHA TMDLs within Anacostia Watershed

TMDLs requiring reduction by MDOT SHA in the Anacostia River watershed include trash and PCBs as shown in **Table 3-2** (MDE, 2010a; MDE, 2011a). The allocated trash baseline for MDOT SHA is to be reduced by 100 percent (this does not mean that trash within the watershed will be reduced to zero). The allocation is divided into separate requirements for each County.

PCBs are to be reduced in certain subwatersheds of the Anacostia River watershed. The Anacostia River Northeast Branch subwatershed requires a 98.6 percent reduction and the Anacostia River Northwest Branch subwatershed requires a 98.1% reduction. The Anacostia River Tidal subwatershed requires a 99.9% reduction.

A.3. MDOT SHA Visual Inventory of ROW

The MS4 permit requires MDOT SHA perform visual assessments. **Part III, Coordinated TMDL Implementation Plan** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Anacostia River watershed is shown in **Figure 4-2** which illustrates that 90 grid cells have been reviewed, encompassing portions of 42 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 468 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- Three (3) new structural SW controls constructed or under contract.
- 247 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.

- 218 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 164 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 68 sites constructed or under contract.
- 15 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 81 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 81 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- 11 sites constructed or under contract.
- 21 additional sites deemed potentially viable for stream restoration and pending further analysis may be candidates for future restoration opportunities.
- 49 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified seven (7) sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Four (4) new structural SW controls constructed or under contract.
- One (1) additional site deemed potentially viable for new structural SW controls and pending further analysis, may be a candidate for future restoration opportunities.
- Two (2) sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 219 outfalls potential for stabilization. Further analysis of these sites resulted in:

- Two (2) outfall sites constructed or under contract.
- 22 outfall sites deemed potentially viable for outfall stabilization efforts and pending further analysis, may be candidates for future restoration opportunities.
- 195 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 33 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of five (5) existing structural SW controls constructed or under contract.
- Seven (7) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- 21 retrofit sites deemed not viable for future restoration opportunities and have been removed from consideration.

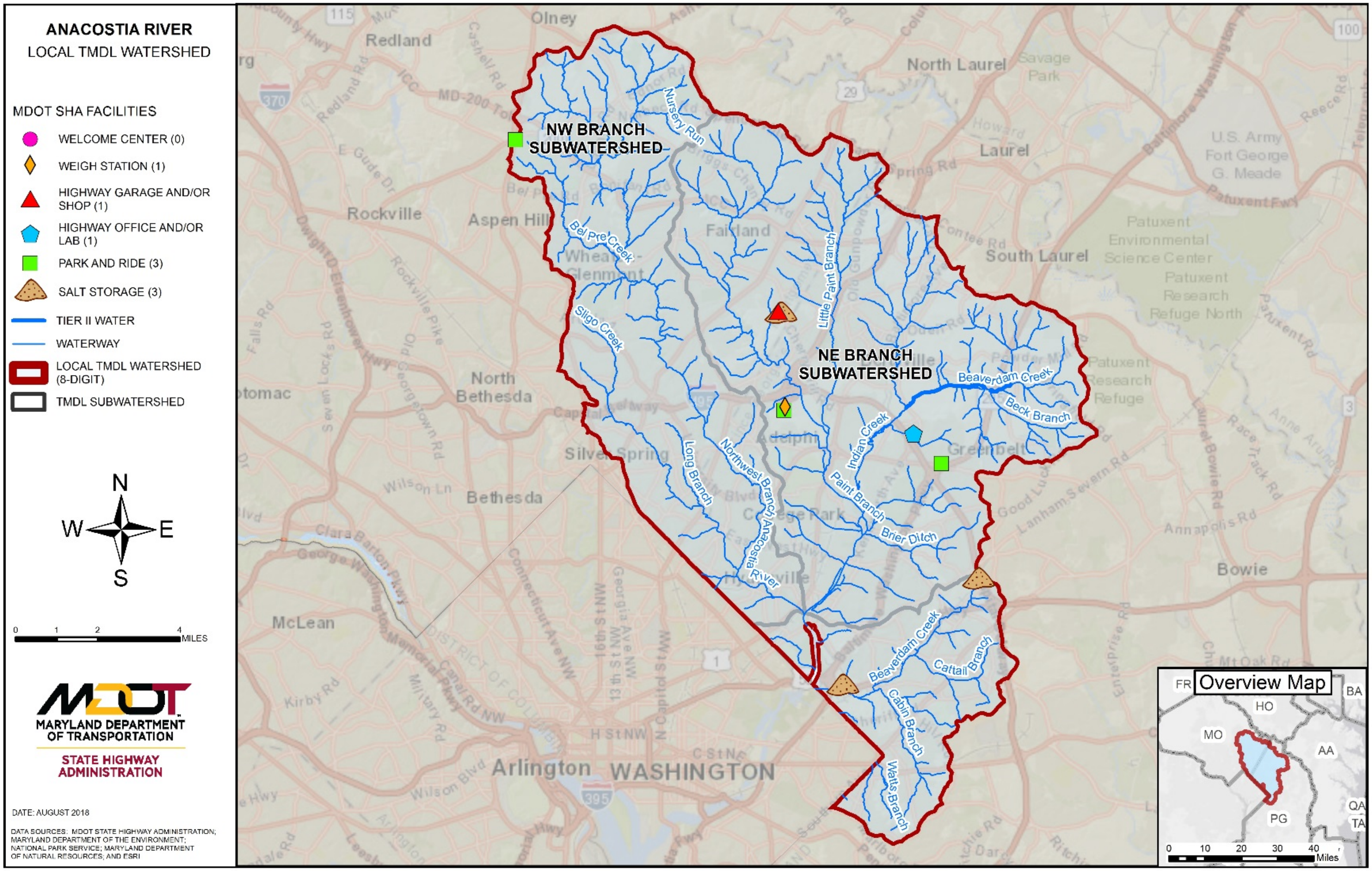


Figure 4-1: Anacostia River Watershed

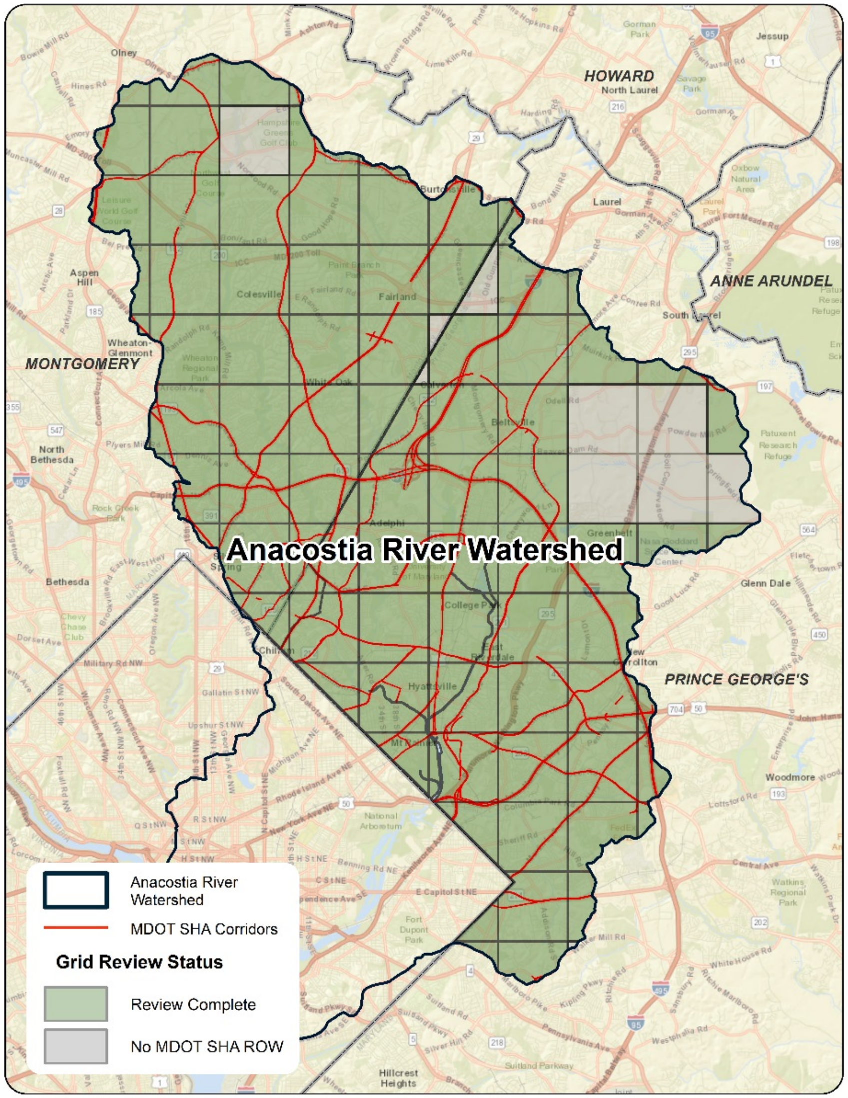


Figure 4-2: Anacostia River Site Search Grids

A.4. Summary of County Assessment Review

Waters within the Anacostia River watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Biochemical oxygen demand (BOD);
- Chlorides;
- Debris/Floatables/Trash;
- *Enterococcus;*
- Heptachlor Epoxide;
- Nitrogen (Total);
- PCB in Fish Tissue;
- Phosphorus (Total);
- PCBs;
- Sulfates; and
- TSS.

Both Montgomery and Prince George's Counties have conducted a watershed assessment for areas within the Anacostia River watershed. These include the 2012 *Anacostia Watershed Implementation Plan* produced for the Montgomery County Department of Environmental Protection and the 2015 *Implementation Plan for the Anacostia River Watershed Trash Total Maximum Load in Prince George's County* produced for the Prince George's County Department of the Environment (Biohabitats et al., 2012a; EA, 2015). Prince George's County also completed the *Restoration Plan for PCB-Impacted Waterbodies in Prince George's County* (Tetra Tech, 2015a) as well as the *Restoration Plan for the Anacostia River Watershed in Prince George's County* (Tetra Tech, 2015b) in 2015.

Many areas of the Anacostia River watershed were developed prior to modern SWM and erosion and sediment control regulations. Impervious land cover comprises a large portion of the watershed (24 percent). Montgomery County identified 6,917 acres (18 percent) with impervious cover. Likewise, the Restoration Plan for the Anacostia River watershed in Prince George's County identifies 15,435.3 acres

(28.5 percent) of impervious cover. In Montgomery County alone, impervious cover contributes 206,312 lbs. per year of nitrogen, 20,953 lbs. per year of phosphorus, and 7,682 tons per year of sediment, to the watershed.

The subwatersheds in Prince George's County were prioritized by ranking the necessary total load reductions for each TMDL parameter. Montgomery County mapped individual stream areas for restoration opportunity prior to 2012, but may have restored several already. Montgomery County noted that according to their testing parameters, Lower Paint Branch, Little Paint Branch, Northwest Branch, and Sligo Creek received consistent "poor" ratings, and should be targeted for restoration efforts.

From 2009-2013 benthic invertebrate surveys were conducted throughout Montgomery and Prince George's Counties. Of the sampled sites, 91 percent of Montgomery County sites were rated as "fair" or "poor," while approximately 50 percent of sites in the most recent round of sampling in Prince George's County were rated as "poor" or "very poor." As a result of the studies, both counties identified several similar restoration strategies for meeting pollution reduction and improvement goals within the watershed. These include:

- Stormwater retrofit;
- Stream restoration;
- Wetland creation/restoration;
- Fish blockage removal/modification;
- Riparian reforestation/street tree planting;
- Green roof;
- Dry water pond;
- Bioswales;
- Permeable pavements/sidewalks;
- Rain gardens and rain barrels;
- Street sweeping; and
- Downspout disconnection.

Additionally, trash reduction strategies are also discussed by both Counties. Trash loading within the watershed is categorized by land use. The trash reduction strategies have been broken into 4 categories including structural, educational, municipal, and enforcement. In both counties, 68 percent of this reduction will be addressed by structural BMPs and the rest (32 percent) from outreach and enforcement activities. All trash reduction efficiencies are a percent reduction from the loading rate of the area's land use. **Table 4-1** outlines Montgomery County's strategies and efficiencies for each.

Table 4-1: Montgomery County Preferred Trash Reduction Strategies and Efficiencies

BMP Program	Category	Unit Reduction Efficiency
SWM and ESD BMPs	Structural	95% of Drainage Area Loading Rate
Trash Interceptors	Structural	90% of Drainage Area Loading Rate
Land Use Change to Reduce Loading Rate	Municipal	Depends on Land Use
Anti-Littering Campaign	Educational	12% Reduction of Residential Land Use Loading Rate
Recycling Education and Enforcement	Educational, Municipal, and Enforcement	25% Reduction of Land Use Loading rate within Areas with Recycling Service
Plastic Bag Ban	Educational, Municipal, and Enforcement	30% of Total Load
Enforcement of Littering and Illegal Dumping	Enforcement	5% Reduction of Industrial and Commercial Land Use Loading Rate

Source: Biohabitats et al. (2012a)

Many of these strategies are not available to MDOT SHA since it is not a municipal entity with its own enforcement capacity. Also, MDOT SHA ROW only has a single land use category being transportation, so changes in land use categories would not be possible. Therefore, the most suitable strategies that would apply to MDOT SHA include structural and educational strategies.

PCB Reduction

Part III, Coordinated TMDL Implementation Plan outlines strategies for PCB reduction. The primary strategy for additional and targeted PCB reduction is the development of a source tracking and elimination program that traces the contamination back to its source and removes it from the system. The source tracking program identifies areas where PCB sources have been documented or are likely to exist. These areas will be assessed to target BMPs (e.g., stormwater ponds) and waterways where PCBs are most likely to have been carried by stormwater. Sediments in these BMPs and waterways will then be sampled and analyzed to determine PCB concentrations. If present above the action level, the PCB-impacted sediments will be removed from the system and the County will take credit for the PCB load reduction. Ideally, the originating source of PCBs can be immediately identified and corrected during the source removal/remediation phase.

The ROW is public space that is owned and maintained either by the County or MDOT SHA. Some of these areas may have a high density of substations and transformers that could contain PCBs, particularly in industrial, commercial, and high-density urban areas. BMPs receiving runoff from such ROW areas will be a priority focus area if there are no access restrictions involved.

Superfund sites have high potential for PCB source pollution. Prince George's County Superfund sites and their known PCB presence are listed in **Table 4-2**.

As a whole, structural and nonstructural BMPs have been implemented by the County including permit compliance, TMDL WLAs, flood mitigation, and more. Prince George's County has also engaged in street sweeping, public outreach to promote environmental awareness, green initiatives and community involvement in protecting natural resources. Additionally, the County has initiated discussions with the board of education and the MDOT SHA to coordinate and take advantage of available land for BMP retrofits (Tetra Tech, 2015b).

Table 4-2: Prince George's County Superfund Sites

Site Name	City	Known PCBs
Andrews Air Force Base (AFB)	Andrews AFB	X
Beltsville Agriculture Research Center (BARC)	Beltsville	X
Brandywine Defense Reutilization and Marketing Office (DRMO)	Brandywine	X
Chillum Gasoline Release	Chillum	
Chillum Perchloroethylene (PERC)	Chillum	
Laurel Chlorine Cylinder	Laurel	
Nazcon Concrete	Beltsville	
Roger's Electric Company	Cheverly	X
Windsor Manor Road	Brandywine	
Source: Tetra Tech (2015a)		

A.5. MDOT SHA Pollution Reduction Strategies

Proposed practices to meet PCB and trash reduction in the Anacostia River Northeast Branch, Northwest Branch, Tidal River Branch, Anacostia River Montgomery County portion, and Anacostia River Prince George's County portion of the watershed are shown in **Table 4-3**, **4-4**, **4-5, 4-6a,** and **4-6b** respectively. Projected PCB and Trash reductions using these practices are described in **Part III, Coordinated TMDL Implementation Plan** and are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs implemented before the baseline year. In this case the baseline for PCBs is 2005 and the baseline for trash is 2010;
- BMPs built after the baseline through fiscal year 2020; and

- BMPs implemented after fiscal year 2020 through fiscal year 2025: and
- Future BMPS to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the PCB TMDL for Anacostia River NE Branch, MDOT SHA will meet 5.1 percent of the MDE 98.6 percent load reduction requirement through implementation of BMPs shown in **Table 4-3**. MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in Part III Section E.

Estimated costs to design, construct, and implement annual practices such as inlet cleaning and street sweeping within the Anacostia River watershed total $6,239,000. These projected costs are based on an average cost per impervious acre treated that is derived from cost history for a group of completed projects for each BMP category. Please see **Table 4-7** for a BMP strategy breakdown.

Figure 4-3 shows a map of MDOT SHA's watershed restoration practices and includes those that are under design or construction. Inlet cleaning is not reflected on this map.

Table 4-3: Anacostia River NE Branch Restoration PCB BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	383.1	17.3	29.9	TBD	430.3
Retrofit	drainage area acres		25.9		TBD	25.9
Inlet Cleaning[1]	dry tons		12.4	9.1	TBD	21.5
Street Sweeping[1]	acres swept		32.6		TBD	32.6
Load Reductions	PCB g/yr.		0.23	0.40	7.78	
				Total Projected Reduction	**7.78**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-4: Anacostia River NW Branch Restoration PCB BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	214.6			TBD	214.6
Retrofit	drainage area acres		35.0		TBD	35.0
Inlet Cleaning[1]	dry tons		22.7	53.0	TBD	75.7

Street Sweeping[1]	acres swept		17.6		TBD	17.6
Load Reductions	PCB g/yr.		0.36	0.36	7.55	
				Total Projected Reduction	**7.55**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-5: Anacostia River Tidal Branch Restoration PCB BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	165.5	1.5		TBD	167.0
Retrofit	drainage area acres		26.0		TBD	26.0
Inlet Cleaning[1]	dry tons		5.4	34.7	TBD	40.1
Street Sweeping[1]	acres swept		33.8		TBD	33.8
Load Reductions	PCB g/yr.		0.97	0.97	16.08	
				Total Projected Reduction	**16.08**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-6a: Anacostia River Watershed Montgomery County Trash & Debris Activities Implementation

BMP	Unit	Restoration BMPs			Total BMPs
		2020	2025	Future	
Stormwater BMP	drainage area acres	17		TBD	17
Stream Clean-Ups	pounds		1,000	TBD	1,000
Media Relations (Use of Free Media)	each			TBD	
Outreach: Community/School Children/ Youth	each		5	TBD	5
Inlet Cleaning[1]	No. Inlets	602		TBD	602
Street Sweeping[1]	acres	234	351	TBD	585
Load Reductions	lbs./yr.	3,273	4,764	6044	
			Total Projected Reduction	**6,044**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-6b: Anacostia River Watershed Prince George's County Trash & Debris Activities Implementation					
BMP	**Unit**	**Restoration BMPs**			**Total BMPs**
		2020	**2025**	**Future**	
Stormwater BMP	drainage area acres	518		N/A	518
Stream Clean-Ups	pounds		4,000	N/A	4,000
Media Relations (Use of Free Media)	each			N/A	
Outreach: Community/School Children/ Youth	each		5	N/A	5
Inlet Cleaning[1]	No. Inlets	813		N/A	813
Street Sweeping[1]	acres	429	644	N/A	1,073
Load Reductions	lbs./yr.	5,604	10,344	14,134	
			Total Projected Reduction	**14,134**	
[1] Inlet cleaning and street sweeping are annual practices.					

Table 4-7: Anacostia River Restoration BMP Cost			
BMP	**2020**	**2025**	**Total**
New Stormwater	$2,196,000		$2,196,000
Retrofits	$3,272,000		$3,272,000
Stream Clean Ups		TBD	TBD
Inlet cleaning	$184,000	$553,000	$737,000
Street Sweeping	$34,000		$34,000
Total			$6,239,000

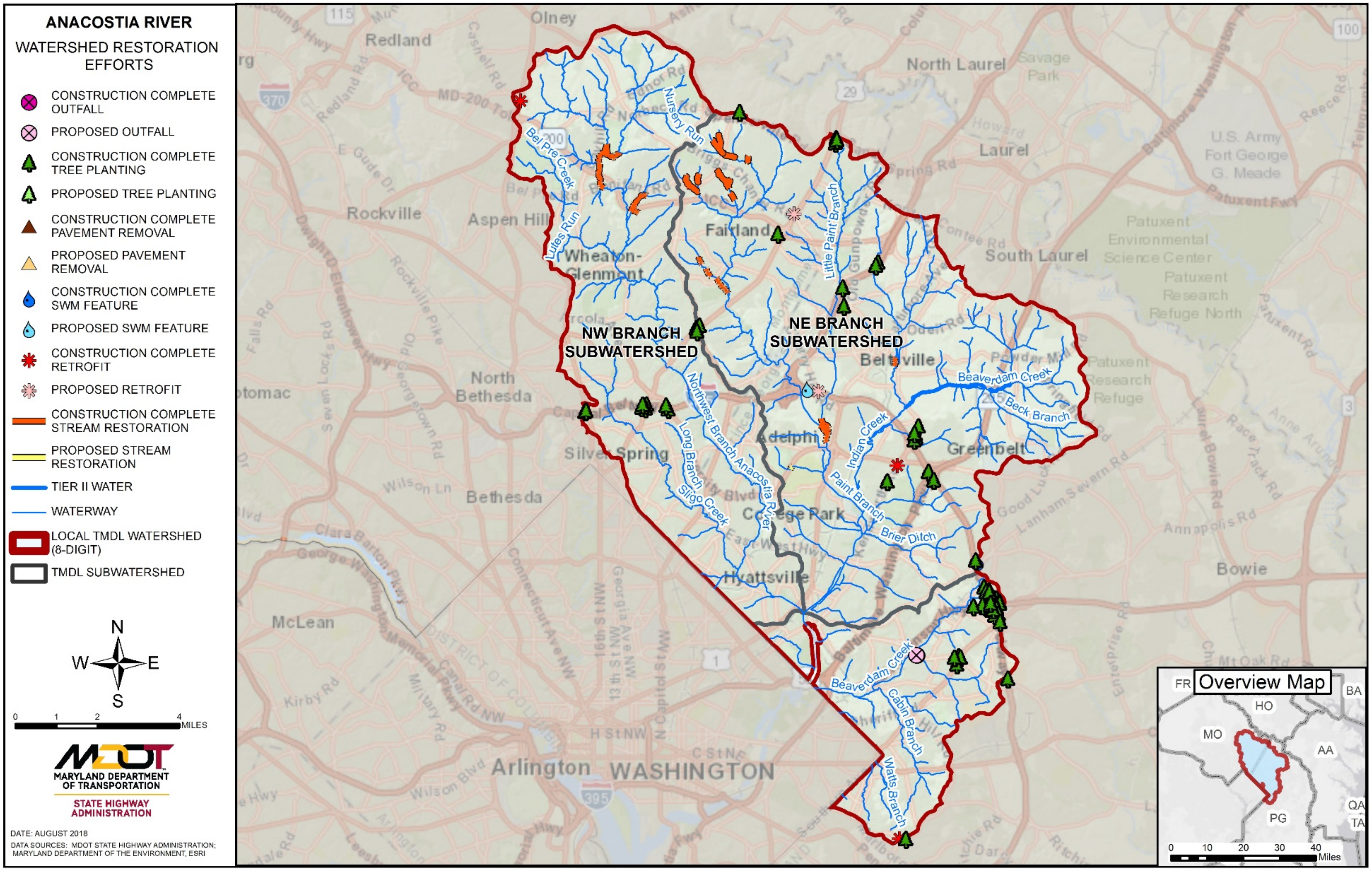


Figure 4-3: MDOT SHA Restoration Strategies within the Anacostia River Watershed

B. ANTIETAM CREEK WATERSHED

B.1. Watershed Description

The Antietam Creek watershed encompasses 290 square miles with 185 square miles in Maryland. Approximately 75 percent of this watershed occurs in Washington County with the remainder in Franklin and Adams Counties, Pennsylvania. Antietam Creek flows about 54 miles from its headwaters in Pennsylvania's Michaux State Forest to the Potomac River near Antietam, Maryland. Major tributary creeks and streams of the Antietam Creek watershed in Maryland include Little Antietam Creek, Beaver Creek, and Marsh Run.

There are 744.4 miles of MDOT SHA roadway located within the Antietam Creek watershed. The associated ROW encompasses 2,201.3 acres, of which 853.2 acres are impervious. MDOT SHA facilities located within the watershed consist of five (5) park and ride facilities, four (4) salt storage facilities, and two (2) highway garage or shop facilities. See **Figure 4-4** for a map of the watershed.

B.2. MDOT SHA TMDLs within Antietam Creek Watershed

TMDLs requiring reduction by MDOT SHA include phosphorus and sediment (TSS) (MDE, 2013a; MDE, 2008a). Phosphorus is to be reduced by 21.4 percent and sediment is to be reduced by 58.1 percent as shown in **Table 3-2**.

B.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Antietam watershed is shown in **Figure 4-5** which illustrates that 84 grid cells have been reviewed, encompassing portions of 684 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 1,215 locations as potential new structural SW control locations. Further analysis resulted in:

- 27 new structural SW controls constructed or under contract.
- 391 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 797 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 564 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 65 sites constructed or under contract.
- 60 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 439 sites deemed not viable for tree planting and have been removed from consideration.

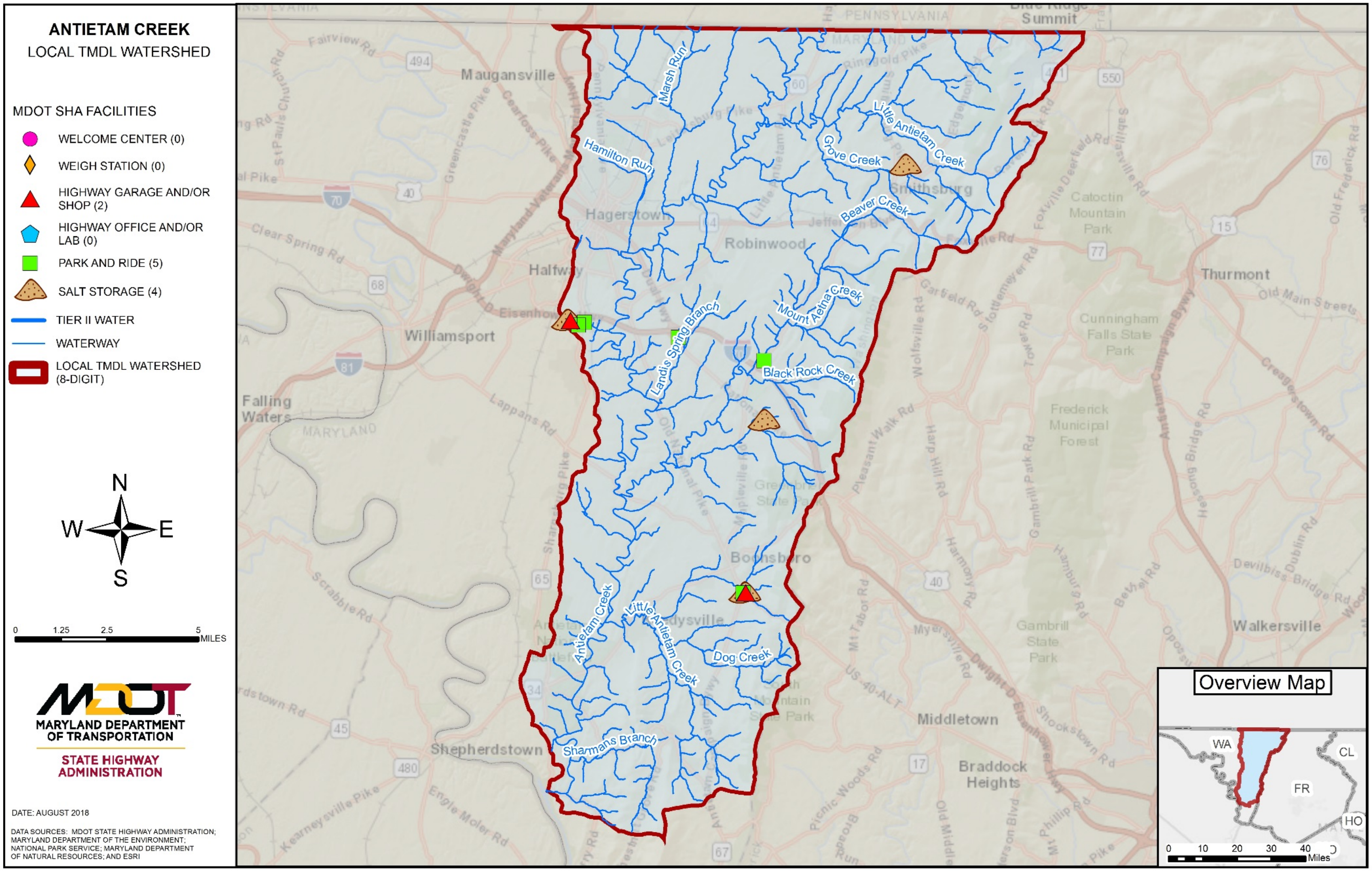


Figure 4-4: Antietam Creek Watershed

Stream Restoration

Preliminary evaluation identified 29 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Four (4) additional sites deemed potentially viable for stream restoration and pending further analysis may be candidates for future restoration opportunities.
- 25 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 28 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Four (4) new structural SW controls constructed or under contract.
- One (1) additional site deemed potentially viable for new structural SW controls and pending further analysis, may be a candidate for future restoration opportunities.
- 23 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified six (6) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of one (1) existing structural SW control constructed or under contract.
- Five (5) retrofit sites deemed not viable for future restoration opportunities and have been removed from consideration.

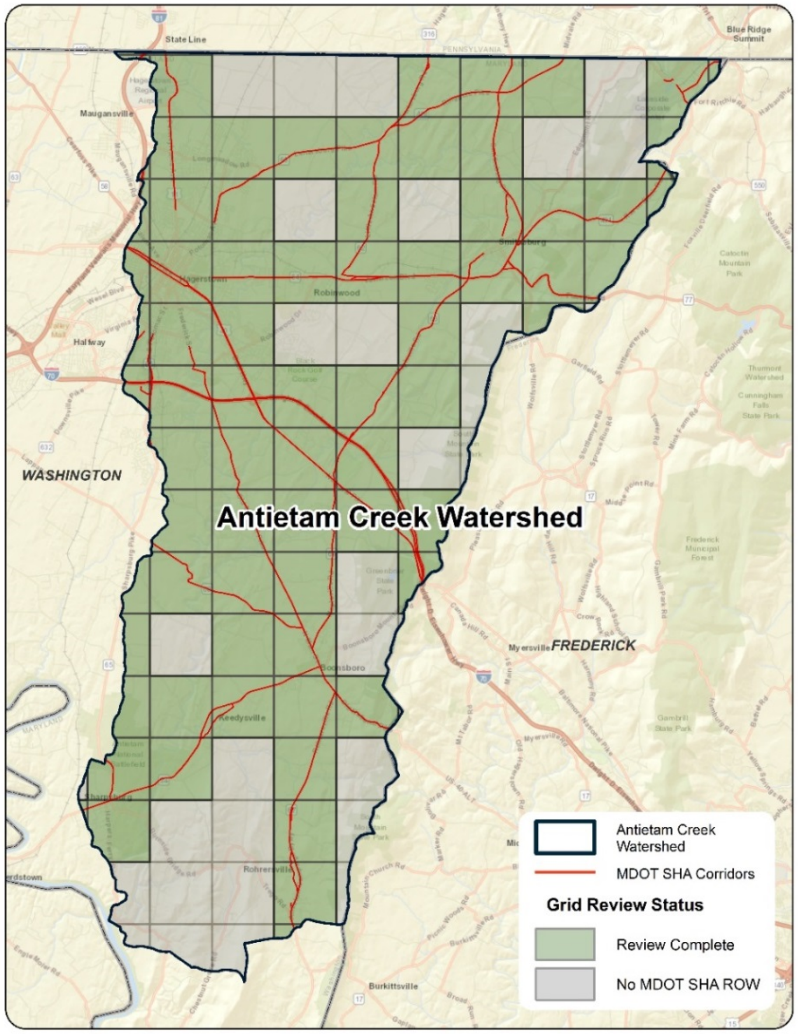


Figure 4-5: Antietam Creek Site Search Girds

B.4. Summary of County Assessment Review

Waters within the Antietam Creek watershed are subject to the following impairments as noted on MDE's 303(d) List:

- *Escherichia coli;*
- PCB in Fish Tissue
- Phosphorus (Total);
- Sulfates;
- Temperature, water; and
- TSS.

The 2012 *Antietam Creek Watershed Restoration Plan* was developed through a partnership (comprised of several organizations including MDE and led by the Washington County Soil Conservation District [WCSCD]) as a comprehensive summary of the issues impacting the watershed area (WCSCD et al., 2012). Antietam Creek currently has completed TMDLs for phosphorus, TSS, and *E. coli*. However, TMDLs are still necessary for PCB in fish tissue, sulfates, and temperature (water).

The watershed has been divided into nine subwatersheds. Approximately 59% of the stream miles were classified as having Fish Index of Biotic Integrity (FIBI) and/or Benthic Index of Biotic Integrity (BIBI) in the "poor" to "very poor" category. After review and evaluation, it was determined that three of the nine watersheds be targeted for pollutant reduction implementation: ANT0277, MRS0000, and BEC0001.

Because a significant portion of the watershed is agricultural land use (42 percent), there are separate BMPs listed for agricultural practices and urban areas. The suggested BMPs for watershed restoration are shown in **Table 4-8**.

Table 4-8: Suggested BMPs in the Antietam Creek Watershed

Agricultural BMPs	Urban BMPs
Pet Waste Runoff Campaign*	Bioretention/Rain Gardens*
Septic System Upgrades	Bio-Swale*
Grass Buffers*	Dry Detention Ponds*
Riparian Forest Buffers*	Dry Extended Detention Ponds*
Stream Protection with Fencing*	Forest Conservation (pervious only)*
Stream Protection without Fencing*	Impervious Urban Surface Reduction*
Livestock Stream Crossing	Permeable Pavement
Nutrient Management Planning*	Urban Forest Practices*
Runoff Control Systems*	Urban Filtering Practices*
Cover Crops	Urban Infiltration Practices*
Animals Waste Management	Street Sweeping*
Conservation Tillage	Urban Nutrient Management*
Retire Highly Erodible Lands	Vegetated Open Channel*
Natural Stream Designs/Armored Steam Banks*	Wet Ponds & Wetlands*
** Denotes practices that may be applicable to MDOT SHA's program*	
Source: WCSCD et al. (2012)	

B.5. MDOT SHA Pollutant Reduction Strategies

Antietam Creek has a TMDL for phosphorus and sediment with baseline years of 2009 and 2000 respectively. Proposed practices to meet the phosphorus and sediment reductions in this watershed are shown in **Table 4-9 and Table 4-10**. Projected phosphorus and sediment reductions using these practices are shown in **Table 3-2**. Four timeframes are included in the BMP implementation tables below:

- BMPs implemented before the baseline year. In this case, the phosphorus baseline is 2009 and the sediment baseline is 2000;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the sediment TMDL, MDOT SHA will meet 23.7 percent of the MDE 58.1 percent load reduction requirement through implementation of BMPs shown in **Table 4-10.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Antietam Creek watershed total $14,586,000. They are based on average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-11** for a summary of estimated BMP costs.

Figure 4-6 is a map of the MDOT SHA restoration practices and includes those that are under design or construction. Inlet cleaning and street sweeping are not shown.

Table 4-9: Antietam Creek Restoration Phosphorus BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	58.8	78.9	44.5	N/A	182.2
Retrofit	drainage area acres		28.8		N/A	28.8
Tree Planting	acres of tree planting	6.7	94.6		N/A	101.3
Stream Restoration	linear feet			2,033.6	N/A	2,033.6
Outfall Stabilization	linear feet			400.0	N/A	400.0
Inlet Cleaning[1]	dry tons			27.8	N/A	27.8
Street Sweeping[1]	acres swept		58.9		N/A	58.9
Load Reductions	TP EOS lbs./yr.		102	290	0	
				Total Projected Reduction	**290**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-10: Antietam Creek Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2000)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	53.4	78.9	44.5	TBD	176.8
Retrofit	drainage area acres		28.8		TBD	28.8
Tree Planting	acres of tree planting		101.3		TBD	101.3
Stream Restoration	linear feet			2,033.6	TBD	2,033.6
Outfall Stabilization	linear feet			400.0	TBD	400.0
Inlet Cleaning[1]	dry tons			27.8	TBD	27.8
Street Sweeping[1]	acres swept		58.9		TBD	58.9
Load Reductions	TSS EOS lbs./yr.		108,098	238,281	1,007,480	
				Total Projected Reduction	**1,007,480**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-11: Antietam Creek Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$2,128,000	$5,786,000	$7,914,000
Retrofits	$1,223,000		$1,223,000
Tree Planting	$3,098,000		$3,098,000
Stream Restoration		$1,358,000	$1,358,000
Outfall Stabilization		$787,000	$787,000
Inlet cleaning		$159,000	$159,000
Street Sweeping	$47,000		$47,000
Total			$14,586,000

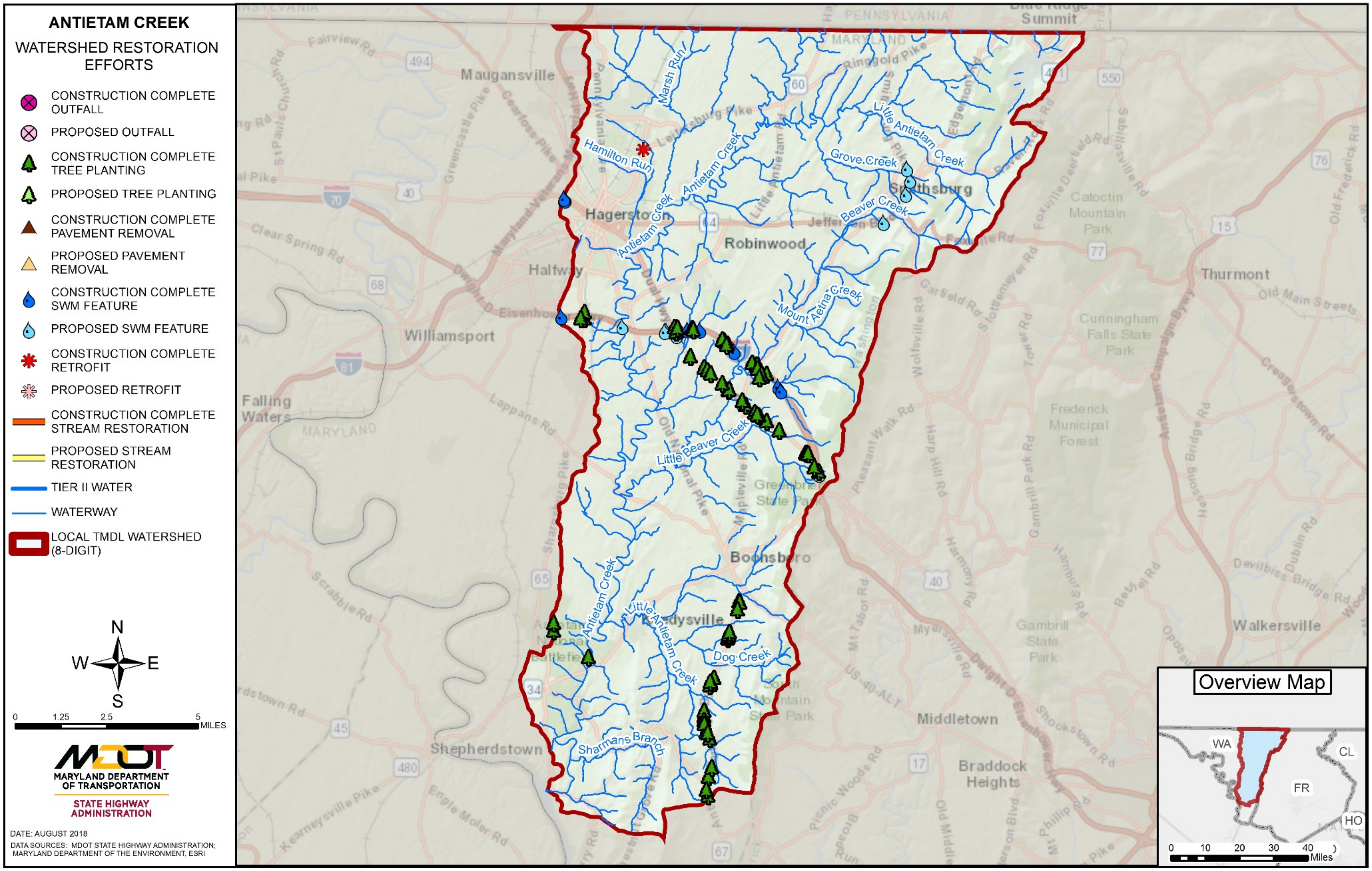


Figure 4-6: MDOT SHA Restoration Strategies within the Antietam Creek Watershed

C. BACK RIVER WATERSHED

C.1. Watershed Description

The Back River watershed encompasses 37 square miles in the western shore region of Maryland within City of Baltimore and Baltimore County. Back River drains into the Chesapeake Bay in Baltimore County. Major tributary creeks and streams of the Back River watershed include Armistead Run, Biddison Run, Bread and Cheese Creek, Brien's Run, Chinquapin Run, Deep Creek, Duck Creek, Herring Run, Moore's Run, Northeast Creek, Redhouse Run, Stemmers Run, and Tiffany Run. The Back River watershed is comprised of the Upper Back River (UBR) subwatershed and the Tidal Back River (TBR) subwatershed. The UBR subwatershed accounts for 78 percent of the Back River watershed and the TBR subwatershed accounts for the remaining 22 percent.

There are 869.3 miles of MDOT SHA roadway located within the Back River watershed. The associated ROW encompasses 1,532.3 acres, of which 718.4 acres are impervious. MDOT SHA facilities located within the Back River watershed consist of three (3) salt storage facilities, and two (2) highway garage or shop facilities. See **Figure 4-7** for a map of the watershed.

C.2. MDOT SHA TMDLs within Back River Watershed

MDOT SHA is included in the PCB TMDL (MDE, 2012a) with a reduction requirement of 53.4 percent, as shown in **Table 3-2.**

C.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Back River watershed is shown in **Figure 4-8** which illustrates that 31 grid cells have been reviewed, encompassing portions of 16 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 205 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 104 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 101 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 151 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 67 sites constructed or under contract.
- 13 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 71 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified seven (7) sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Seven (7) sites deemed not viable for stream restoration.

Grass Swale Rehabilitation

Preliminary evaluation identified 101 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 23 new structural SW controls constructed or under contract.
- Two (2) additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 76 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified six (6) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of two (2) existing structural SW controls constructed or under contract.
- Four (4) retrofit sites deemed not viable for retrofit and have been removed from consideration.

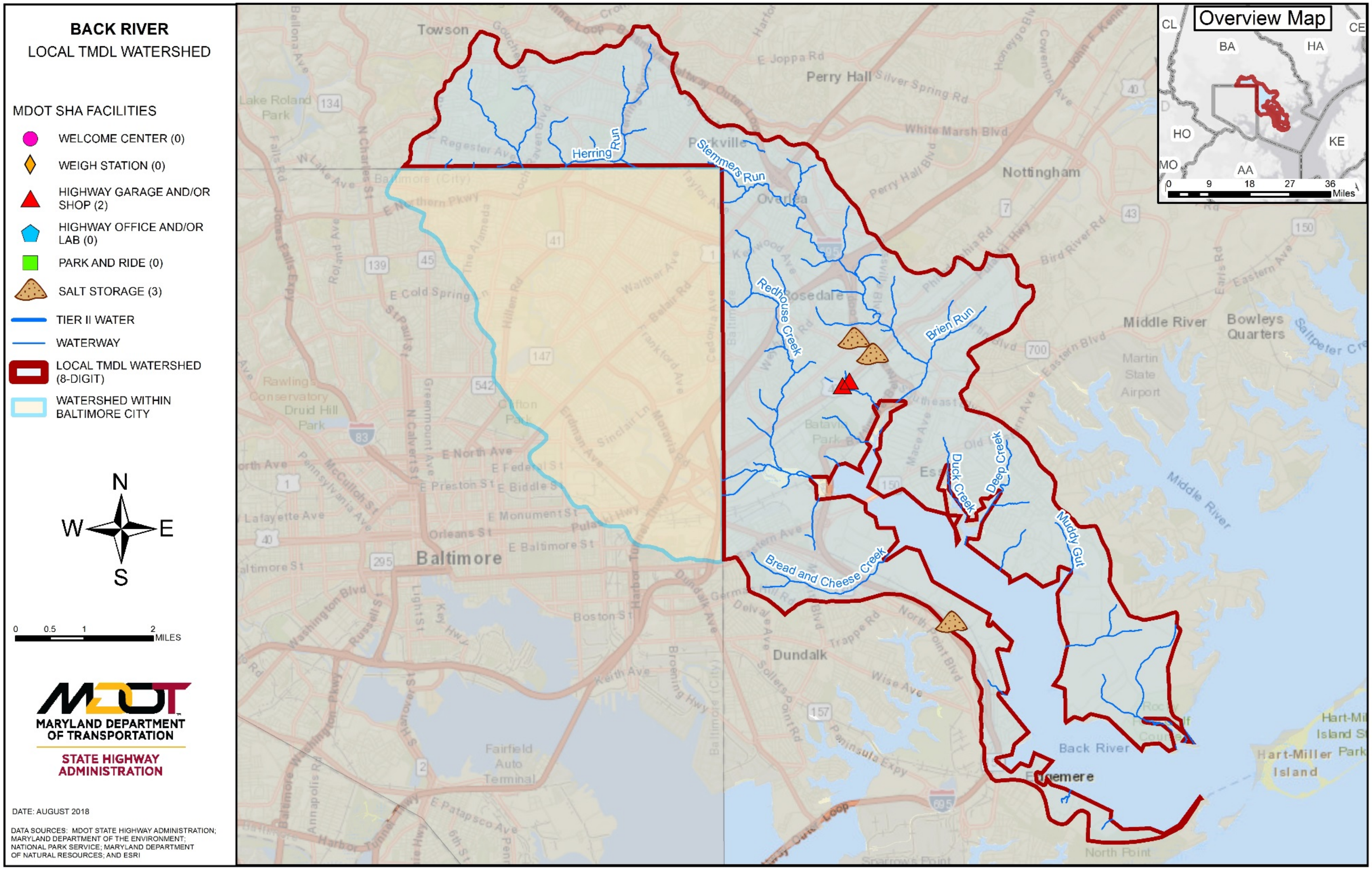


Figure 4-7: Back River Watershed

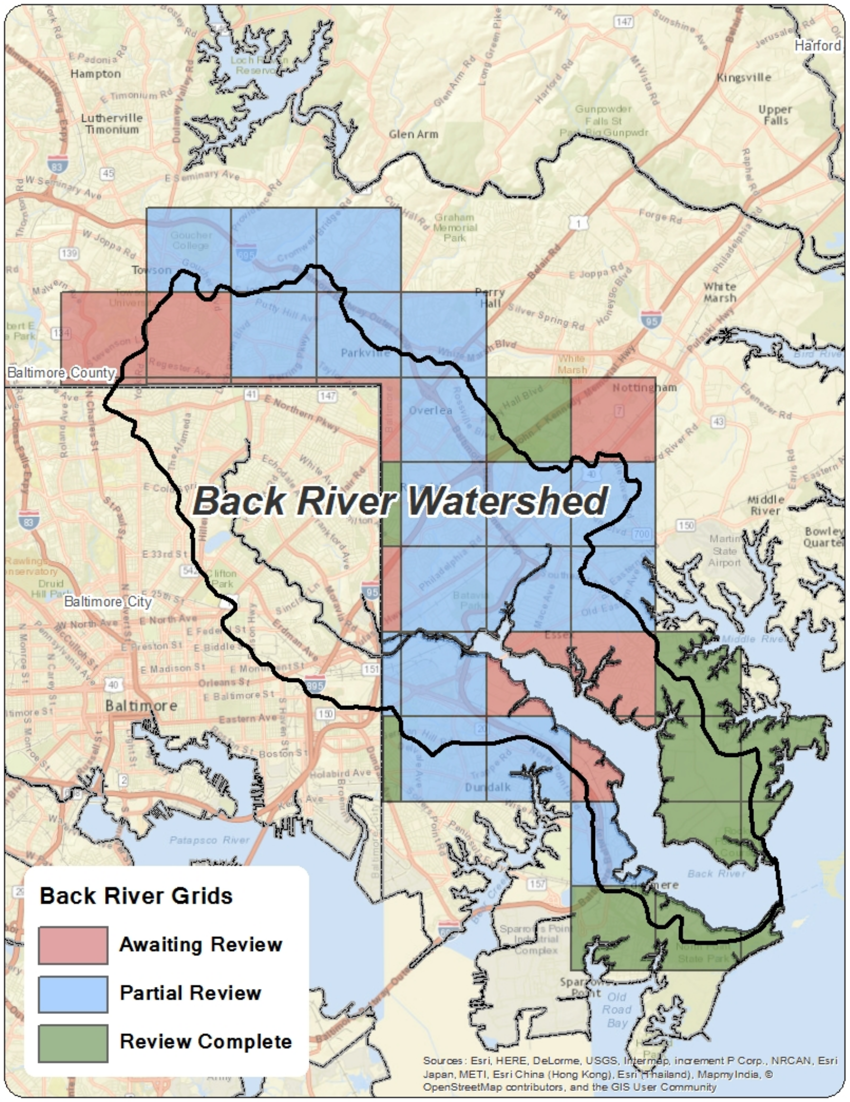


Figure 4-8: Back River Site Search Grids

C.4. County Assessment Review Summary

Waters within the Back River watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlordane;
- Chlorides;
- Fecal Coliform;
- Nitrogen (Total);
- PCB in Fish Tissue;
- Phosphorus (Total);
- PCBs;
- Sulfates; and
- TSS.

The Baltimore County completed Small Watershed Action Plans (SWAPs) for the UBR subwatershed in 2008 (BA-DEPRM, 2008a) and the TBR subwatershed in 2010 (Parsons Brinckerhoff [PB], 2010). Impervious land cover comprises 31 percent of the UBR subwatershed and 18 percent of the TBR subwatershed. Over 46 percent of soils within the UBR subwatershed and over 25 percent of soils within the TBR subwatershed are considered of high runoff potential.

Baltimore County estimates that impervious urban land use is responsible for contributing 314,619 lbs. of nitrogen and 40,182 lbs. of phosphorus in the UBR subwatershed per year (BA-DEPRM, 2008a) and 19,444 lbs. of nitrogen and 3,117 lbs. of phosphorus in the TBR watershed per year (PB, 2010). Back River currently has completed TMDLs for nitrogen, phosphorus, TSS, chlordane, and PCBs in the Chesapeake Bay tidal segment and fecal coliform in the river mainstem (Herring Run). Back River also has Category Five impairment listings (i.e., TMDL required) for sediment, chlorides, and sulfates in 1st through 4th order streams.

The County SWAPs prioritized subwatersheds within the UBR and TBR subwatersheds based on ranking criteria in order to identify which subwatersheds have the greatest need and potential for restoration. For the UBR subwatershed, Chinquapin Run, Tiffany Run, Herring Run Mainstem, Armistead Run, Biddison Run, Moore's Run, and Redhouse Run were rated "very high" and West Branch Herring Run, East Branch Herring Run, and an unnamed tributary were rated "high" in terms of restoration need and potential (BA-DEPRM, 2008a). For the TBR subwatershed, Deep Creek, Duck Creek, and Bread and Cheese Creek were rated "very high" and Lynch Point Cove, Back River-G, and Muddy Gut were rated "high" in terms of restoration need and potential. In the UBR subwatershed, all sites assessed by Baltimore City (42) and County (25) had BIBI scores in the "poor" or "very poor" categories (PB, 2010).

For the purposes of planning, the County SWAPS suggest the following generalized restoration strategies to aid in meeting restoration goals within the Back River watershed:

- SWM for new development and redevelopment;
- Existing SWM facility conversions;
- SWM retrofits;
- Stream restoration;
- Street sweeping and storm drain inlet cleaning;
- Illicit connection detection and disconnection program and hotspot remediation;
- Sanitary sewer consent decrees;
- Downspout disconnection;
- Citizen awareness (fertilizer application and pet waste); and
- Reforestation and tree planting.

The County identified numerous potential restoration sites within each subwatershed by conducting neighborhood source assessments, hotspot site investigations, institutional site investigations, and pervious area assessments. The County also identified multiple potential stormwater conversions within each subwatershed: 91 for the UBR subwatershed and three for the TBR subwatershed. Detailed information on site locations can be found in the SWAPs.

The following potential stream restoration sties were identified within the Back River watershed in **Table 4-12**. An additional six sites were also identified in the UBR subwatershed for SWM retrofit on County-owned property.

Table 4-12: Potential Stream Restoration Sites in Back River Watershed				
Subwatershed	**Reach**	**Number of Sites**	**Total Linear Feet**	**Conditions**
UBR	Herring Run	24	12,675	-
UBR	Stemmers Run	30	23,488	-
UBR	Brien’s Run	10	8,603	-
TBR	Bread and Cheese Creek	4	2,600	Erosion, dumping, and inadequate buffers
TBR	Duck Creek	3	80	Severe dumping, inadequate buffers, and invasive vegetation
TBR	Muddy Gut	2	-	Severe dumping and disturbance (all-terrain vehicle [ATV] trails)
TBR	Deep Creek	4	1,315	Concrete channels, inadequate buffers, severe channel alterations, severe erosion (scouring), and severe fish barrier
Sources: BA-DEPRM (2008a); PB (2010)				

C.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet PCB reductions in the Back River watershed are shown in **Table 4-13**. Projected PCB reduction using these practices are shown in **Table 3-2**. Four timeframes are included in the BMP implementation tables below:

- BMPs built before the TMDL baseline. In this case, the baseline is 2001;
- BMPs built after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025,
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the PCB TMDL, MDOT SHA will meet 4.4 percent of the MDE 53.4 percent load reduction requirement through implementation of BMPs shown in **Table 4-13.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement practices within the Back River watershed to address the PCB TMDL total $2,157,000. These projected costs are based on an average cost per impervious acre treated that is derived from cost history for a group of completed projects for each BMP category. Please see **Table 4-14** for a BMP strategy breakdown.

Figure 4-9 shows a map of MDOT SHA's restoration practices in the watershed and includes those that are under design or constructed. Inlet cleaning is not reflected on this map.

Table 4-13: Back River Restoration PCB BMP Implementation

BMP	Unit	Baseline (Before 2001)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	117.5	7.0	14.7	TBD	139.2
Retrofit	drainage area acres		12.3		TBD	12.3
Inlet Cleaning[1]	dry tons		17.5		TBD	17.5
Street Sweeping[1]	acres swept		31.1		TBD	31.1
Load Reductions	PCB g/yr.		0.36	0.45	10.31	
				Total Projected Reduction	**10.31**	

[1] Inlet cleaning and street sweeping are annual practices.

Table 4-14: Back River Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$509,000	$1,118,000	$1,627,000
Retrofits	$399,000		$399,000
Inlet cleaning	$84,000		$84,000
Street Sweeping	$47,000		$47,000
Total			$2,157,000

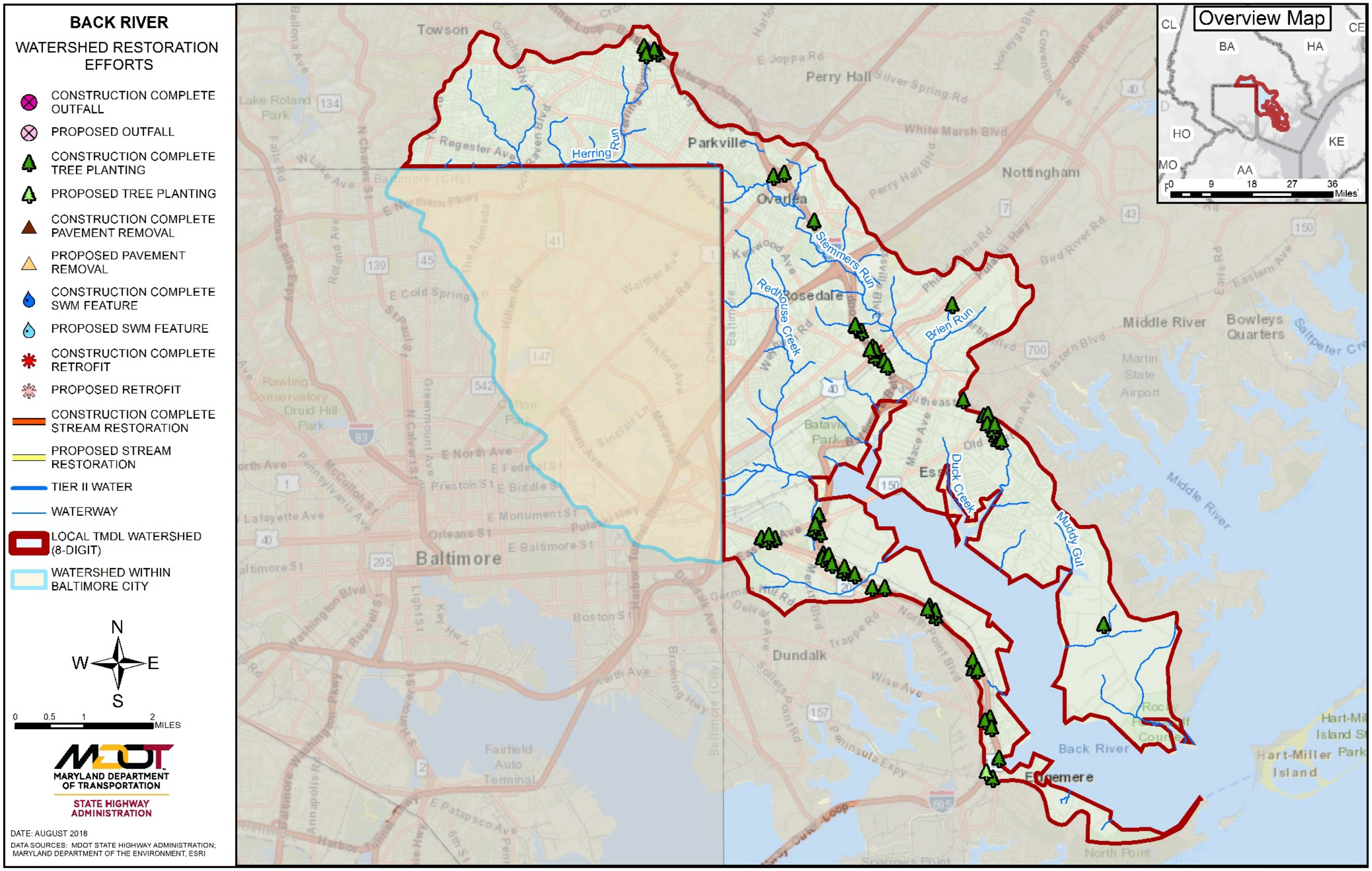


Figure 4-9: MDOT SHA Restoration Strategies within the Back River Watershed

D. BALTIMORE HARBOR WATERSHED

D.1. Watershed Description

The Baltimore Harbor watershed encompasses 90 square miles within Anne Arundel County, Baltimore County, and Baltimore City. The watershed is located in the Western Shore region of Maryland south of the Back River watershed and ultimately drains into the Chesapeake Bay. Tributaries of the Baltimore Harbor watershed include Gwynns Falls, Jones Falls, Bear Creek, and Curtis Bay/Creek. The areas of focus for the TMDLs in this watershed are within the subwatersheds of Baltimore Harbor Embayment, Bear Creek, Curtis Creek, Furnace Creek, and Marley Creek in Baltimore and Anne Arundel counties.

There are 1,258 miles of MDOT SHA roadway located within the Baltimore Harbor watershed. The associated ROW encompasses 2,374 acres, of which 1,031 acres are impervious. MDOT SHA facilities located within the watershed consist of two (2) salt storage facilities, one (1) highway garage or shop, one (1) highway office or lab, and one (1) weigh station located outside of the MDOT SHA MS4 Permit coverage area. See **Figure 4-10** for a map of the 8-digit Baltimore Harbor watershed with MDOT SHA facilities indicated.

D.2. MDOT SHA TMDLs within Baltimore Harbor Watershed

MDOT SHA is included in both PCBs (MDE, 2012b) and bacteria (MDE, 2011b) TMDLs. PCBs are to be reduced by 91.1% in the Baltimore Harbor Embayment, Anne Arundel County, 91.4 percent in the Baltimore Harbor Embayment, Baltimore County, 93.5 percent in the Curtis Creek subwatershed, and 91.5 percent in the Bear Creek subwatershed as shown in **Table 3-2**. Bacteria must be reduced by 75.8 percent in the Marley Creek subwatershed and 77.8 percent in the Furnace Creek subwatershed as shown in **Table 3-3**.

D.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Baltimore Harbor watershed is shown in **Figure 4-11** which illustrates that 42 grid cells have been reviewed, encompassing portions of 30 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 236 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 26 new structural SW controls constructed or under contract.
- 79 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 131 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 158 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 69 sites constructed or under contract.
- Three (3) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 86 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified five (5) sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Five (5) sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 114 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 37 new structural SW controls constructed or under contract.
- Three (3) additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 74 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 163 outfalls potential for stabilization. Further analysis of these sites resulted in:

- Six (6) outfall sites deemed potentially viable for outfall stabilization efforts and pending further analysis, may be candidates for future restoration opportunities.
- 157 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 26 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of three (3) existing structural SW controls constructed or under contract.
- One (1) retrofit site deemed potentially viable for retrofit and pending further analysis may be a candidate for future restoration opportunities.
- 22 retrofit sites deemed not viable for retrofit and have been removed from consideration.

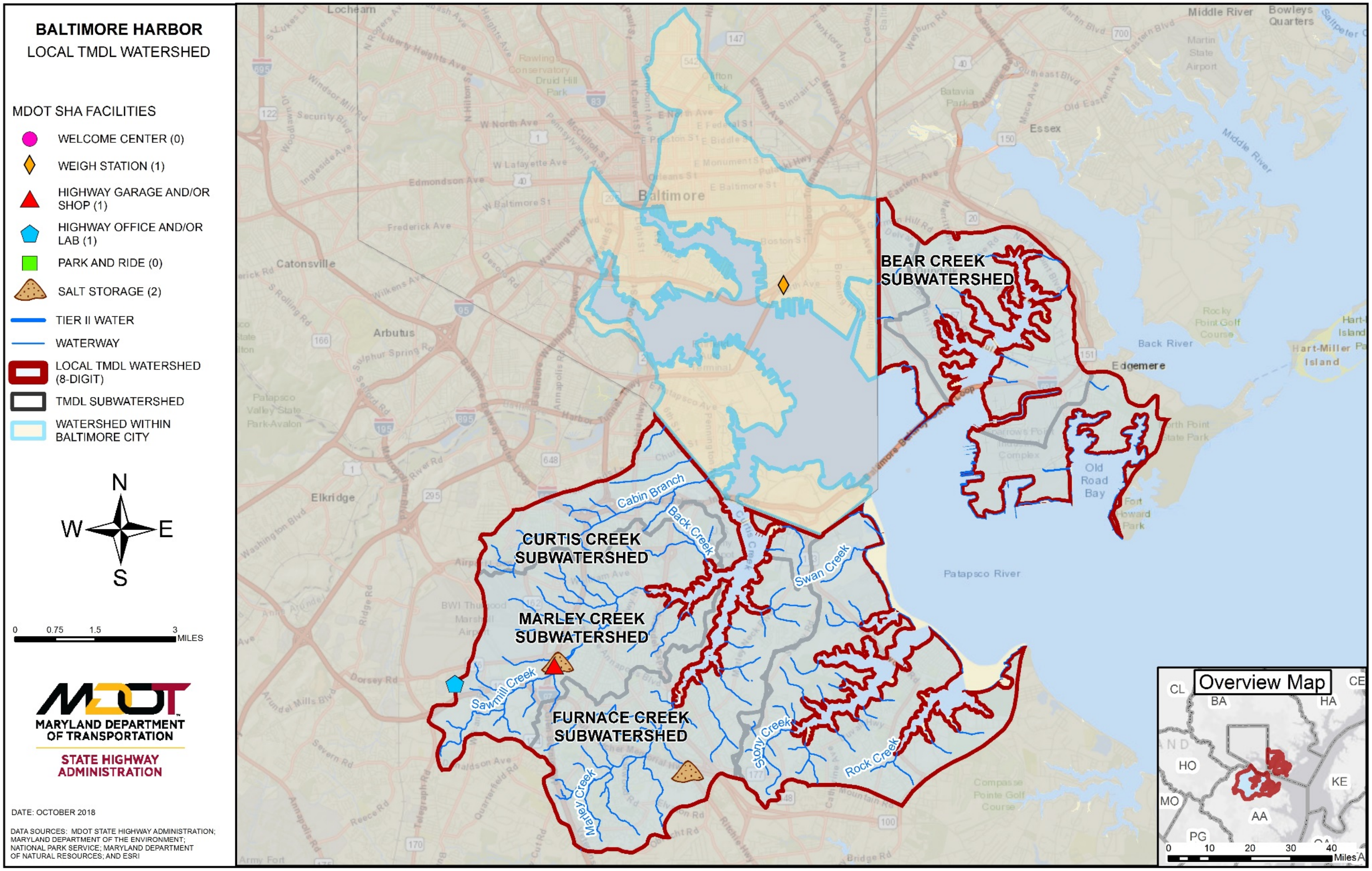


Figure 4-10: Baltimore Harbor Watershed

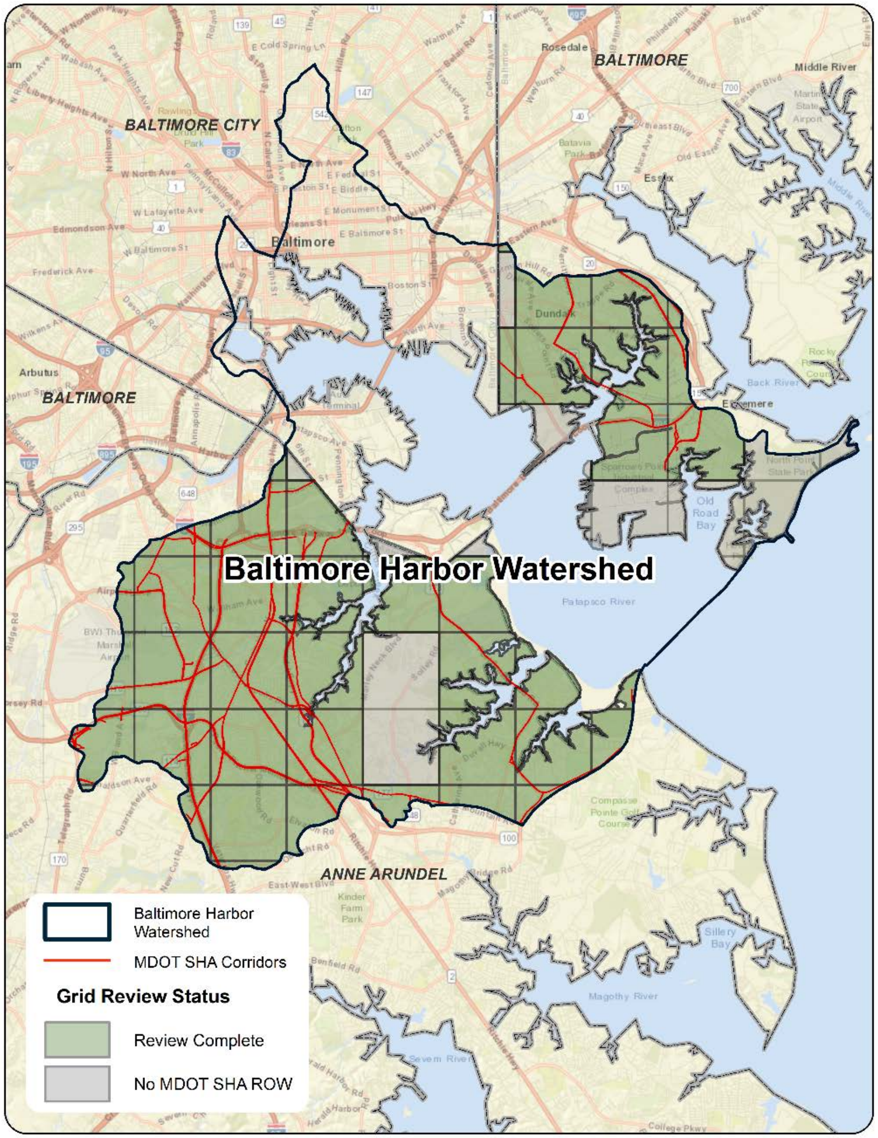


Figure 4-11: Baltimore Harbor Site Search Grids

D.4. Summary of County Assessment Review

Waters within the Baltimore Harbor watershed are subject to the following impairments as noted on MDE's 303(d) List.

- Chlordane;
- Chlorides;
- Chromium;
- Copper;
- Cyanide;
- Debris/Floatables/Trash;
- Enterococcus;
- Lead (sediments);
- Nitrogen;
- PCB in Fish Tissue;
- PCBs – Sediment and Fish Tissue;
- Phosphorus (Total);
- Sulfates;
- TSS; and
- Zinc (sediments).

In 2012, the Baltimore County Department of Environmental Protection and Sustainability published the *Bear Creek/Old Road Bay Small Watershed Action Plan* (PB, 2012). Within the Bear Creek subwatershed, Sparrows Point and the area immediately surrounding Colgate Creek and Peach Orchard Cove received a "very high" prioritization ranking for restoration. Out of these three areas, Sparrows Point ranked first in need of prioritization because it is almost entirely comprised of industrial land uses and because the EPA and MDE has documented contamination issues there. Colgate Creek and Peach Orchard Cove areas were ranked second and third, respectively, in terms of priority for restoration in part because both areas include environmental justice areas of concern (PB, 2012). In this SWAP, the County discusses and provides maps of all restoration opportunities in the Bear Creek subwatershed that are most likely to limit pollution sources and help implement pollution reduction. The types of restoration opportunities identified include downspout redirect, tree planting, street sweeping, parking lot/alley retrofits, and bayscaping (PB, 2012).

Anne Arundel County's Department of Public Works participated in a collaborative effort to prepare the *Patapsco Tidal and Bodkin Creek Watershed Assessment* (LimnoTech & Versar, 2012). The assessment determines the condition and prioritizes watershed management activities for areas within the Baltimore Harbor watershed. Bodkin Creek watershed is also included in the County's assessment, but is not part of the Baltimore Harbor 8-digit watershed area.

The majority of soils within the Patapsco Tidal subwatersheds are highly erodible (58 percent). Residential land cover dominates the Patapsco Tidal watershed (40 percent), attributing to 30 percent impervious area over the entire watershed.

Both Patapsco Tidal and Bodkin Creek watersheds fall within the Patapsco River Mesohaline segmentshed which has Chesapeake Bay TMDLs for phosphorus, nitrogen, and TSS and a Baltimore Harbor (Anne Arundel, Baltimore, Carroll, and Howard Counties and Baltimore City) TMDL for nitrogen and phosphorus. The Patapsco River Mesohaline segmentshed also has a Category Five impairment listing (i.e., TMDL required) for *Enterococcus* in tidal waters upstream of the Harbor Tunnel. Approximately 16 percent of the streams evaluated in the Patapsco Tidal watershed were classified as "severely degraded" by the Maryland Physical Habitat Index. Three subwatersheds were identified to have the highest percentages of stream reaches that were either "degraded" or "severely degraded": Cabin Branch 2, Marley Creek 1, and Cabin Branch.

The County identified five subwatersheds within the Patapsco Tidal watershed with more than one-third of their perennial streams rated as "high" or "medium high" for restoration need: Cabin Branch (PT3), Cabin Branch 2 (PT2), Marley Creek 1 (PT8), Marley Creek 3 (PTF), and Sawmill Creek 1 (PT7). Six subwatersheds were identified in Patapsco Tidal for BMP implementation: Marley Creek 3 (PTF), Furnace Creek (PT5), Cabin Branch (PT3), Sawmill Creek 1 (PT7), Back Creek (PTC), and Marley Creek 2 (PTE).

The County suggests the following BMPs for the Patapsco Tidal and Bodkin Creek watersheds:

- Outfall retrofits – all major outfalls characterized by the IMD as impaired;
- Stormwater pond retrofits – all ponds constructed prior to 2002 with a drainage area greater than 10 acres;
- Stream restoration – targeting degraded and severely degraded reaches;
- Street Sweeping – all closed curbed County roads;
- Inlet cleaning – vacuum cleaning stormwater curb inlets and catch basins;
- Public land reforestation; and
- ESD retrofit to the MEP – including green roofs, permeable pavement, bioretention, etc.

The County ranked several stream reaches based on priority for restoration as shown in **Table 4-15**, with the value one being the highest priority:

Table 4-15: Anne Arundel County Identified Priority Areas for Treatment

Priority	Watershed	Subwatershed	Reach
1	Patapsco Tidal	Marley Creek 3	PTF016
3	Patapsco Tidal	Rock Creek	PTB048
4	Patapsco Tidal	Cabin Branch 2	PT2026
4	Patapsco Tidal	Cabin Branch	PT3039
10	Patapsco Tidal	Marley Creek 4	PTG086
10	Patapsco Tidal	Cabin Branch	PT3010

Source: LimnoTech & Versar (2012), Map 4.1

D.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet PCB reduction in the Baltimore Harbor Embayment, Bear Creek, and Curtis Creek/Bay subwatersheds are shown in **Tables 4-16**, **4-17**, and **4-18**, respectively. Proposed practices to meet bacteria reduction in the Furnace Creek and Marley Creek subwatersheds are shown in **Table 4-19** and **Table 4-20.** Projected reductions are shown in **Table 3-2**. Four timeframes are included in the tables:

- BMPs implemented before the baseline year. In this case, the PCB baseline is 2004 and the bacteria baseline is 2006;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Baltimore Harbor watershed total $12,399,000. They are based on average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-21** for a summary of estimated BMP costs.

Figure 4-12 shows a map of MDOT SHA's restoration practices in the watersheds and includes those that are under design or construction. Inlet cleaning is not reflected on this map.

Table 4-16: Baltimore Harbor Embayment Restoration PCB BMP Implementation

BMP	Unit	Baseline (Before 2004)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	6.1			TBD	6.1
Inlet Cleaning[1]	dry tons		1.2	70.0	TBD	71.2
Street Sweeping[1]	acres swept		4.4		TBD	4.4
Load Reductions	PCB g/yr.		1.36	1.36	5.65	
				Total Projected Reduction	**5.65**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-17: Bear Creek Restoration PCB BMP Implementation

BMP	Unit	Baseline (Before 2004)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	10.1			TBD	10.1
Inlet Cleaning[1]	dry tons		4.6	26.8	TBD	31.4
Street Sweeping[1]	acres swept		11.0		TBD	11.0
Load Reductions	PCB g/yr.		0.64	0.64	5.79	
				Total Projected Reduction	**5.79**	

[1] Inlet cleaning and street sweeping are annual practices.

Table 4-18: Curtis Creek/Bay Restoration PCB BMP Implementation

BMP	Unit	Baseline (Before 2004)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	1,299.7	32.2		TBD	1,331.9
Retrofits	drainage area acres		191.2		TBD	191.2
Inlet Cleaning[1]	dry tons		5.3	1.3	TBD	6.6
Load Reductions	PCB g/yr.		1.39	1.39	29.26	
				Total Projected Reduction	**29.26**	

[1] Inlet cleaning is an annual practice.

Table 4-19: Baltimore Harbor – Furnace Creek Restoration Bacteria BMP Implementation

BMP	Unit	Baseline (Before 2004)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	453.0	1.0	6.9	TBD	460.9
Retrofits	drainage area acres		46.4		TBD	46.4
Load Reductions	Enterrococci Billion counts/ day		1,300	1,300	3226,525	
				Total Projected Reduction	**26,525**	

Table 4-20: Baltimore Harbor – Marley Creek Restoration Bacteria BMP Implementation						
BMP	**Unit**	**Baseline (Before 2006)**	**Restoration BMPs**			**Total BMPs**
			2020	**2025**	**Future**	
New Stormwater	drainage area acres	562.0	1.6		TBD	563.6
Retrofits	drainage area acres		109.3		TBD	109.3
Load Reductions	Enterrococci Billion counts/ day		3,050	3,050	15,678	
				Total Projected Reduction	**15,678**	

Table 4-21: Baltimore Harbor Restoration BMP Cost			
BMP	**2020**	**2025**	**Total**
New Stormwater	$3,815,000		$3,815,000
Retrofits	$7,944,000		$7,944,000
Inlet cleaning	$56,000	$560,000	$616,000
Street Sweeping	$24,000		$24,000
Total			$12,399,000

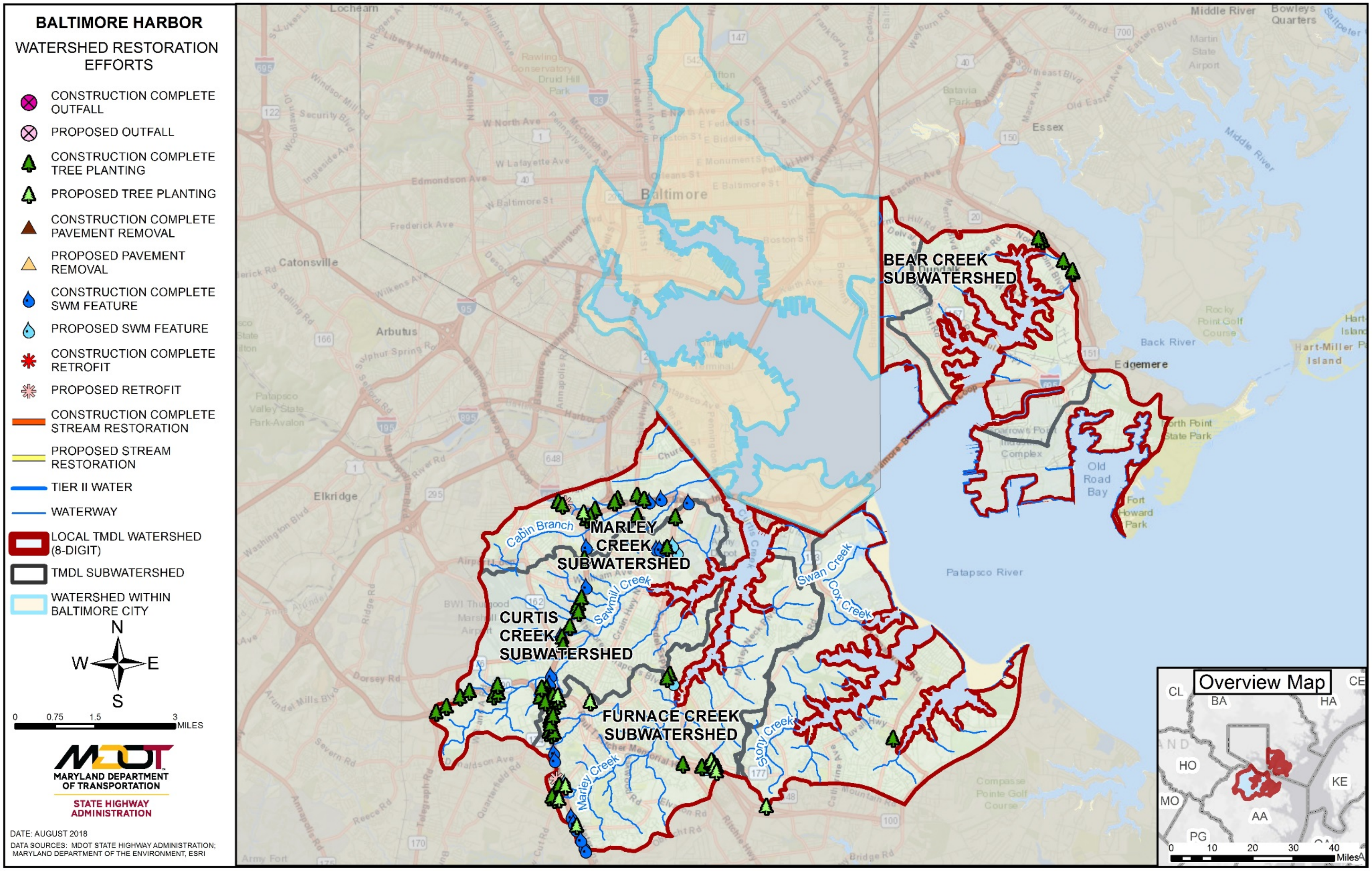


Figure 4-12: MDOT SHA Restoration Strategies within the Baltimore Harbor Watershed

E. BUSH RIVER SEGMENTSHED IMPLEMENTATION PLAN

E.1. Segmentshed Description

Areas draining to the Bush River Oligohaline Segment will be referred to as the Bush River segmentshed. The Bush River Oligohaline Segment will be hereinafter referred to as the Bush River. The Bush River is an estuary that extends south from the community of Riverside for approximately nine miles to the Chesapeake Bay. Three 8-digit watersheds compose the Bush River segmentshed: Winters Run watershed (the Atkisson Reservoir watershed and the Lower Winters Run watershed are collectively known as the Winters Run watershed), Bynum Run watershed, and Bush River watershed (excludes the Romney Creek drainage area). The Bush River segmentshed is located entirely within Harford County, Maryland and encompasses approximately 130 square miles. Tributaries of the Bush River segmentshed include Winters Run, Bynum Run, Broad Run, James Run, Grays Run, and Cranberry Run.

There are 228 centerline miles of MDOT SHA roadway located within the Bush River segmentshed. The associated ROW encompasses 1,843 acres, of which 796 are impervious. MDOT SHA facilities located within the Bush River segmentshed consist of one (1) welcome center, two (2) salt storage facilities and eight (8) park and ride facilities. See **Figure 4-13** for a map of MDOT SHA facilities with the Bush River segmentshed.

E.2. MDOT SHA TMDLs within Bush River Segmentshed

MDOT SHA is included in the PCB TMDL (MDE, 2016d) with a reduction requirement of 62 percent, as shown in **Table 3-2**.

E.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan, Section C** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Bush River watershed is shown in **Figure 4-14** which illustrates that 65 grid cells have been reviewed, encompassing portions of nine (9) state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 343 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- Five (5) new structural SW controls constructed or under contract.
- 46 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 292 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 25 locations as potential tree planting locations. Further analysis of these locations resulted in:

- Seven (7) sites constructed or under contract.

- Four (4) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 14 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified one (1) site as a potential stream restoration location. Further analysis of this location resulted in:

- One (1) site deemed not viable for stream restoration and has been removed from consideration.

Grass Swale Rehabilitation

No grass swale rehabilitation sites were identified within this watershed for potential restoration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified six (6) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Six (6) retrofit sites deemed not viable for retrofit and have been removed from consideration.

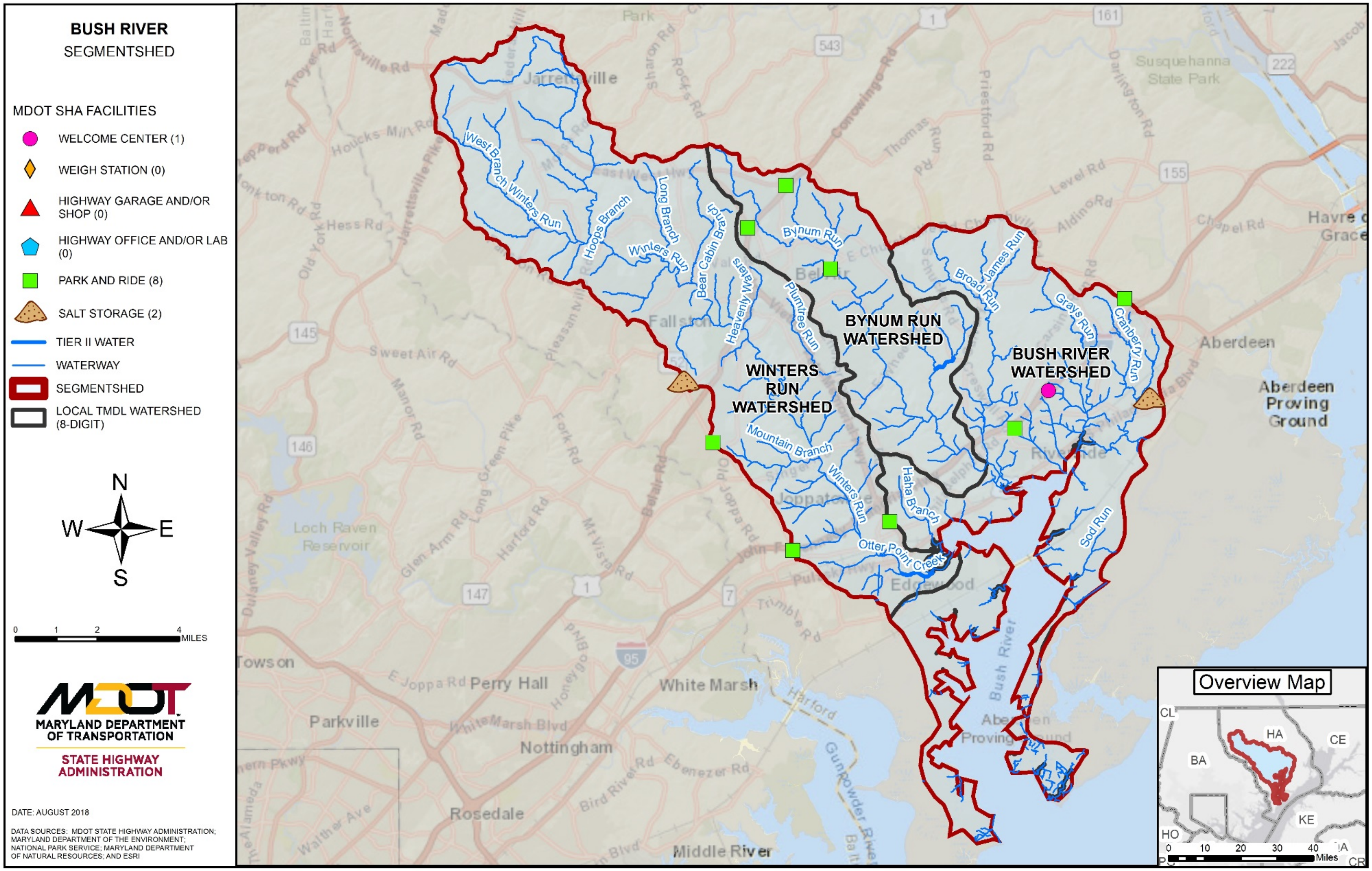


Figure 4-13: Bush River Segmentshed

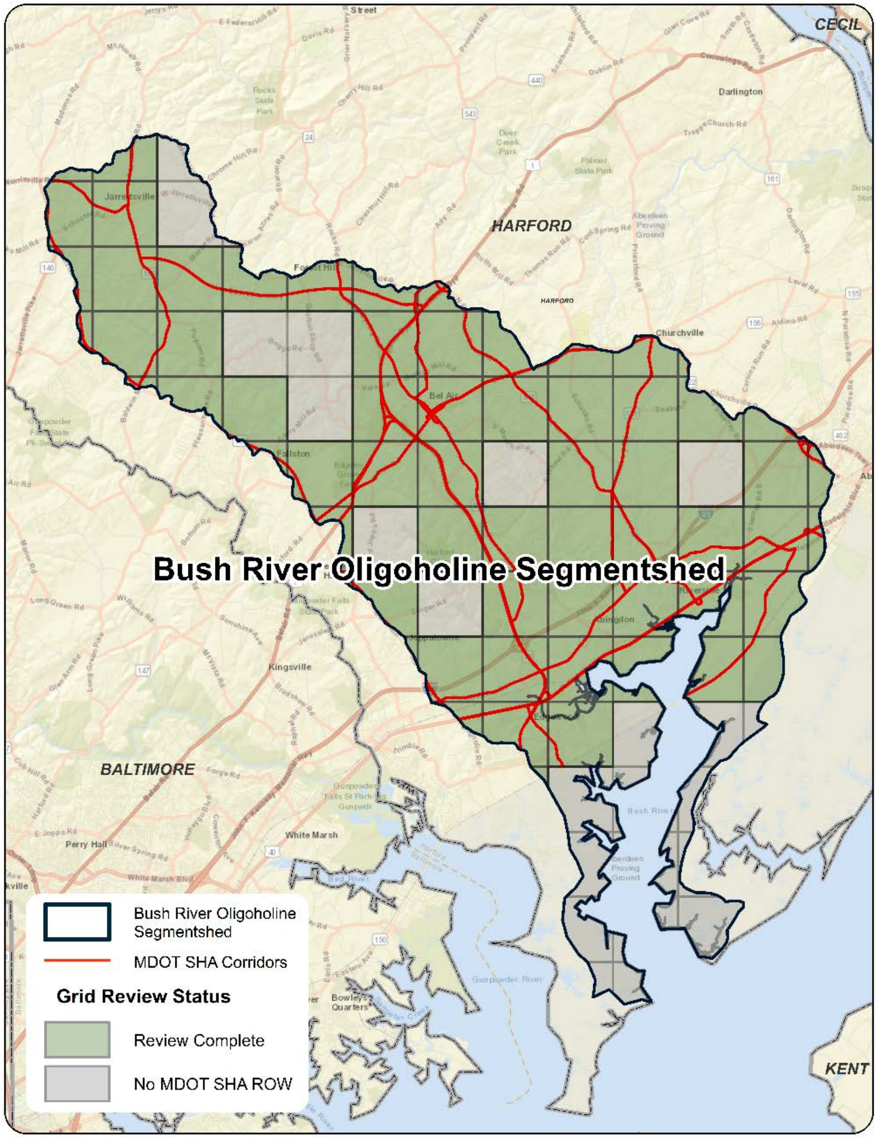


Figure 4-14: Bush River Segmentshed Site Search Grids

E.4. Summary of County Assessment Review

The designated use of the waters of the Bush River (8-digit Basin Code: 02130701) is Use II – Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting (MDE, 2016d). Waters within the Bush River segmentshed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- Nitrogen (Total);
- PCB in Fish Tissue;
- Phosphorus (Total);
- Sulfates; and
- TSS.

Prepared by the Center for Watershed Protection (CWP) for the Harford County Department of Public Works, the 2003 *Bush River Watershed Management Plan* (WAMP) (hereinafter referred to as the "Bush River WAMP") serves as Harford County's overall assessment of the Bush River segmentshed (CWP, 2003). While the Bush River WAMP contained analysis on all three 8-digit watersheds (Winters Run, Bynum Run, and Bush River) within the Bush River segmentshed, the study area did not extend along the Bush River to the Chesapeake Bay. More recently, Harford County published the *Bush River Watershed Total Maximum Daily Load (TMDL) Restoration Plan for PCBs* (HA-DPW, 2017)—hereinafter the "Bush River PCBs Restoration Plan"—in response to the 2016 Bush River Oligohaline Segment PCBs TMDL (MDE, 2016d). The following is a summary of both documents, beginning with the Bush River WAMP.

The Bush River WAMP was developed using a watershed "vulnerability analysis," a tool that is often used when assessing large watersheds. The vulnerability analysis is designed to identify subwatersheds that are most vulnerable to current and future land development and management problems. Accordingly, the CWP worked with Harford County staff to delineate the study area into 19 subwatersheds for analysis and assessment. The delineations generally aligned with distinct land uses within the study area. This method was particularly helpful because the area serves a wide range of diverse land uses such as urban, agriculture, forest, and wetlands. The complexity of the Bush River segmentshed is further evidenced by its location within two Maryland physiographic regions (Piedmont Plateau and Coastal Plain), its inclusion of both tidal and non-tidal waters, and its susceptibility to development pressures. Overall, the Bush River segmentshed impairments generally involve excess nutrients, poor habitat quality, and channel instability.

Regarding the impact of development, the Bush River WAMP emphasized the impact of increased development and urbanization on the area, noting that a significant portion is within the "development envelope." The "development envelope" refers to Harford County's highly developed residential and industrial area that follows the Route 40/I-95 corridor and extends northward to include the Route 24/Bel Air corridor. According to the Bush River WAMP, an increase in development will exacerbate current problems such as the delivery of large amounts of sediment, nutrients, and bacteria from the Winters Run and Bynum Run tributaries to Bush River. Because urbanization and development is expected to increase, a main goal of the Bush River WAMP is to identify which subwatersheds should be evaluated for protection against future development.

Of the 19 subwatersheds within the Bush River WAMP study area, nine are in the Winters Run watershed (West Branch, East Branch, Bear Cabin, Upper Winters Direct Drainage [DD], Middle Winters DD, Lower Winters DD, Mountain Branch, Plumtree Run, Otter Point DD), four are in the Bynum Run watershed (Upper Bynum, Middle Bynum, Lower Bynum, Little East Bynum), and six are in the Bush River watershed (James Run, Grays Run, Cranberry Run, Church Creek DD, Bush Creek DD, Haha Branch).

The existing data, impervious cover calculations, and several field verifications (evaluations of stream habitat, contiguous forest, and wetlands) determined that there are four different subwatershed types (also known as subwatershed "management categories") within the Bush River segmentshed: 1) Sensitive, 2) Impacted, 3) Rurally Impacted, and 4) Impacted Special Resource. The Bush River WAMP provided the following definitions for these four subwatershed types/management categories (CWP, 2003):

- **<u>Sensitive</u>:** Subwatersheds that have an impervious cover of 0 to 10 percent. Streams in these subwatersheds are of high quality (i.e., stable channels, excellent habitat structure, good to excellent water quality, diverse communities of aquatic species). The primary goal for these subwatersheds is to maintain predevelopment stream biodiversity and channel stability.

- **<u>Impacted</u>:** Subwatersheds that have an impervious cover ranging from 11 to 25 percent and show obvious signs of degradation due to watershed urbanization. Greater storm flows have started to alter stream geometry and both erosion and channel widening are readily apparent. Stream banks are unstable and there is noticeably less physical habitat and biodiversity in the streams.

- **<u>Rurally Impacted</u>:** Subwatersheds that have an impervious cover of 0 to 10 percent, but may have a degraded riparian zone and isolated stream bank erosion due to livestock access and grazing/cropping practices. The streams, however, tend to recover once the riparian management improves.

- **<u>Impacted Special Resource</u>:** Subwatersheds that have an impervious cover ranging from 11 to 25 percent, but also have notable natural resource areas such as tidal waters, contiguous forest, and high quality wetlands. The primary goal for these subwatersheds is to maintain the present status of these significant natural resource areas through conservation, restoration, and stormwater retrofits.

When these definitions were applied to the 19 subwatersheds, the three watersheds within the Bush River segmentshed contained the following subwatershed types/management categories:

The Winters Run watershed had:

- 4 Sensitive subwatersheds (East Branch, Bear Cabin, Upper Winters DD, Mountain Branch);
- 3 Impacted subwatersheds (Middle Winters DD, Lower Winters DD, Plumtree Run);
- 1 Rurally Impacted subwatershed (West Branch); and
- 1 Impacted Special Resource subwatershed (Otter Point DD).

The Bynum Run watershed had:

- 3 Impacted subwatersheds (Upper Bynum, Middle Bynum, Lower Bynum); and
- 1 Rurally Impacted subwatershed (Little East Bynum).

The Bush River watershed had:

- 2 Sensitive subwatersheds (Grays Run, James Run);
- 1 Impacted subwatershed (Cranberry Run); and
- 3 Impacted Special Resource subwatersheds (Church Creek DD, Bush Creek DD, Haha Branch).

After all types/management categories were determined, the subwatersheds were prioritized. Priority was given to the most vulnerable subwatersheds so that Harford County can concentrate its resources on the subwatersheds that need immediate restoration and/or preservation actions. Out of the 19 subwatersheds, 10 priority subwatersheds were identified by the County: Grays Run, Little East Bynum, West Branch, Middle Bynum, Lower Bynum, Plumtree Run, Otter Point DD, Church Creek DD, Bush Creek DD, and Haha Branch (See **Table 4-22**). **Table 4-23** presents County-suggested BMPs for the entire Bush River segmentshed.

Table 4-22: County Identified Priority Areas for Treatment in the Bush River Segmentshed

Subwatershed Management Category	Priority Subwatershed	Watershed (within the Bush River Segmentshed)
Sensitive	Grays Run	Bush River
Impacted	Middle Bynum	Bynum Run
	Lower Bynum	Bynum Run
	Plumtree Run	Winters Run
Rurally Impacted	West Branch	Winters Run
	Little East Bynum	Bynum Run
Impacted Special Resource	Otter Point DD	Winters Run
	Bush Creek DD	Bush River
	Church Creek DD	Bush River
	Haha Branch	Bush River

Source: CWP (2003)

Table 4-23: County Suggested BMPs for the Bush River Segmentshed

Subwatershed Management Category	Recommendation
Sensitive	Preserve Contiguous Forests in all Sensitive Subwatersheds
Sensitive	Enhance Existing Riparian Buffer in all Sensitive Subwatersheds
Sensitive	Grays Run Contiguous Forest Preservation
Sensitive	Grays Run Stream Buffer Enhancement
Sensitive	Maintain Grays Run Sensitive Status
Sensitive	Field Verify and Prioritize Contiguous Forest Areas for Preservation
Impacted	Educate Residents on Watershed Stewardship in Impacted Subwatersheds
Impacted	Implement Stormwater Retrofits in Impacted Subwatersheds
Impacted	Conduct Stream Clean-ups in Lower and Middle Bynum
Impacted	Preserve Contiguous Forest in Lower Winters DD and Cranberry Run
Impacted	Investigate Other Stormwater Retrofit Opportunities in Impacted Subwatersheds
Rurally Impacted	Preserve Farmlands in Rurally Impacted Subwatersheds
Rurally Impacted	Restore Riparian Buffer in Rurally Impacted Subwatersheds
Rurally Impacted	Reduce Livestock Access in Little East Bynum
Rurally Impacted	Agricultural Practices Assessment in Rurally Impacted Subwatersheds
Rurally Impacted	Septic System Education in Rurally Impacted Subwatersheds
Impacted Special Resource	Preserve Large Wetland Tracts in Impacted Special Resource Subwatersheds
Impacted Special Resource	Implement Stormwater Retrofits in Impacted Special Resource Subwatersheds
Impacted Special Resource	Streambank Stabilization in Haha and Otter Point Subwatersheds
Impacted Special Resource	Develop a Heightened Plan Review in Impacted Special Resource Subwatersheds
Watershed-Wide	Establish an Implementation Committee
Watershed-Wide	Foster the Development of Bush River Watershed Association
Watershed-Wide	Create Watershed Stewardship Website
Watershed-Wide	Implement Recommendations of Harford County Site Planning Roundtable
Watershed-Wide	Establish an Adopt-a-Pond Program
Watershed-Wide	Improve ESC Implementation, Inspection, and Enforcement

Source: CWP (2003) (Recommendations reprinted from Table E1 in CWP (2003)

In 2017, Harford County took a closer look at the Bush River watershed with regard to PCBs in the Bush River PCBs Restoration Plan (HA-DCW, 2017). In this document, the County proposes to target TSS reductions as a surrogate to reducing PCBs directly since reduction of sediments has been shown to result in reduction of PCBs. For this effort, Harford County will focus on the Bynum Run watershed as it is the most urbanized watershed draining to Bush River (HA-DCW, 2017).

E.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet the PCB reduction in the Bush River segmentshed are shown in **Table 4-24**. Projected PCB reductions using these practices are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs built before the TMDL baseline. In this case, the baseline is 2010;
- BMPs built after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025,
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the PCB TMDL, MDOT SHA will meet 5.6 percent of the MDE 62.0 percent load reduction requirement through implementation of BMPs shown in **Table 4-24**. MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in Part III Section E.

Estimated Capital Budget costs to design and construct practices within the Bush River segmentshed total $ 5,346,000. These projected costs are based on an average cost per impervious acre treated that is derived from cost history for a group of completed projects for each BMP category. Please see **Table 4-25** for a BMP strategy cost breakdown.

Figure 4-15 shows a map of MDOT SHA’s restoration practices in the segmentshed and includes those that are under design or construction. Inlet cleaning is not reflected on this map.

Table 4-24: Bush River Segmentshed Restoration PCB BMP Implementation						
BMP	Unit	Baseline (Before 2010)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	564.0	41.6	16.6	TBD	622.2
Retrofit	drainage area acres		27.7		TBD	27.7
Inlet Cleaning[1]	dry tons		100.2	7.0	TBD	107.2
Load Reductions	PCB g/yr.		0.34	0.39	6.85	
				Total Projected Reduction	**6.85**	

[1] Inlet cleaning is an annual practice.

Table 4-25: Bush River Segmentshed Restoration BMP Cost			
BMP	2020	2025	Total
New Stormwater	$3,756,000	$395,000	$4,151,000
Retrofits	$605,000		$605,000
Inlet cleaning	$550,000	$40,000	$590,000
Total			$5,346,000

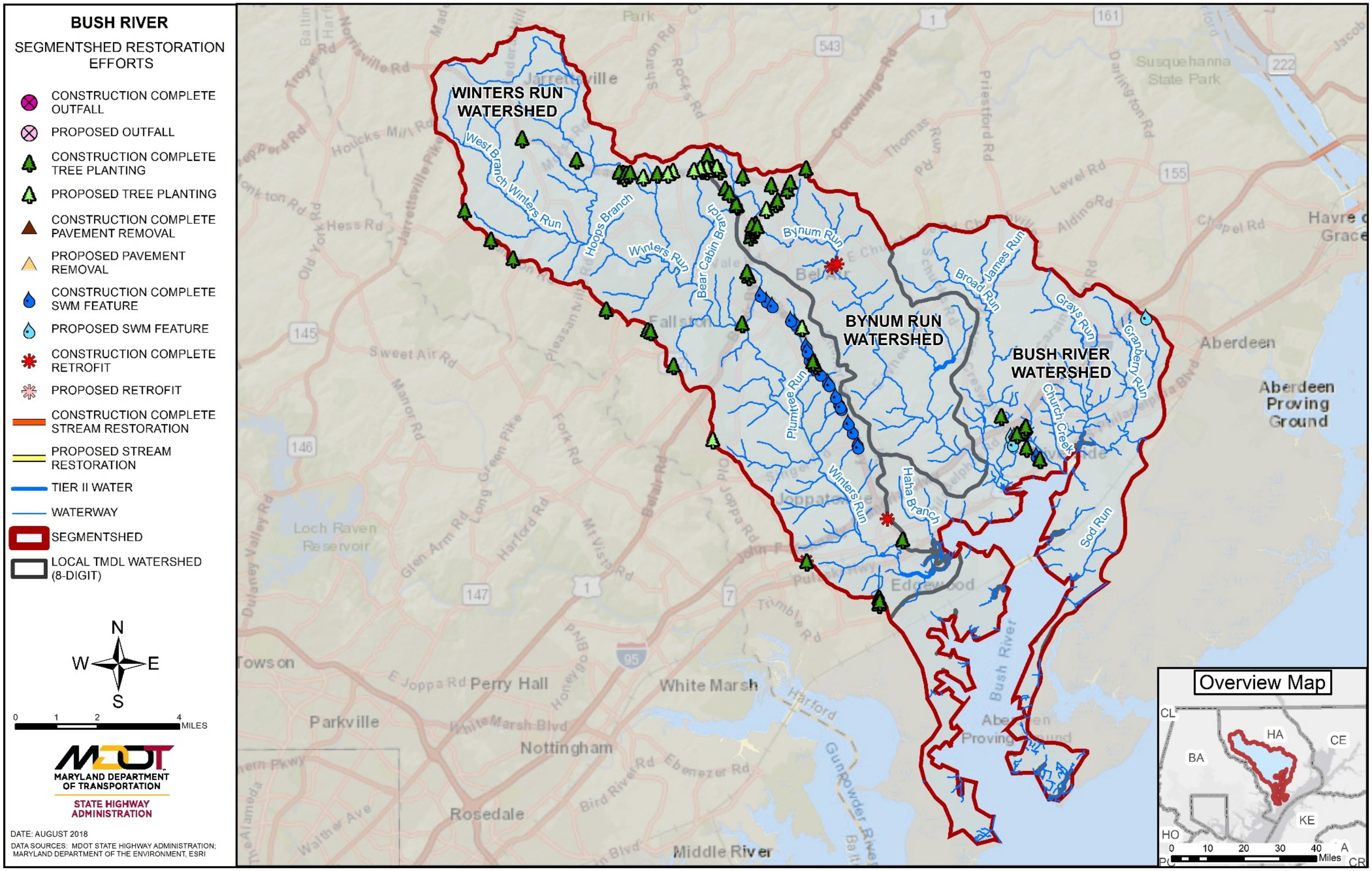


Figure 4-15: MDOT SHA Restoration Strategies within the Bush River Segmentshed

F. BYNUM RUN WATERSHED

F.1. Watershed Description

The Bynum Run watershed encompasses 23 square miles solely within Harford County, Maryland. Bynum Run is a stream that originates in the town of Forest Hill and flows 14 miles in a southeasterly direction until it empties into the tidally influenced Bush River. The Bush River ultimately flows into the Chesapeake Bay.

There are 220.2 miles of MDOT SHA roadway located within the Bynum Run watershed. The associated ROW encompasses 473.8 acres, of which 211.9 acres are impervious. MDOT SHA facilities located within the watershed consist of three (3) park and ride facilities. See **Figure 4-16** for a map of the watershed.

F.2. MDOT SHA TMDLs within Bynum Run Watershed

MDOT SHA is included in the sediment (TSS) TMDL (MDE, 2011c) with a reduction requirement of 19.3 percent as shown in **Table 3-2**.

F.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Bynum Run watershed is shown in **Figure 4-17** which illustrates that 21 grid cells have been reviewed, encompassing portions of nine (9) state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 145 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 58 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 87 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 60 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 26 sites constructed or under contract.
- Eight (8) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 26 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 10 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- 10 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified nine (9) sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Nine (9) sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

- No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 10 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of two (2) existing structural SW controls constructed or under contract.
- Five (5) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- Three (3) retrofit sites deemed not viable for retrofit and have been removed from consideration.

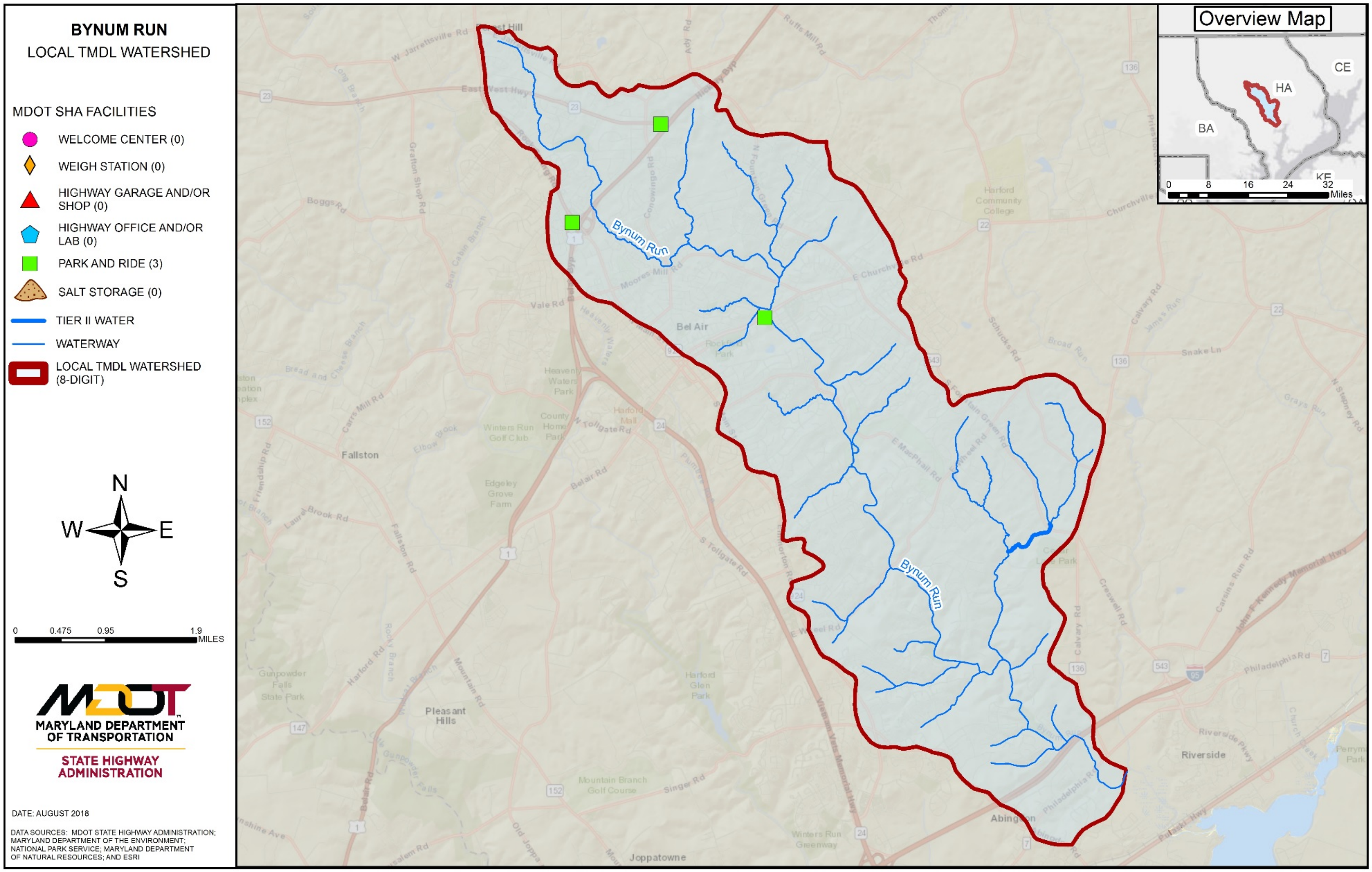


Figure 4-16: Bynum Run Watershed

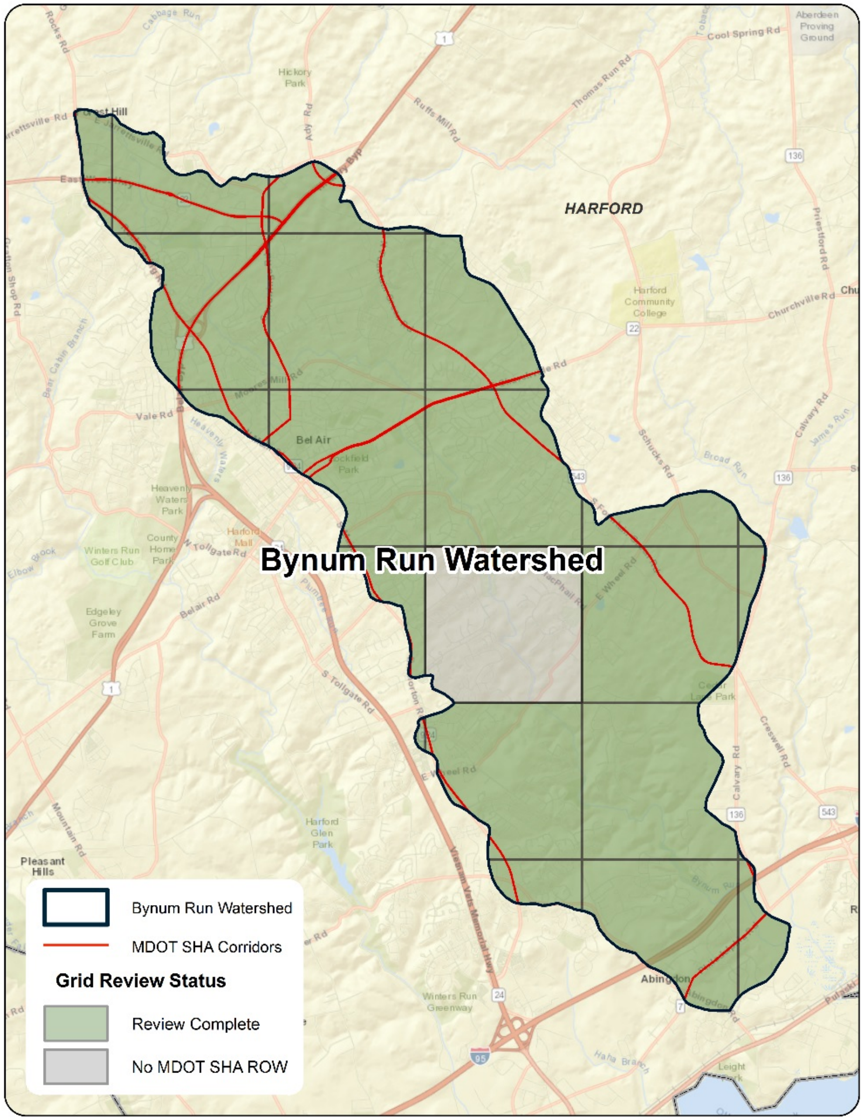


Figure 4-17: Bynum Run Site Search Grids

F.4. Summary of County Assessment Review

The waters within the Bynum Run watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Temperature, water; and
- TSS.

Overall, the Bynum Run watershed was studied and included in the 2003 Bush River WAMP (CWP, 2003); the Bush River WAMP was previously summarized herein in the above Bush River Oligohaline Segmentshed Plan. After the Bush River WAMP was published, the County responded to the 2011 Bynum Run Sediment TMDL (MDE, 2011c) with the 2016 *Bynum Run Watershed Total Maximum Daily Load Restoration Plan for Sediment* (URS, 2016), hereinafter the "Bynum Run Sediment Restoration Plan."

The Bynum Run watershed is the most urban watershed in Harford County, containing approximately 50% of the Town of Bel Air and 21% impervious surface (URS, 2016). Harford County considered proposed structural BMP projects identified on County-owned properties as "high priority." The Bynum Run Sediment Restoration Plan provides descriptions and locations of the proposed high priority projects. In addition to structural BMPs, alternative urban BMPs such as urban tree planting are also considered high priority (URS, 2016). Approximately 14 acres of open area are available for urban tree planting; locations of the Harford County properties within the watershed that are available for tree planting are included in Appendix A of the Bynum Run Sediment Restoration Plan (URS, 2016).

The Harford County Department of Public Works has also prepared the *Declaration Run and Riverside Watersheds Small Watershed Action Plan* (URS, 2014a) Declaration Run is within the Bynum Run watershed, and Riverside watershed is outside the Bynum Run watershed. The County has suggested implementing the following means to achieve watershed improvements using structural BMPs:

- Stream Restoration;
- Structural Projects;
- Wetland;
- Bioretention;
- Bioswale;
- Step pool conveyance system;
- Micropool;
- Green roofs;
- Green street bump out;
- Tree box filters; and
- Upgrade infiltration basin.

Nonstructural BMPs include:

- Public education and outreach;
- Preserving existing forested areas, especially stream buffers;
- Tree planting;
- Downspout disconnection;
- Reduction of impervious surfaces; and
- Curbcuts to direct stormwater runoff to open areas.

Although field observations determined there were no stormwater hotspots within the Declaration Run subwatershed, the County suggested the following specific project sites for additional SWM. BMP implementation and retrofits shown in **Tables 4-26**, **4-27**, and **4-28**. These sites have been prioritized based on the following criteria:

- Property ownership;
- Access to project site;
- Drainage area;
- Contributing impervious area;
- Cost;
- Utility impacts; and
- Environmental impacts.

Table 4-26: Declaration Run Priority Restoration Stream Restoration Projects

Stream Reach ID	Proposed Project	Location	Project Priority
Declaration Run Reach 1	Remediate headcuts with riffle grade control structures or step pools	Upstream Baneberry	High
Tributary DR5	Correct minor headcut with grade control structures; Remediate slope failure at storm drain outfall	Downstream of Baneberry Drive and north of and between Arabis Court and Germander Drive	High
Declaration Run Reach 2	Outfall stabilization	Downstream of Baneberry Drive and west of Arabis Court and Foxglove Court	High
Tributary DR9 Reach 1 and 2	Stream bank stabilization; Remove failed instream SWM feature; Remediate headcuts; Remediate storm drain outfall	Downstream of Riverside Parkway and east of Church Creek Elementary School toward Church Creek Road; Downstream of Church Creek Elementary School and upstream of Church Creek Road	High

Source: URS (2014a)

Table 4-27: Declaration Run Priority Restoration Structural Projects

Project ID	Proposed Project	Location	Project Priority
D-ES-2	Wetland	End of Oreganum Court	High
D-ES-5	Bioretention	North end of Foxglove Court	Low
D-ES-6	Bioretention	Germander Drive	Medium
D-ES-7	Bioswale and Bioretention	Germander Drive and Church Creek Road	High
D-ES-8	Wetland and Step pool conveyance system	Baneberry Drive	High
D-ES-12	Micropool and Wetland	End of Marigold Lane	Medium
D-ES-15	Bioretention	Procedure Way	High
D-NS-3	Green roofs	Liriope Court	Low
D-NS-4	Green street bump out	Church Creek Road	Medium
D-NS-7	Step pool conveyance system	Foxglove Court	Low
D-NS-8	Bioretention	Dalmation Place	High
D-NS-9	Tree box filters	Golden Rod Court	Low
D-NS-12	Bioretention or Tree box filters	Church Creek Elementary School	High
D-NS-13	Green street bump out	Church Creek Road	High
D-SWM0110 (ES-1)	Upgrade infiltration basin	Church Creek Elementary School	High

Source: URS (2014a)

Table 4-28: Declaration Run Priority Restoration Non-Structural Projects

Project ID	Proposed Project	Location	Project Priority
D-NS-1	Downspout disconnection	Golden Rod Court Neighborhood	NA
D-NS-2	Impervious surface reduction	Wide residential driveways on Marigold Lane	NA
D-NS-5	Curb cuts in parking lots to direct stormwater runoff to open areas	Sedum Square, Horner Lane, Downs Square, Baylis Court	NA
D-NS-6	Curb cuts in parking lots to direct stormwater runoff to open areas	Magness Court, Hampton Hall Court, Talbots Square	NA

Source: URS (2014a)

F.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment reduction in the Bynum Run watershed are shown in **Table 4-29**. Projected sediment reduction using these practices is described in **Part III, Coordinated TMDL Implementation Plan** and is shown in **Table 3-2**. Three timeframes are included in the table below:

- BMPs built before the TMDL baseline. In this case, the baseline is 2005;
- BMPs built after the baseline through fiscal year 2018; and

- BMPs built after fiscal year 2018 through 2030, the projected target date. MDOT SHA will accomplish the projected reduction to be achieved as a percent of the baseline load presented in **Table 3-2**. The reduction is expected to meet MDE's 19.3% load reduction requirement.

Estimated Capital Budget costs to design and construct practices within the Bynum Run watershed total $ 1,862,000. These projected costs are based on an average cost per impervious acre treated that is derived from cost history for a group of completed projects for each BMP category. Please see **Table 4-30** for a BMP strategy cost breakdown.

Figure 4-18 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design or constructed. Inlet cleaning is not reflected on this map.

Table 4-29: Bynum Rum Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	123.7	0.7	4.6	N/A	129.0
Retrofit	drainage area acres		11.5		N/A	11.5
Tree Planting	acres of tree planting		25.1	0.8	N/A	25.9
Stream Restoration	linear feet			246.0	N/A	246.0
Outfall Stabilization	linear feet			307.5	N/A	307.5
Inlet Cleaning[1]	dry tons		30.2			30.2
Load Reductions	TSS EOS lbs/yr.		16,469	43,240	0	
				Total Projected Reduction	**43,240**	

[1] *Inlet cleaning is an annual practice.*

Table 4-30: Bynum Run Restoration BMP Cost

BMP	Progress (2005 – FY18)	2025	Total
New Stormwater		$34,000	$34,000
Retrofits	$100,000		$100,000
Tree Planting	$768,000	$25,000	$793,000
Stream Restoration		$164,000	$164,000
Outfall Stabilization		$605,000	$605,000
Inlet cleaning	$166,000		$166,000
Total			$1,862,000

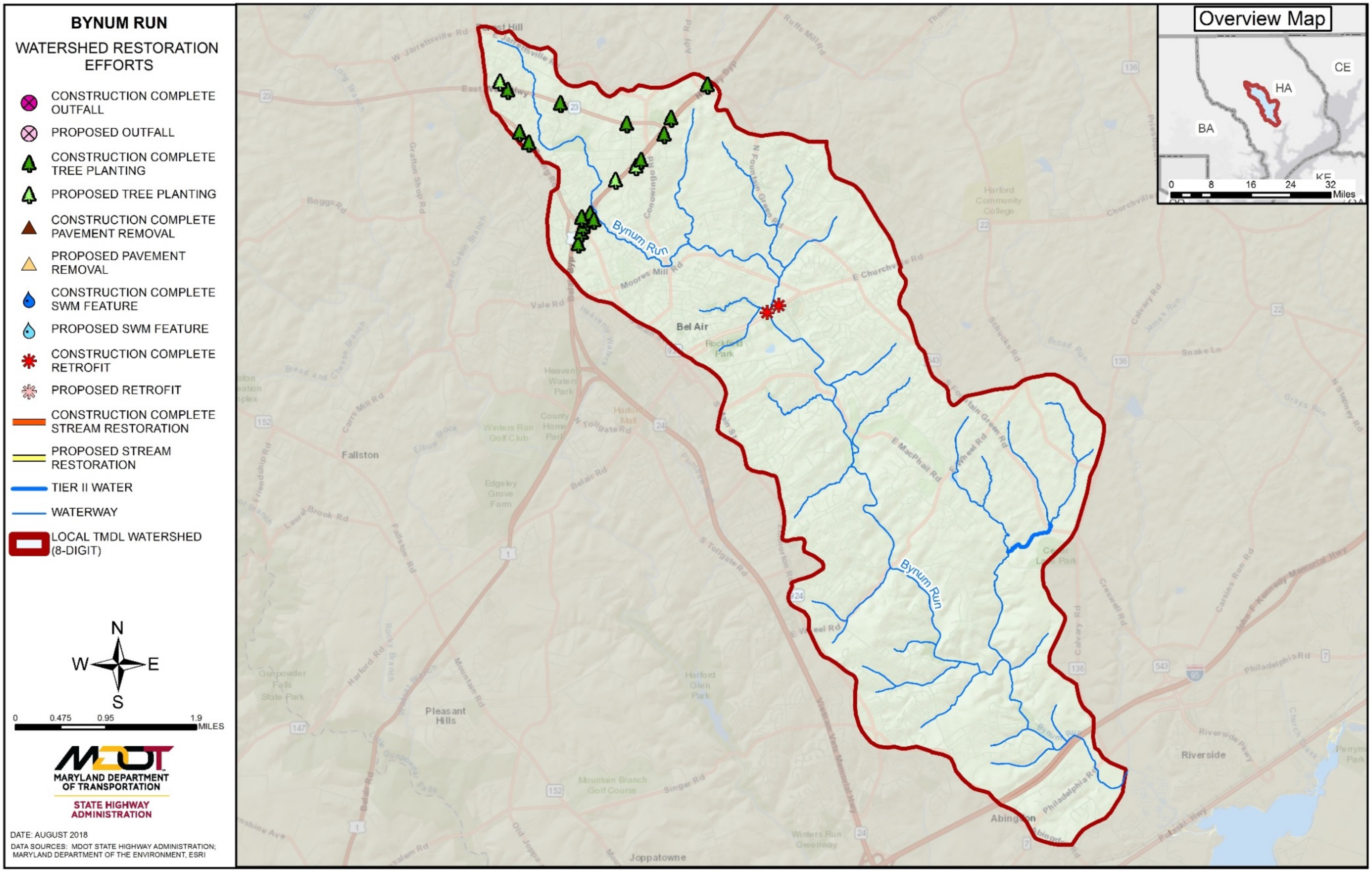


Figure 4-18: MDOT SHA Restoration Strategies within the Bynum Run Watershed

G. CABIN JOHN CREEK WATERSHED

G.1. Watershed Description

The Cabin John Creek watershed encompasses 26 square miles solely within southern Montgomery County, Maryland. Cabin John Creek originates in the City of Rockville and flows south approximately ten miles to its confluence with the Potomac River near Cabin John and Glen Echo. Major tributary creeks and streams of the Cabin John Creek watershed include Bogley Branch, Booze Creek, Buck Branch, Congressional Branch, Ken Branch, Old Farm Branch, Snakeden Branch, and Thomas Branch.

There are 353.1 miles of MDOT SHA roadway located within the Cabin John Creek watershed. The associated ROW encompasses 862.6 acres, of which 484.8 acres are impervious. There are no MDOT SHA facilities located within the Cabin John Creek watershed. See **Figure 4-19** for a map of the watershed.

G.2. MDOT SHA TMDLs within Cabin John Creek Watershed

MDOT SHA is included in the sediment (TSS) TMDL (MDE, 2011d) and has a reduction requirement of 22.9 percent as shown in **Table 3-2**.

G.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Cabin John Creek watershed is shown in **Figure 4-20** which illustrates that 21 grid cells have been reviewed, encompassing portions of 12 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 57 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 43 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 14 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 22 locations as potential tree planting locations. Further analysis of these locations resulted in:

- Eight (8) sites constructed or under contract.
- One (1) additional site deemed potentially viable for tree planting and pending further analysis, may be a candidate for future restoration opportunities.
- 13 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified six (6) sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Two (2) additional sites deemed potentially viable for stream restoration and pending further analysis may be candidates for future restoration opportunities.

- Four (4) sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

No grass swale rehabilitation sites were identified within this watershed for potential restoration.

Outfall Stabilization

Preliminary evaluation identified three (3) outfalls potential for stabilization. Further analysis of these sites resulted in:

- Three (3) outfall sites constructed or under contract.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified nine (9) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of two (2) existing structural SW controls constructed or under contract.

- Seven (7) retrofit sites deemed not viable for retrofit and have been removed from consideration.

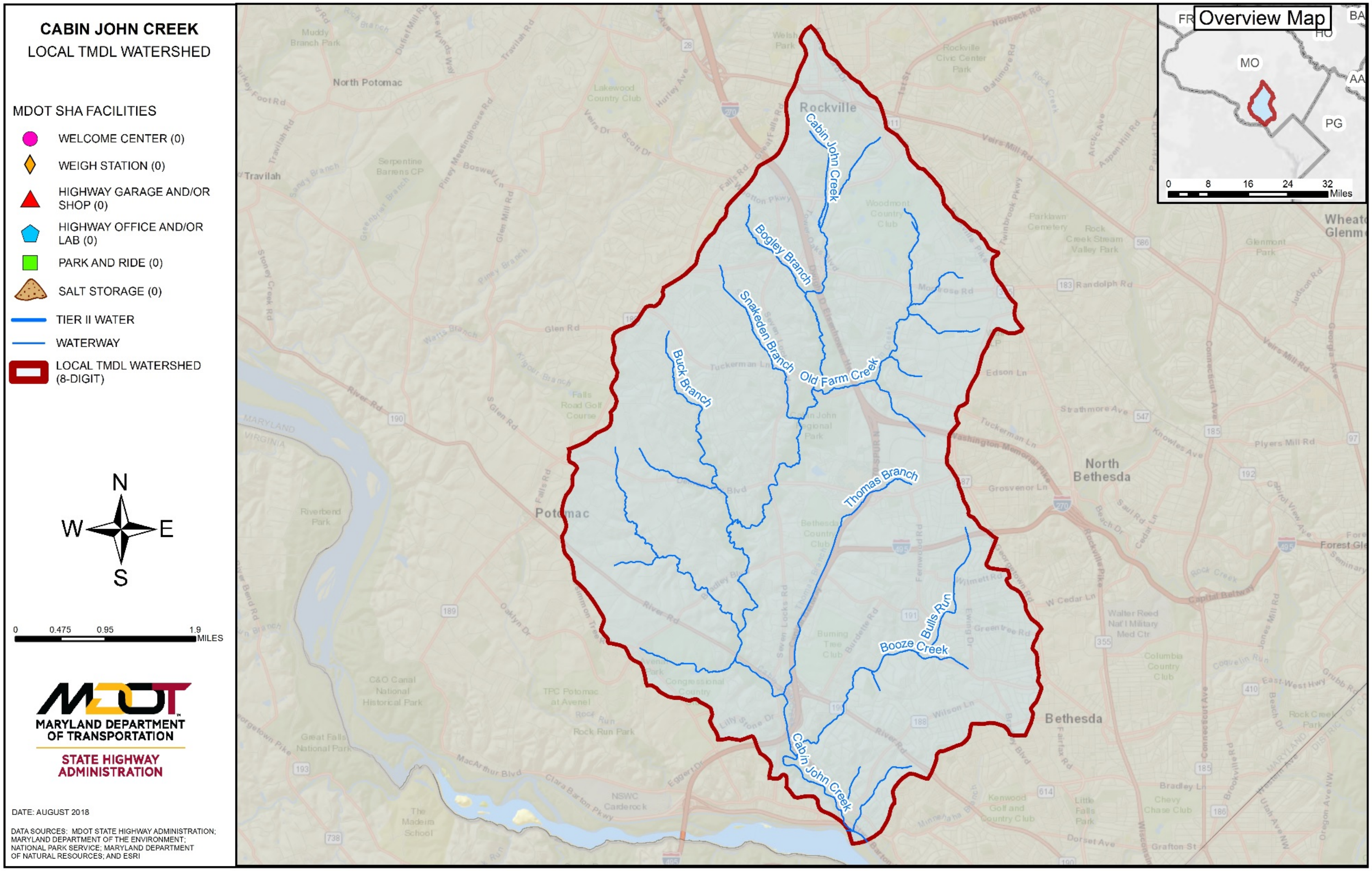


Figure 4-19: Cabin John Creek Watershed

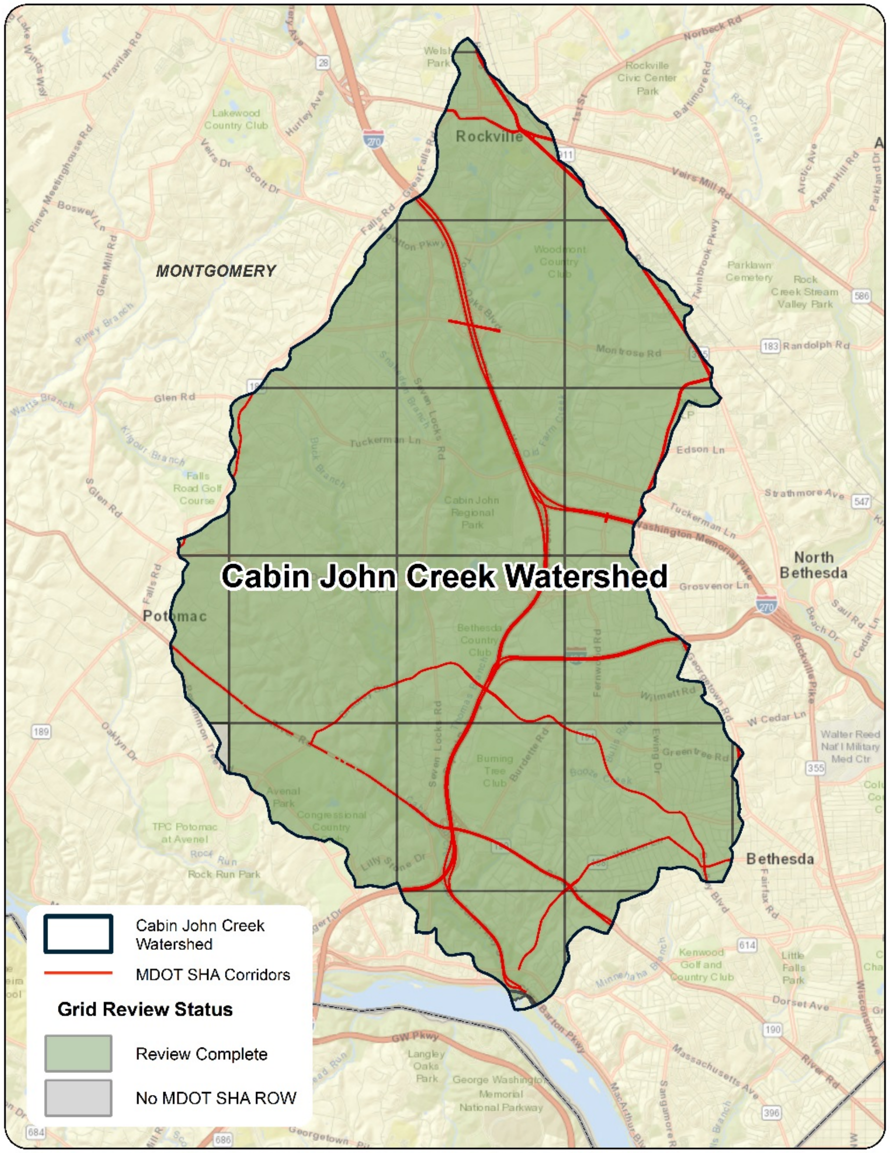


Figure 4-20: Cabin John Creek Site Search Grids

G.4. Summary of County Assessment Review

Waters within the Cabin John Creek watershed are subject to the following impairments as noted on MDE's 303(d) List:

- *Escherichia coli*;
- Chlorides;
- Sulfates; and
- TSS.

The *Cabin John Creek Implementation Plan* (Versar et al., 2012a) prepared by the Montgomery County Department of Environmental Protection, was adopted in January 2012. The implementation plan provides a comprehensive approach for watershed restoration targeting bacteria reduction, sediment nutrient reduction, runoff management, and trash management.

The Cabin John Creek watershed comprises primarily residential land use, covering about 70 percent of the watershed. Municipal/institutional comprises 13 percent and roadway comprises approximately 7 percent. Approximately 5 percent is identified as forest, open water, or bare ground. The majority of the stream resource conditions in Cabin John Creek were assessed as "Fair" (82.5 percent) (Cabin John Creek, Buck Branch, Bogley Branch, Old Farm Creek), the remaining 17.5 percent were assessed as "Poor" (Thomas Branch, Bills Run, Boole Creek). Zero stream miles were assessed as "Good" or "Excellent."

MDE developed TMDLs for fecal bacteria and sediment within the Cabin John Creek watershed and nutrient WLAs for the Bay-wide TMDL. BMPs implemented by the county proposed within Cabin John Creek watershed are estimated to result in 41.9 percent load reductions for total nitrogen, 41.7 percent for total phosphorus, and 29.5 percent for TSS.

Montgomery County is focusing on county-owned land for restoration projects, and has not addressed needs on MDOT SHA ROW. Projects identified include two new stormwater ponds (Cabin John Shopping Center, Tuckerman I) and four stormwater pond retrofits (Executive Blvd, Fox Hills of Potomac, Pine Knolls, Washington Science Center). Impervious area restoration is also proposed for various sites within the watershed.

G.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment reduction in the Cabin John Creek watershed are shown in **Table 4-31**. Projected sediment reduction using these practices is described in **Part III, Coordinated TMDL Implementation Plan** and is shown in **Table 3-2**. Four timeframes are included in the BMP implementation table:

- BMPs implemented before the baseline year. In this case, the sediment baseline is 2005;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the sediment TMDL MDOT SHA will meet 42.3 percent of the MDE 22.9 percent load reduction through implementation BMPs shown in table **4-31.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Cabin John Creek watershed total $ 4,368,000. They are based on an average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-32** for a summary of estimated BMP costs.

Figure 4-21 shows a map of MDOT SHA's restoration practices in the watershed and includes those that are under design or constructed. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-31: Cabin John Creek Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	197.0	2.6	3.1	TBD	202.7
Retrofit	drainage area acres		14.1		TBD	14.1
Tree Planting	acres of tree planting		3.6	0.5	TBD	4.2
Stream Restoration	linear feet		971.0	166.4	TBD	1,137.4
Outfall Stabilization	linear feet		36.4	207.9	TBD	244.3
Inlet Cleaning[1]	dry tons		9.8	31.9	TBD	41.7
Street Sweeping[1]	Acres swept		31.5		TBD	31.5

Load Reductions	TSS EOS lbs/yr.		79,327	98,008	231,907	
				Total Projected Reduction	**231,907**	
[1] *Inlet cleaning and street sweeping are annual practices.*						

Table 4-32: Cabin John Creek Restoration BMP Cost

BMP	2020	2025	Future	Total
New Stormwater	$87,000	$2,182,000		$2,270,000
Retrofits	$493,000			$493,000
Tree Planting	$111,000	$17,000		$128,000
Stream Restoration	$648,000	$111,000		$760,000
Outfall Stabilization	$71,000	$409,000		$480,000
Inlet cleaning	$41,000	$182,000		$223,000
Street Sweeping	$14,000			$14,000
Total				$4,368,000

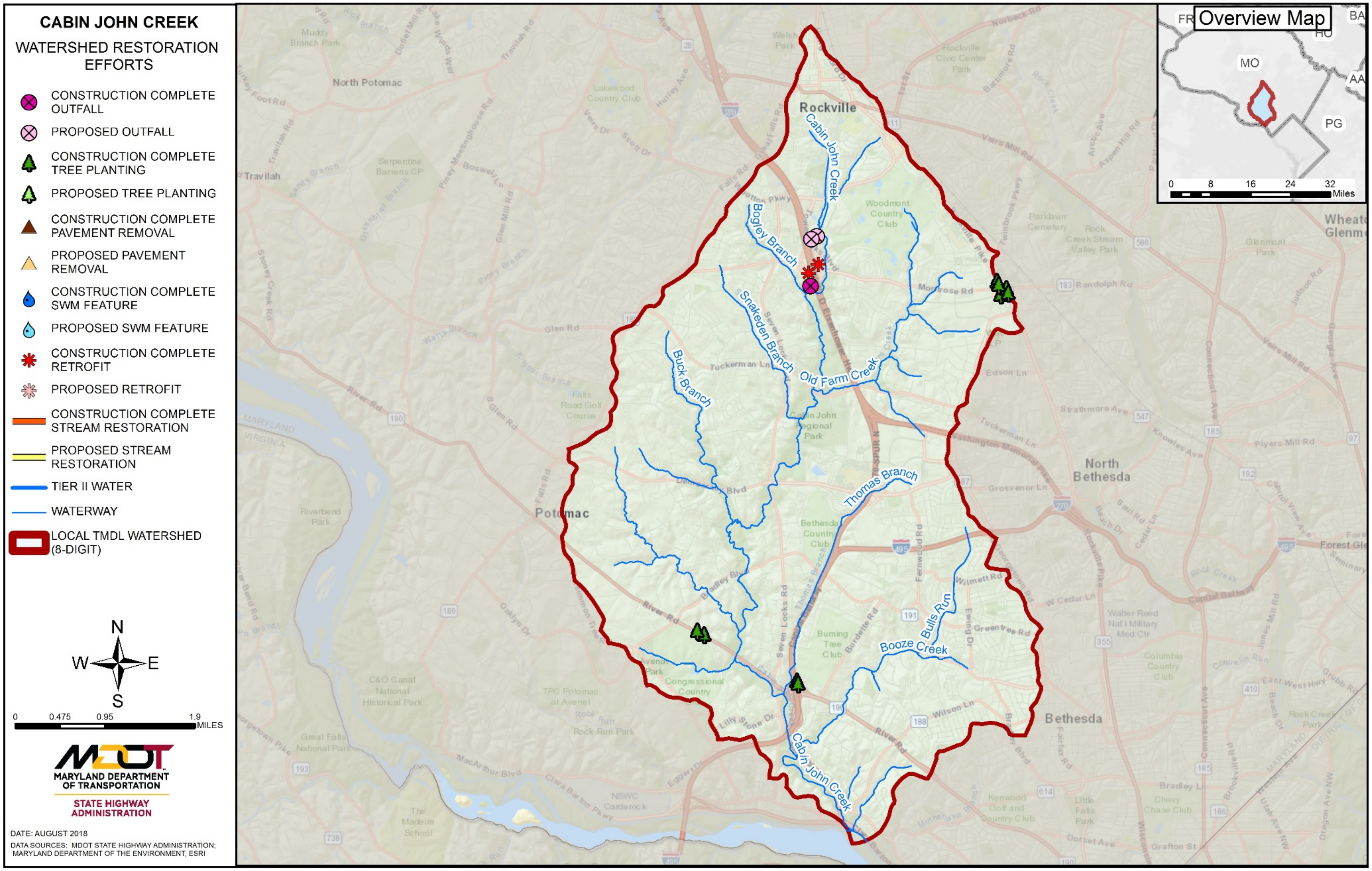


Figure 4-21: MDOT SHA Restoration Strategies within the Cabin John Creek Watershed

H. CATOCTIN CREEK WATERSHED

H.1. Watershed Description

The Catoctin Creek watershed is located within the Middle Potomac River subbasin in Frederick County, Maryland. The Catoctin Creek watershed drains an area of 120 square miles, which includes areas of forested mountain slopes, agricultural valleys, and small areas of urban development. There is a significant amount of agriculture within the watershed, which consists mostly of row crop, but also includes pasture. The largest urban centers within the watershed are the towns of Myersville and Middletown. According to the CBP's Phase 5.2 Model, the land use distribution in the watershed is approximately 43 percent agricultural, 42 percent forest/herbaceous, and 15 percent urban.

Tributary creeks and streams of the Catoctin Creek watershed include Bolivar Branch, Broad Run, Burkitts Run, Cone Branch, Deer Springs Branch, Dry Run, Grindstone Run, Harman Branch, Hollow Road Creek, Lewis Mill Branch, Little Catoctin Creek, Middle Creek, and Spruce Run.

There are 359.6 centerline miles of MDOT SHA roadway located within the Catoctin Creek watershed. The associated ROW encompasses 1,300 acres, of which 428.7 acres are impervious. MDOT SHA facilities located within the watershed consist of two (2) welcome centers, two (2) park and ride facilities, and two (2) salt storage facilities. See **Figure 4-22** for a map of the watershed.

H.2. MDOT SHA TMDLs within Catoctin Creek Watershed

MDOT SHA is included in both the phosphorus and sediment TMDLs (MDE, 2013b; MDE, 2009b) with reduction requirements of 9.0 percent and 49.1 percent, respectively, as shown in **Table 3-2**.

H.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Catoctin Creek watershed is shown in **Figure 4-23** which illustrates that 57 grid cells have been reviewed, encompassing portions of nine (9) state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 816 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 579 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 237 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 210 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 93 sites constructed or under contract.
- One (1) additional site deemed potentially viable for tree planting and pending further analysis, may be a candidate for future restoration opportunities.
- 116 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified eight (8) sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Two (2) sites constructed or under contract.
- Six (6) sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 57 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Six (6) new structural SW controls constructed or under contract.
- 15 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 36 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified three (3) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Three (3) retrofit sites deemed not viable for retrofit and have been removed from consideration.

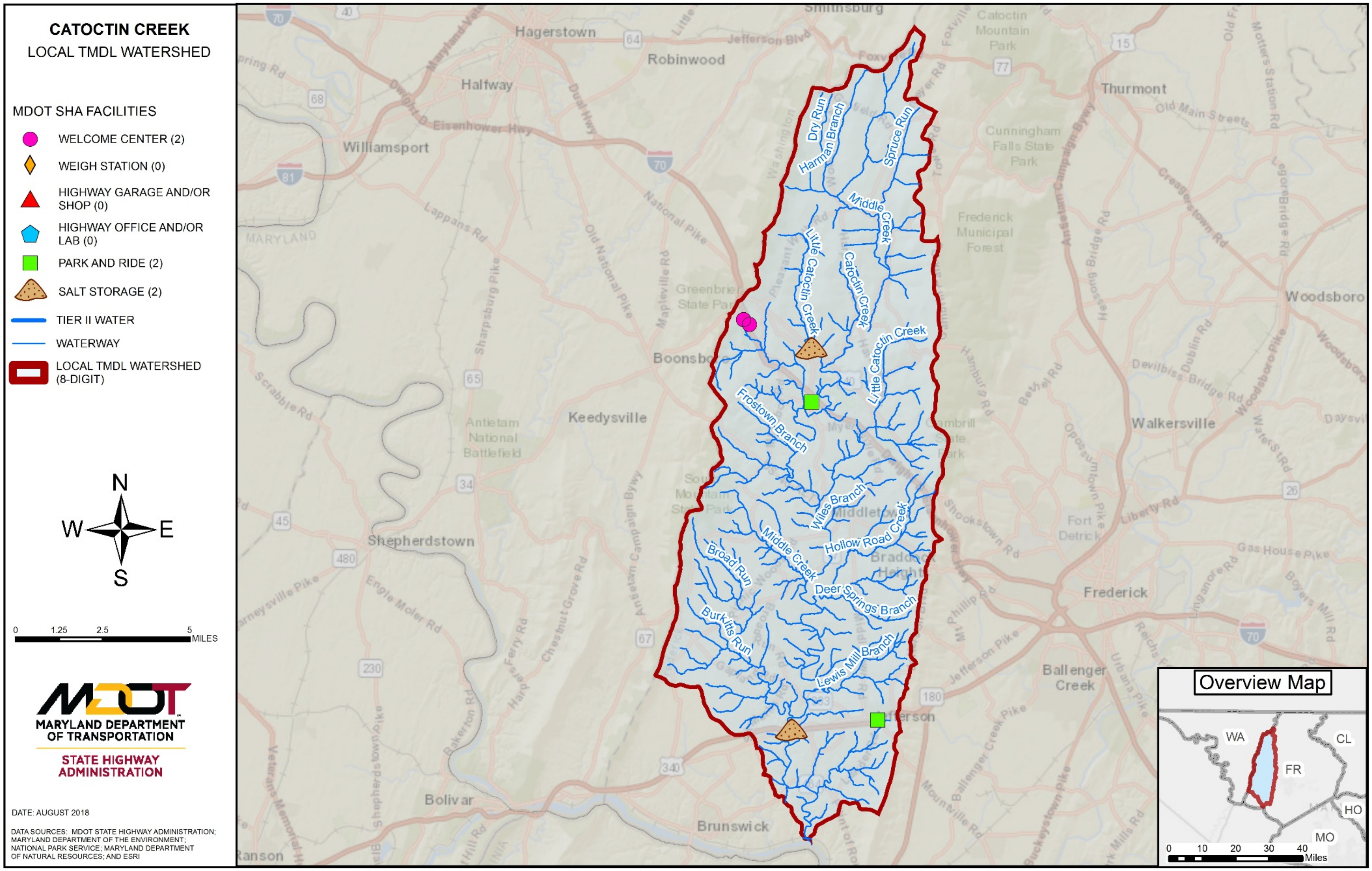


Figure 4-22: Catoctin Creek Watershed

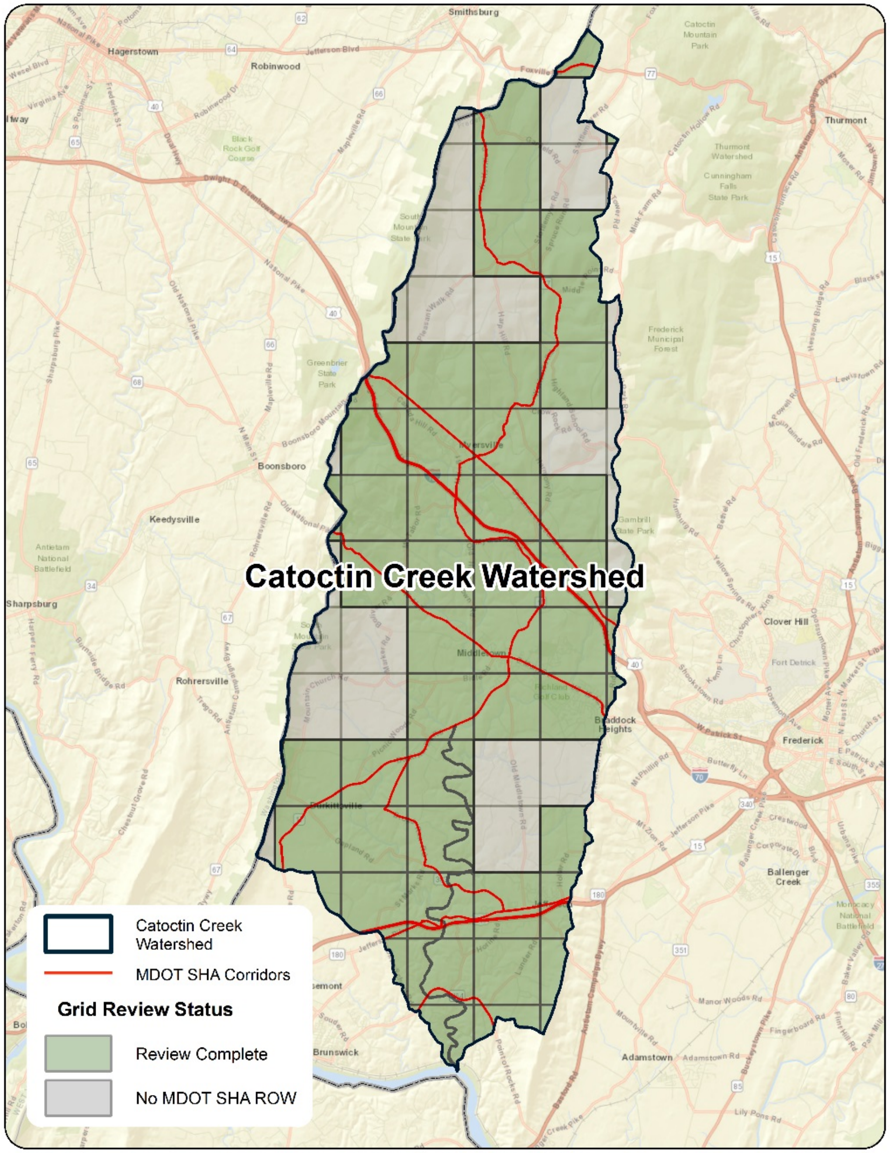


Figure 4-23: Catoctin Creek Site Search Grids

H.4. Summary of County Assessment Review

Waters within the Catoctin Creek watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Phosphorus (Total);
- Temperature, water; and
- TSS.

MDE prepared the *Watershed Report for Biological Impairment of the Catoctin Creek Watershed in Frederick County, Maryland Biological Stressor Identification Analysis Results and Interpretation* in 2012 (MDE, 2012c, pgs. 18 and 26). The following excerpts from the Biological Stressor Identification (BSID) describe land use throughout the watershed and associated potential pollutant sources:

Agricultural land use is an important source of pollution when rainfall carries fertilizers, manure, and pesticides into streams. The three major nutrients in fertilizers are nitrogen, phosphorus, and potassium. High concentrations of nutrients in agricultural streams were correlated with inputs from fertilizers and manure used for crops and from livestock wastes.

The BSID analysis identified pasture/hay land use as significant in the riparian buffer zone (92%). Pasture/hay land use within the riparian buffer often results in increased incidences of livestock being allowed direct access to streams, and one of the primary sources of nutrients and ammonia to surface waters is livestock waste. The agricultural land uses in the Catoctin Creek watershed are potential sources for the elevated levels of nitrogen, phosphorus, orthophosphate, and ammonia.

The lack of a riparian buffer has resulted in a stream ecosystem that eliminates large woody debris and *allochthonous input in streams, which results in loss of optimal habitat. Loss of riparian buffers also allows increased terrestrial inputs of nutrients from agricultural sources. Due to the increased proportions of agricultural land use in Catoctin Creek, the watershed has experienced an increase of nutrients that can potentially be extremely toxic to aquatic organisms. The combined AR for riparian habitat stressors and water chemistry stressors is approximately 83 percent, suggesting that altered riparian habitat and water chemistry stressors adequately account for the biological impairment in Catoctin Creek* (MDE, 2012c).

As stated in the Catoctin Creek sediment TMDL (MDE, 2009b, p.30):

Potential best management practices for reducing sediment loads and resulting impacts can be grouped into three general categories. The first is directed toward agricultural lands, the second to urban (developed) land, and the third applies to all land uses.

In agricultural areas comprehensive soil conservation plans can be developed that meet criteria of the USDA-NRCS Field Office Technical Guide. Soil conservation plans help control erosion by modifying cultural practices or structural practices. Cultural practices may change from year to year and include changes to crop rotations, tillage practices, or use of cover crops. Structural practices are long-term measures that include, but are not limited to, the installation of grass waterways (in areas with concentrated flow), terraces, diversions, sediment basins, or drop structures. In addition, livestock can be controlled via stream fencing and rotational grazing.

Sediment from urban areas can be reduced by stormwater retrofits, impervious surface reduction, and stream restoration. Stormwater retrofits include modification of existing stormwater structural practices to address water quality.

All non-forested land uses can benefit from improved riparian buffer systems. A riparian buffer reduces the effects of upland sediment sources through trapping and filtering. Riparian buffer efficiencies vary depending on type (grass or forested), land use (urban or agriculture), and physiographic region.

H.5. MDOT SHA Pollutant Reduction Strategies

Catoctin Creek is listed for both phosphorus and sediment with each TMDL having a different baseline year; 2000 for sediment and 2009 for phosphorus. Proposed practices to meet phosphorus and sediment reductions in the Catoctin Creek watershed are shown in **Table 4-33** and **Table 4-34**, respectively. Projected phosphorus and sediment reductions using these practices are described in **Part III, Coordinated TMDL Implementation Plan** and are shown in **Table 3-2**. Four timeframes are included in the tables below:

- BMPs implemented before the phosphorus and sediment TMDL baseline. In this case, the phosphorus baseline is 2009 and the sediment baseline is 2000;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the sediment TMDL, MDOT SHA will meet 85.7 percent of the MDE 49.1 percent load reduction requirement through implementation of BMPs shown in **Table 4-34.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Catoctin Creek watershed total $ 11,808,000. They are based on average cost per impervious acre treated derived from a cost history for each BMP type. Please see **Table 4-35** for a summary of estimated BMP costs.

Figure 4-24 shows a map of MDOT SHA's watershed restoration strategies throughout the Catoctin Creek watershed. The practices shown only include those that are under design or constructed.

Table 4-33: Catoctin Creek Restoration Phosphorus BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	55.1		38.6	N/A	93.7
Impervious Surface Elimination	acres removed		0.2		N/A	0.2
Tree Planting	acres of tree planting	16.0	71.8	49.5	N/A	137.3
Stream Restoration	linear feet	719.0	4,965.0	3,965.2	N/A	9,649.2
Outfall Stabilization	linear feet			400.0	N/A	400.0
Inlet Cleaning[1]	dry tons		0.1	13.5	N/A	13.7
Load Reductions	TP EOS lbs./yr.		393	759	0	
				Total Projected Reduction	**759**	

[1] *Inlet cleaning is an annual practice.*

Table 4-34: Catoctin Creek Restoration Sediment BMP Implementation						
BMP	**Unit**	**Baseline (Before 2000)**	**Restoration BMPs**			**Total BMPs**
			2020	**2025**	**Future**	
New Stormwater	drainage area acres	54.9		38.6	TBD	93.5
Impervious Surface Elimination	acres removed		0.2		0.0	0.2
Tree Planting	acres of tree planting		87.8	49.5	TBD	137.3
Stream Restoration	linear feet		5,684.0	3,965.2	TBD	9,649.2
Outfall Stabilization	linear feet			400.0	TBD	400.0
Inlet Cleaning[1]	dry tons		0.1	13.5	TBD	13.7
Load Reductions	TSS EOS lbs./yr.		280,379	509,359	594,338	
				Total Projected Reduction	**594,338**	

[1] *Inlet cleaning is an annual practice.*

Table 4-35: Catoctin Creek Restoration BMP Cost			
BMP	**2020**	**2025**	**Total**
New Stormwater		$257,000	$257,000
Impervious surface Elimination	$43,000		$43,000
Tree Planting	$2,685,000	$1,514,000	$4,200,000
Stream Restoration	$3,796,000	$2,648,000	$6,443,000
Outfall Stabilization		$787,000	$787,000
Inlet cleaning	$1,000	$77,000	$78,000
Total			$11,808,000

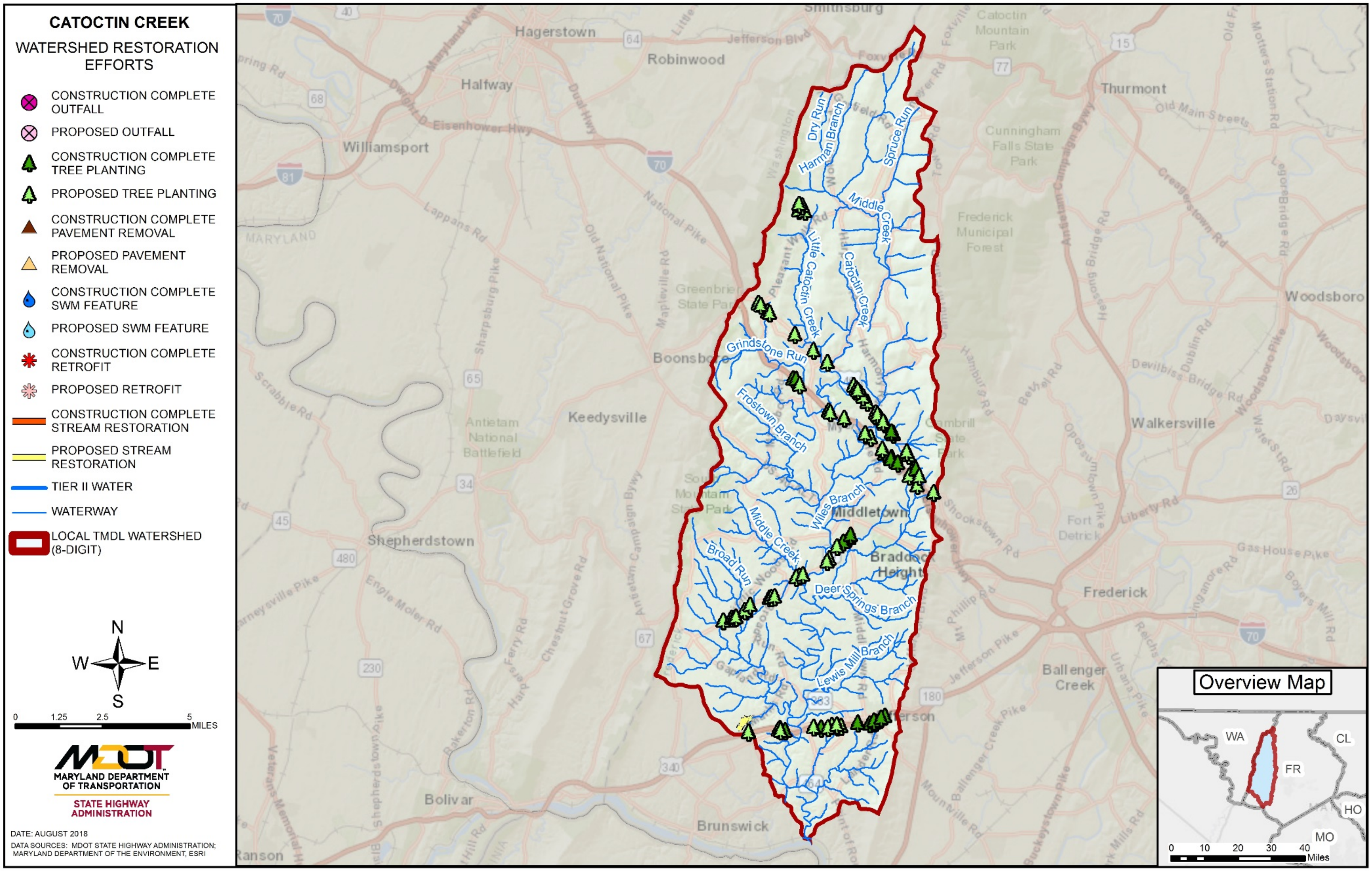


Figure 4-24: MDOT SHA Restoration Strategies within the Catoctin Creek Watershed

I. CONOCOCHEAGUE CREEK WATERSHED

I.1. Watershed Description

The Conococheague Creek watershed encompasses 65 square miles within Washington County, Maryland. The entire watershed is approximately 566 square miles, most of which is located in Pennsylvania. Conococheague Creek flows 80 miles south from its headwaters in Pennsylvania to the Potomac River near Williamsport, Maryland. Tributary creeks and streams of the Conococheague Creek watershed, within Maryland, include Meadow Brook, Rockdale Run, Rush Run, Semple Run, and Toms Run.

There are 285.6 centerline miles of MDOT SHA roadway located within the Conococheague Creek watershed. The associated ROW encompasses 1,428.3 acres, of which 489.6 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) park and ride facility and one (1) salt storage facility. See **Figure 4-25** for a map of the watershed.

I.2. MDOT SHA TMDLs within Conococheague Creek

MDOT SHA is included in the sediment (TSS) TMDL (MDE, 2008b) and has a reduction requirement of 45.3 percent as shown in **Table 3-2**.

I.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Conococheague watershed is shown in **Figure 4-26** which illustrates that 37 grid cells have been reviewed, encompassing portions of 13 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 507 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 25 new structural SW controls constructed or under contract.
- 229 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 253 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 205 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 22 sites constructed or under contract.
- 32 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 151 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 17 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- 17 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 88 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 12 new structural SW controls constructed or under contract.
- Five (5) additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 71 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified three (3) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of two (2) existing structural SW controls constructed or under contract.
- One (1) retrofit site deemed not viable for retrofit and has been removed from consideration.

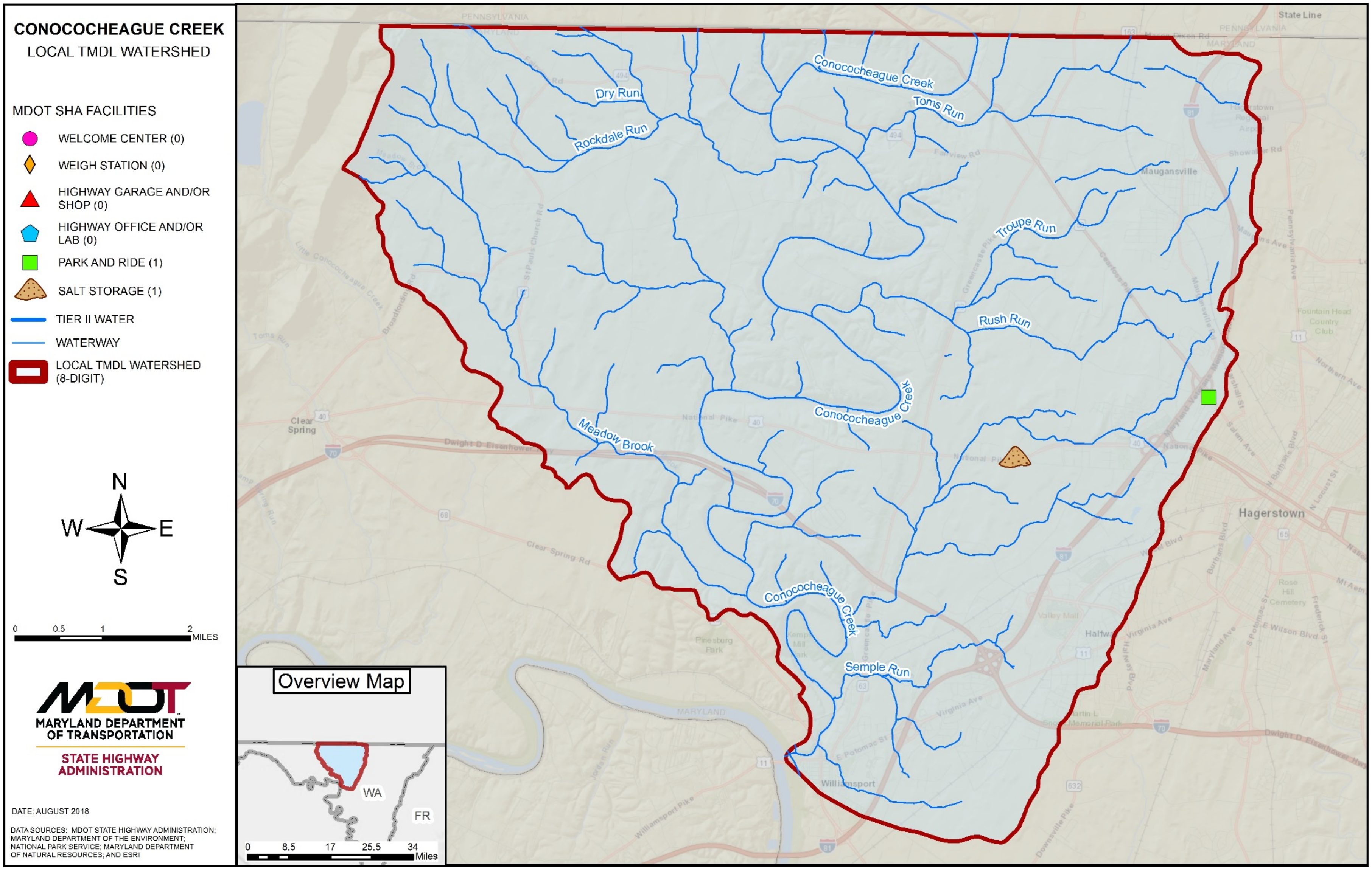


Figure 4-25: Conococheague Creek Watershed

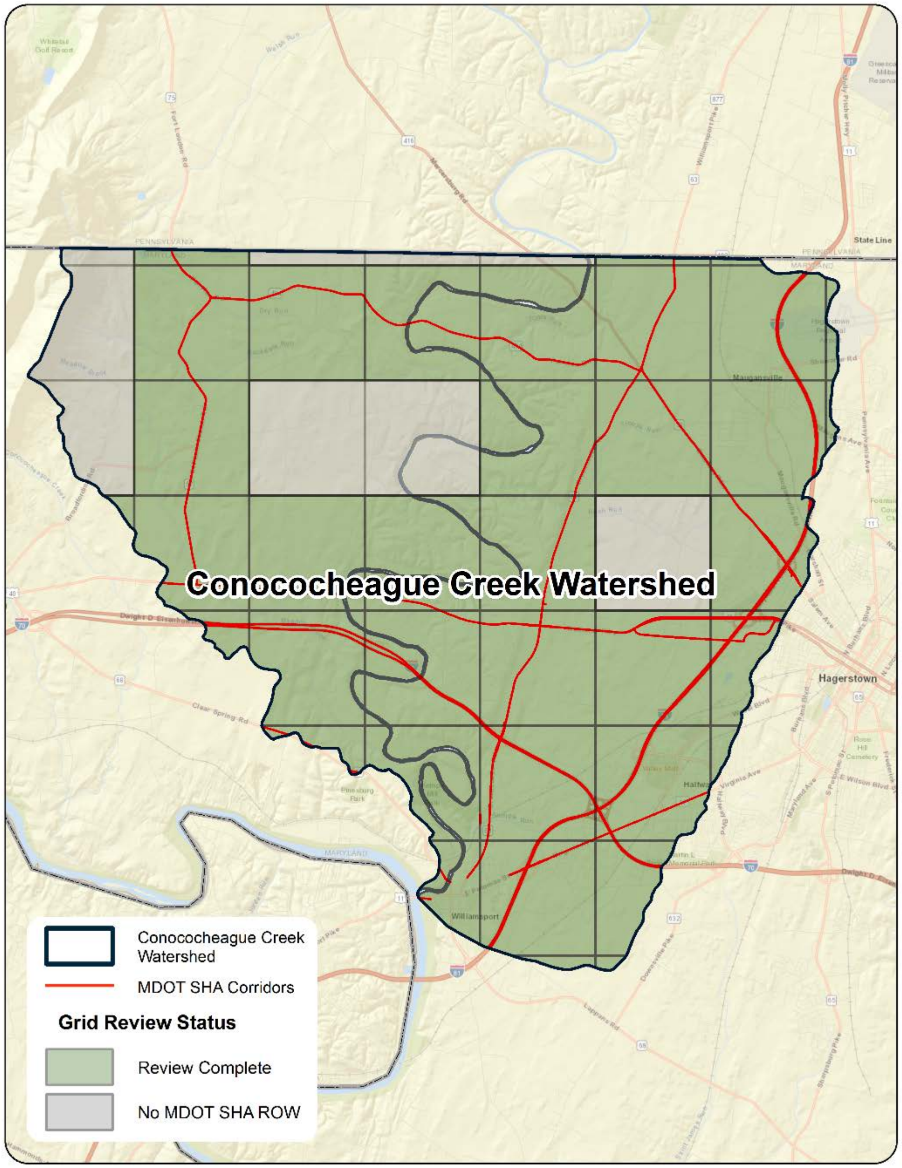


Figure 4-26: Conococheague Creek Site Search Grids

I.4. Summary of County Assessment Review

Waters within the Conococheague Creek watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- *Escherichia coli;*
- Mercury in Fish Tissue;
- PCB in Fish Tissue;
- pH, High;
- Phosphorus (Total);
- Sulfates; and
- TSS.

According to the 2014 Washington County NPDES MS4 Annual Report (WA-DPW, 2014), a restoration plan for the Conococheague Creek watershed was expected to be completed in 2015, but as of September 2018, this report was not yet available online.

I.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment reduction in the Conococheague Creek watershed are shown in **Table 4-36**. Projected sediment reduction using these practices is described in **Part III, Coordinated TMDL Implementation Plan** and is shown in **Table 3-2**. Four timeframes are included in the table:

- BMPs implemented before the TMDL baseline. In this case, the baseline is 2000;
- BMPs implemented after the baseline through fiscal year 2020; and

- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the sediment TMDL, MDOT SHA will meet 19.3 percent of the MDE 45.3 percent load reduction requirement through implementation of BMPs shown in **Table 4-36.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct and implement BMPs within the Conococheague Creek watershed total $6,511,000. They are based average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-37** for a summary of estimated BMP costs.

Figure 4-27 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design or constructed. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-36: Conococheague Creek Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2000)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	101.6	22.3	15.2	TBD	139.1
Retrofit	drainage area acres		12.7		TBD	12.7
Tree Planting	acres of tree planting		57.6		TBD	57.6
Stream Restoration	linear feet			694.4	TBD	694.4
Outfall Stabilization	linear feet			400.0	TBD	400.0
Inlet Cleaning[1]	dry tons			8.6	TBD	8.6
Street Sweeping[1]	Acres swept		11.6			11.6
Load Reductions	TSS EOS lbs/yr.		43,821	100,574	**522,122**	
				Total Projected Reduction	**522,122**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-37: Conococheague Creek Restoration BMP Cost			
BMP	**2020**	**2025**	**Total**
New Stormwater	$2,843,000	$52,000	$2,895,000
Retrofits	$545,000		$545,000
Tree Planting	$1,762,000		$1,762,000
Stream Restoration		$464,000	$464,000
Outfall Stabilization		$787,000	$787,000
Inlet cleaning		$49,000	$49,000
Street Sweeping	$9,000		$9,000
Total			$6,511,000

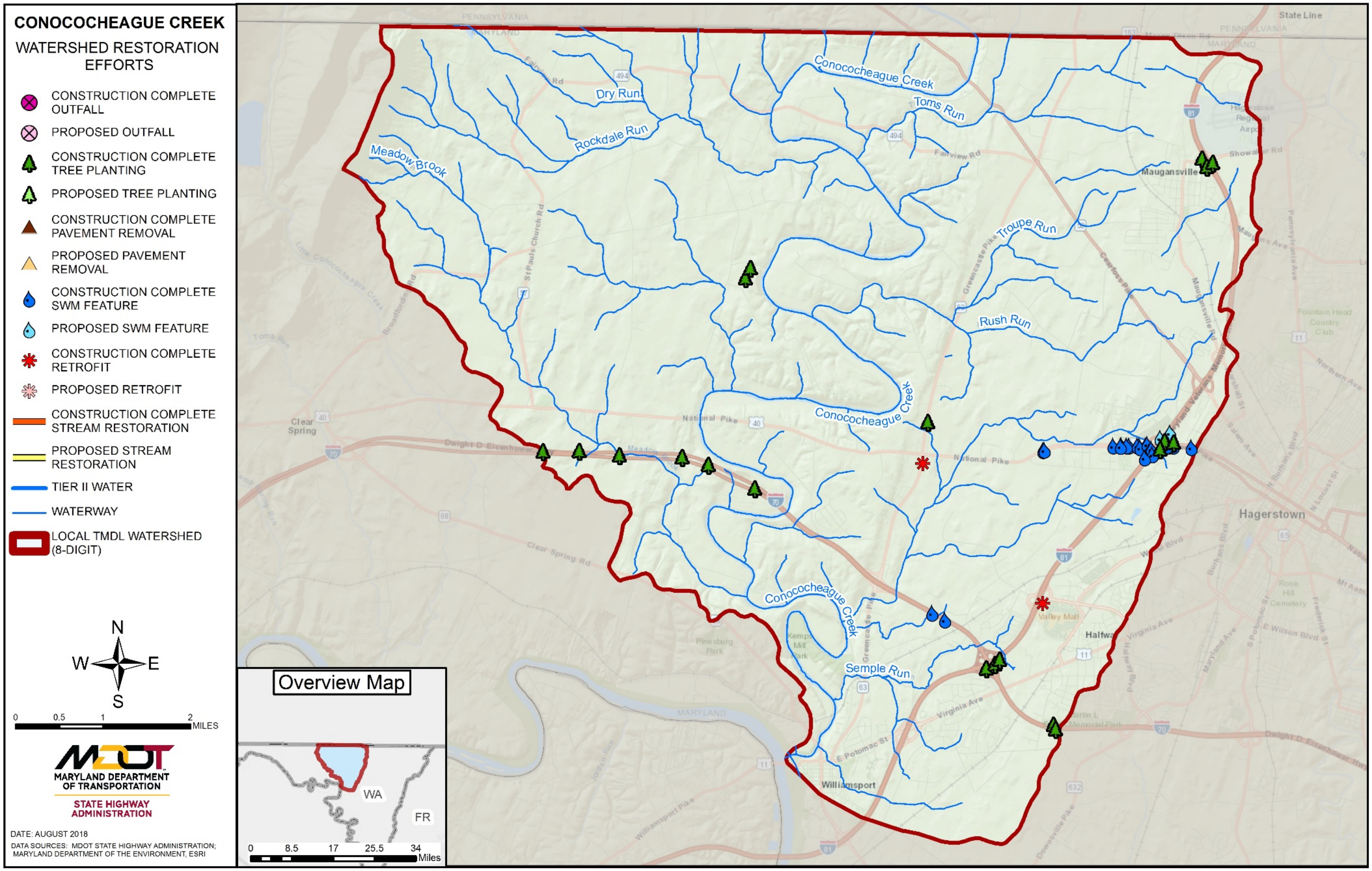


Figure 4-27: MDOT SHA Restoration Strategies within the Conococheague Creek Watershed

J. DOUBLE PIPE CREEK WATERSHED

J.1. Watershed Description

The Double Pipe Creek watershed encompasses 193 square miles spanning Carroll and Frederick Counties, and is composed of Big Pipe Creek, which makes up 58 percent of the watershed, and Little Pipe Creek, which makes up the remaining 42 percent. The portion of the watershed within Carroll County is approximately 86 percent of the watershed, with 14 percent within Frederick County. This watershed drains into the Monocacy River, which is a State-designated Scenic River. The headwaters of Double Pipe Creek originate in Westminster and Manchester, and flows west toward Rocky Ridge, into the Monocacy River and ultimately into the Middle Potomac River near the town of Dickerson. Tributary creeks and streams of the Double Pipe Creek watershed include Bear Branch, Big Pipe Creek, Cherry Branch, Deep Run, Dickenson Run, Little Pipe Creek, Meadow Branch, Prisetland Branch, Sams Creek, Silver Run, Turkeyfoot Run, and Wolf Pit Creek.

There are 545.2 centerline miles of MDOT SHA roadway located within the Double Pipe Creek watershed. The associated ROW encompasses 1,107.1 acres, of which 420.2 acres are impervious. MDOT SHA facilities located within the Double Pipe Creek watershed consist of one (1) park and ride facility, and one (1) salt storage facility. See **Figure 4-28** for a map of the watershed.

J.2. MDOT SHA TMDLs within Double Pipe Creek

MDOT SHA is included in the phosphorus TMDL (MDE, 2013c) and sediment (TSS) TMDL (MDE, 2009c) and has reduction requirements of 46.8 percent for sediment and 66 percent for phosphorus in Carroll and Frederick Counties, respectively as shown in **Table 3-2**.

J.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Double Pipe Creek watershed is shown in **Figure 4-29** which illustrates that 84 grid cells have been reviewed, encompassing portions of 16 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 416 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 247 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 169 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 232 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 70 sites constructed or under contract.
- 24 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 138 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 13 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Three (3) sites constructed or under contract.
- 10 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified two (2) sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Two (2) sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified two (2) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Two (2) retrofit sites deemed not viable for retrofit and have been removed from consideration.

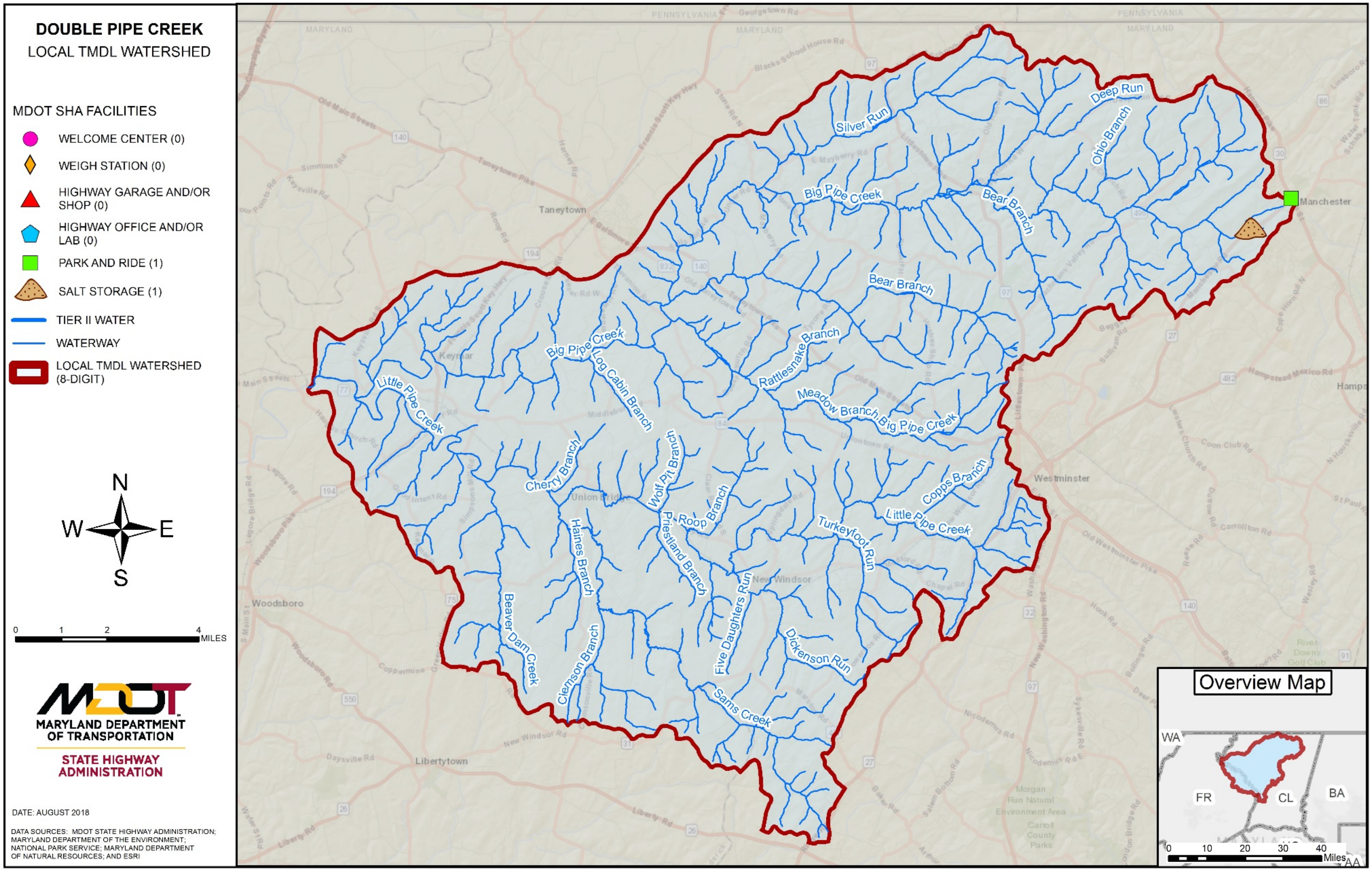


Figure 4-28: Double Pipe Creek Watershed

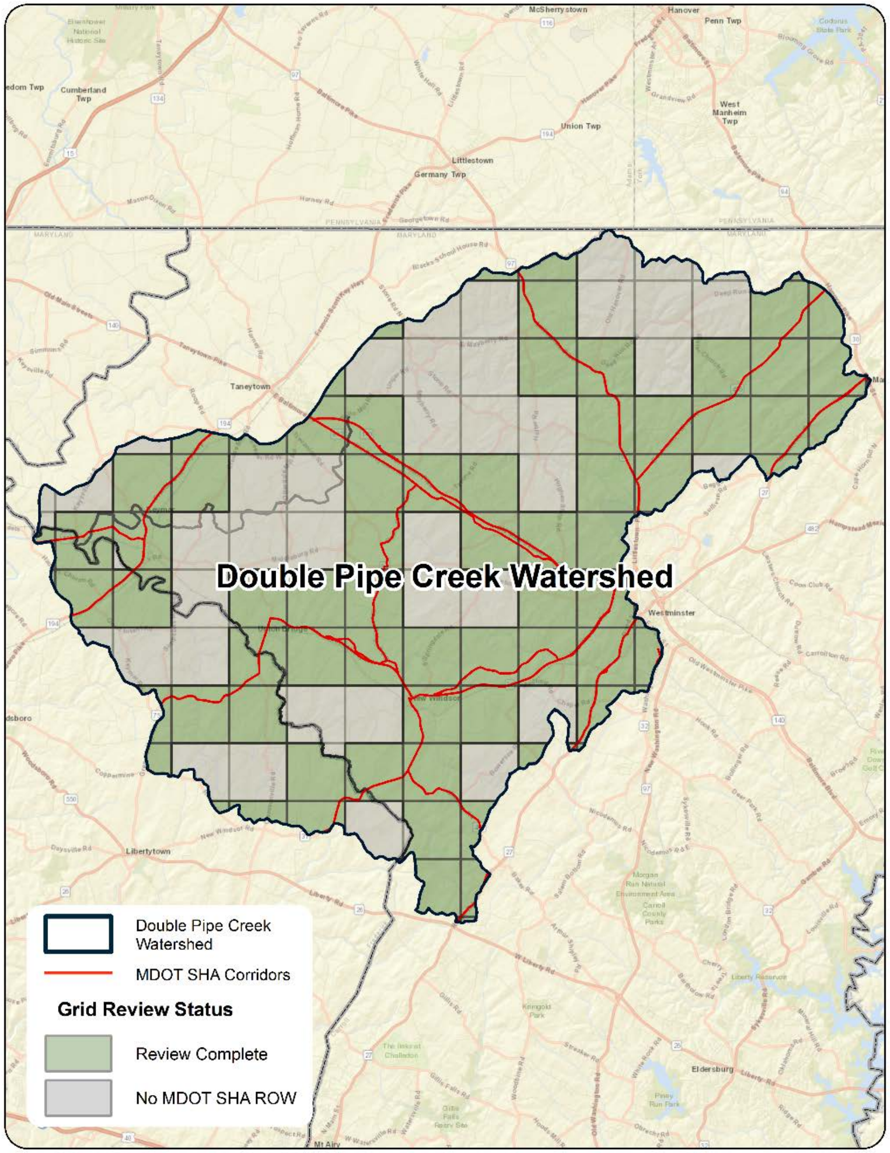


Figure 4-29: Double Pipe Creek Site Search Grids

J.4. Summary of County Assessment Review

Waters within the Double Pipe Creek watershed are subject to the following impairments as noted on MDE's 303(d) List:

- *Escherichia coli;*
- Phosphorus (Total); and
- TSS.

In 2006, MDE completed a report on *Prioritizing Sites for Wetland Restoration, Mitigation, and Preservation in Maryland* (MDE, 2006). Impervious land cover comprises 2.5% of the Frederick County portion of the Double Pipe Creek watershed. According to MDE (2006), regulated impervious developed land comprises 2.04% in the Frederick County portion, and 2.14% in the Carroll County portion. The predominant soils in this watershed are considered moderately erodible. Double Pipe Creek currently has completed TMDLs for sediment (TSS), fecal bacteria, and phosphorus. Double Pipe Creek also has a Category Five impairment listing (i.e., TMDL required) for PCBs in fish tissue.

Although Carroll County has not yet published an implementation plan for its portion of the Double Pipe Creek watershed, it has completed the preliminary watershed characterization plan that will help inform and direct the future implementation plan, namely 2016's *Double Pipe Creek Watershed Characterization Plan* (CL-BRM, 2016a). According to this characterization plan, the current impairments within the Double Pipe Creek watershed are bacteria, phosphorus, and sediment (CL-BRM, 2016a). The Double Pipe Creek watershed is mostly rural with mixed urban uses accounting for less than three percent of the total land use; agriculture is the dominant land use with the Double Pipe Creek watershed (CL-BRM, 2016a). Within the watershed, the Little Pipe Creek subwatershed has the highest percentage (10.6%) of total impervious area for the entire watershed (Little Pipe Creek subwatershed contains a large portion of the City of Westminster) (CL-BRM, 2016a).

The Frederick County Office of Sustainability and Environmental Resources conducted Stream Corridor Assessments (SCAs) between 2013 and 2016 that included Frederick County's portion of the Double Pipe Creek watershed (Versar, 2017a). According to Versar (2017a), land use within Frederick County's portion of the Double Pipe Creek watershed is agricultural (80.7%), forested (12.31%), and urban (6.99%); impervious surface constitutes 3.1%. The BIBI and PHI scores for the Double Pipe Creek watershed fell in the "Poor/Degraded" condition class (Versar, 2017a).

Information on water quality, erosion, physical habitat, and BIBI scores for several sites within Little Pipe Creek can be found in the SCA reports; however, detailed location information is not provided.

J.5. MDOT SHA Pollutant Reduction Strategies

Double Pipe Creek is listed for both sediment and phosphorus with each TMDL having a different baseline year; 2000 for sediment and 2009 for phosphorus. Proposed practices to meet the sediment and phosphorus reduction in the Double Pipe Creek watershed are shown in **Table 4-38 and 4-39**. Projected sediment and phosphorus reductions using these practices are described in **Part III, Coordinated TMDL Implementation Plan** and are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs implemented before the phosphorus and sediment TMDL baseline. In this case, the phosphorus baseline is 2009 and the sediment baseline is 2000;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

MDOT SHA will meet the required reductions.

Estimated costs to design, construct, and implement BMPs within the Double Pipe Creek watershed total $ 21,105,000. They are based on average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-40** for a summary of estimated BMP costs.

Figure 4-30 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design or construction. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-38: Double Pipe Creek Restoration Phosphorus BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	Total
New Stormwater	drainage area acres	32.7	18.5	92.4	N/A	143.6
Impervious Surface Elimination	acres removed		0.1		N/A	0.1
Tree Planting	acres of tree planting		108.5	16.2	N/A	124.7
Stream Restoration	linear feet		7,569.0	11,275.2	N/A	18,844.2
Outfall Stabilization	linear feet			800.0	N/A	800.0
Inlet Cleaning[1]	dry tons			0.2	N/A	0.2
Street Sweeping[1]			10.1		N/A	10.1
Load Reductions	TP EOS lbs./yr.		585	1,514	0	
				Total Projected Reduction	1,514	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-39: Double Pipe Creek Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	Total
New Stormwater	drainage area acres	19.7	18.5	92.4	N/A	130.6
Impervious Surface Elimination	acres removed		0.1		N/A	0.1
Tree Planting	acres of tree planting		108.5	16.2	N/A	124.7
Stream Restoration	linear feet		7,569.0	11,275.2	N/A	18,844.2
Outfall Stabilization	linear feet			800.0	N/A	800.0
Inlet Cleaning[1]	dry tons			0.2	N/A	0.2
Street Sweeping[1]			10.1		N/A	10.1
Load Reductions	TP EOS lbs./yr.		371,013	959,856	0	
				Total Projected Reduction	959,856	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-40: Double Pipe Creek Restoration BMP Cost			
BMP	**2020**	**2025**	**Total**
New Stormwater	$582,000	$2,508,000	$3,090,000
Impervious surface Elimination	$24,000		$24,000
Tree Planting	$3,321,000	$496,000	$3,817,000
Stream Restoration	$5,055,000	$7,529,000	$12,584,000
Outfall Stabilization		$1,574,000	$1,574,000
Inlet cleaning		$1,000	$1,000
Street Sweeping	$15,000		$15,000
Total			$21,105,000

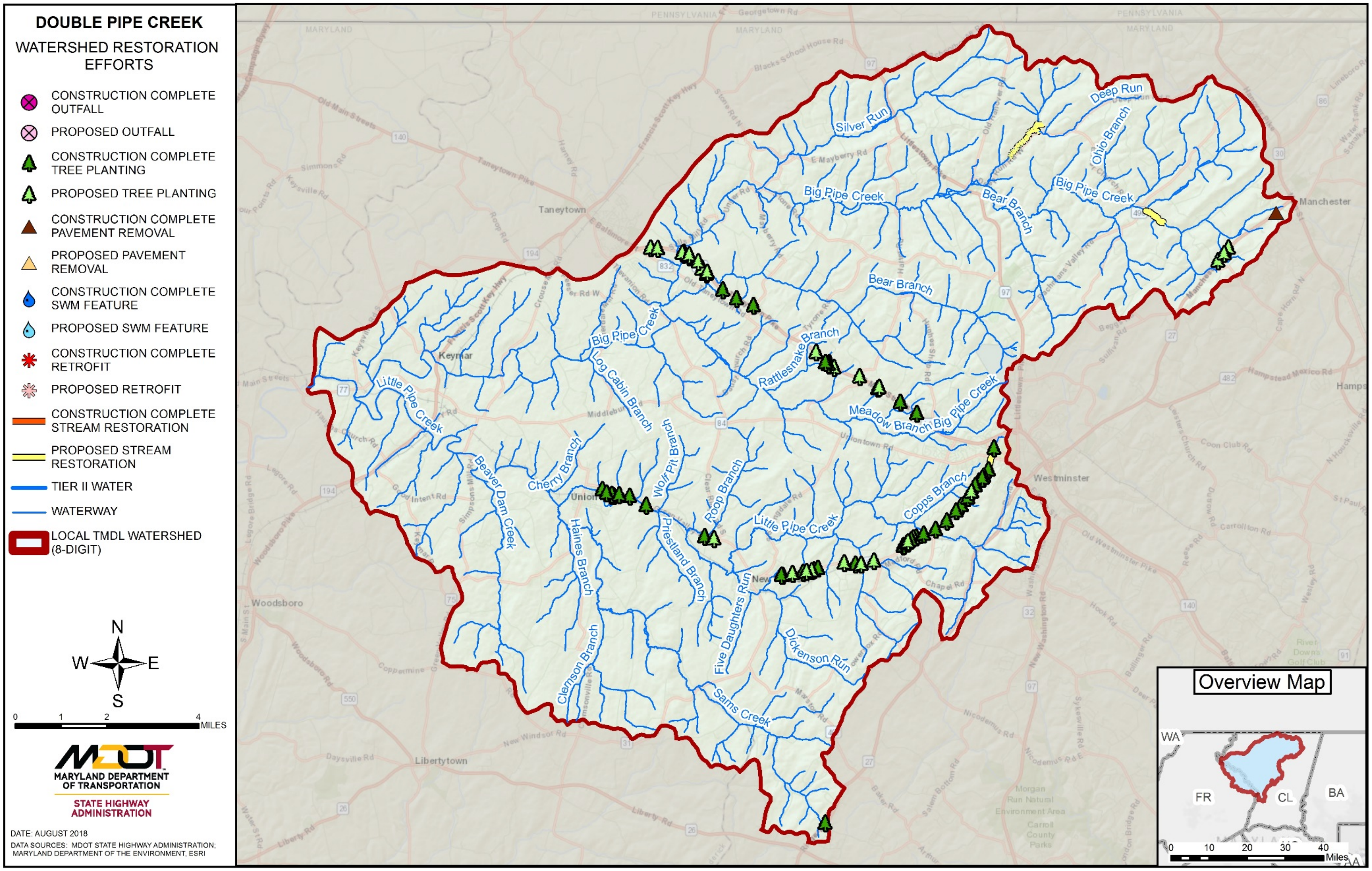


Figure 4-30: MDOT SHA Restoration Strategies within the Double Pipe Creek Watershed

K. GUNPOWDER RIVER & BIRD RIVER SUBSEGMENTS

K.1. Subsegments Description

The Gunpowder River Oligohaline Segment is one of the 92 tidal water body segments of the Chesapeake Bay and its tributaries. The Gunpowder River Oligohaline Segment includes both the Gunpowder River subsegment (hereinafter "Gunpowder River") and the Bird River subsegment (hereinafter "Bird River").

The Gunpowder River is a 6.8-mile-long (10.9 km) tidal inlet on the western side of the Chesapeake Bay in Baltimore and Harford Counties. The Gunpowder River is formed by the convergence of two freshwater tributaries: Gunpowder Falls (often referred to locally as "Big Gunpowder Falls") and Little Gunpowder Falls. Gunpowder River is surrounded by the Gunpowder River watershed (8-digit Basin Code: 02130801, excluding the Seneca Creek portion) in Harford County to the east and Baltimore County to the west. The total area of the Gunpowder River watershed is approximately 20 square miles. Major tributaries of the Gunpowder River watershed include Foster Branch and Emmord Branch.

The Bird River is located above the Baltimore County portion of the Gunpowder River watershed and is approximately 7 miles (11.3 km) in length. The Bird River watershed (8-digit Basin Code: 02130803) encompasses approximately 26 square miles solely within Baltimore County, Maryland. The Bird River flows east into the Gunpowder River; accordingly, both the Gunpowder River watershed and the Bird River watershed drain into the Gunpowder River. The Gunpowder River ultimately flows into the Chesapeake Bay. Major tributaries of the Bird River watershed include Whitemarsh Run, Honeygo Run, and Windlass Run.

There are 46 centerline miles of MDOT SHA roadway located within the Gunpowder River watershed; the associated ROW encompasses 530 acres, of which 246 acres are impervious.

There are no MDOT SHA facilities located within the Gunpowder River and the Bird River watersheds (**Figure 4-31**).

K.2. MDOT SHA TMDLs in the Gunpowder River & Bird River Subsegments

MDOT SHA is included in the PCBs TMDL (MDE, 2016c) and has reduction requirements of 70 percent in the Bird River watershed and 0 percent in the Gunpowder River watershed, as shown in **Table 3-2**. Because MDOT SHA does not have a reduction requirement in the Gunpowder River watershed, **Section K.3.**, **Section K.4.**, and **Section K.5.** below only pertain to the Bird River watershed.

K.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan, Section C** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Bird River subsegment is shown in **Figure 4-32** which illustrates that 21 grid cells have been reviewed, encompassing portions of nine (9) state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 66 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 41 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 25 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 26 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 12 sites constructed or under contract.
- Five (5) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- Nine (9) sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified one (1) site as a potential stream restoration location. Further analysis of this location resulted in:

- One (1) site deemed not viable for stream restoration and has been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 27 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Two (2) additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 25 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified two (2) outfalls potential for stabilization. Further analysis of these sites resulted in:

- One (1) outfall site constructed or under contract.
- One (1) outfall site deemed potentially viable for outfall stabilization efforts and pending further analysis, may be a candidate for future restoration opportunities.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 21 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of two (2) existing structural SW controls constructed or under contract.
- One (1) retrofit site deemed potentially viable for retrofit and pending further analysis may be a candidate for future restoration opportunities.
- 18 retrofit sites deemed not viable for retrofit and have been removed from consideration.

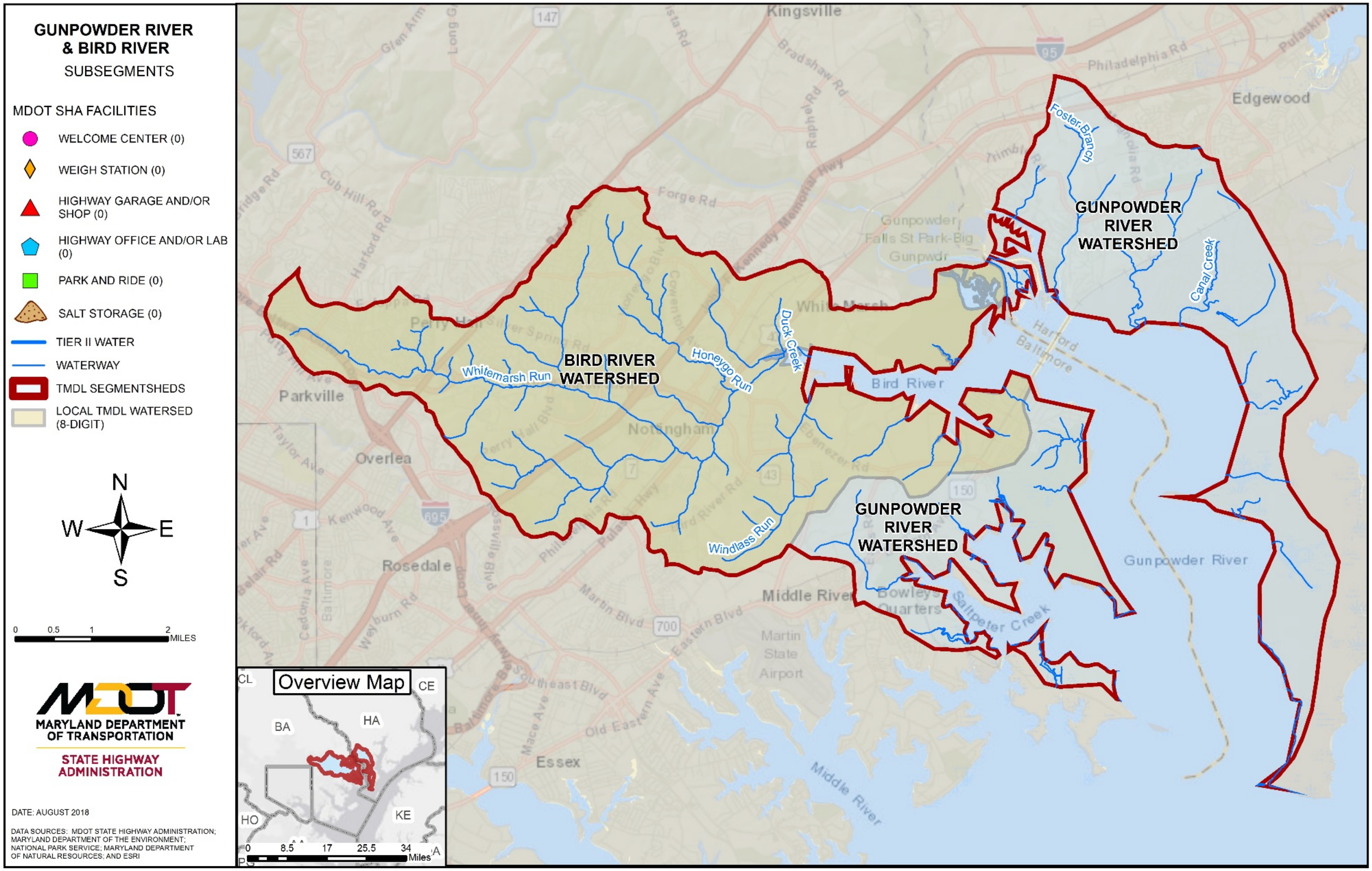


Figure 4-31: Gunpowder River & Bird River Subsegments of Gunpowder River Oligohaline Segmentshed

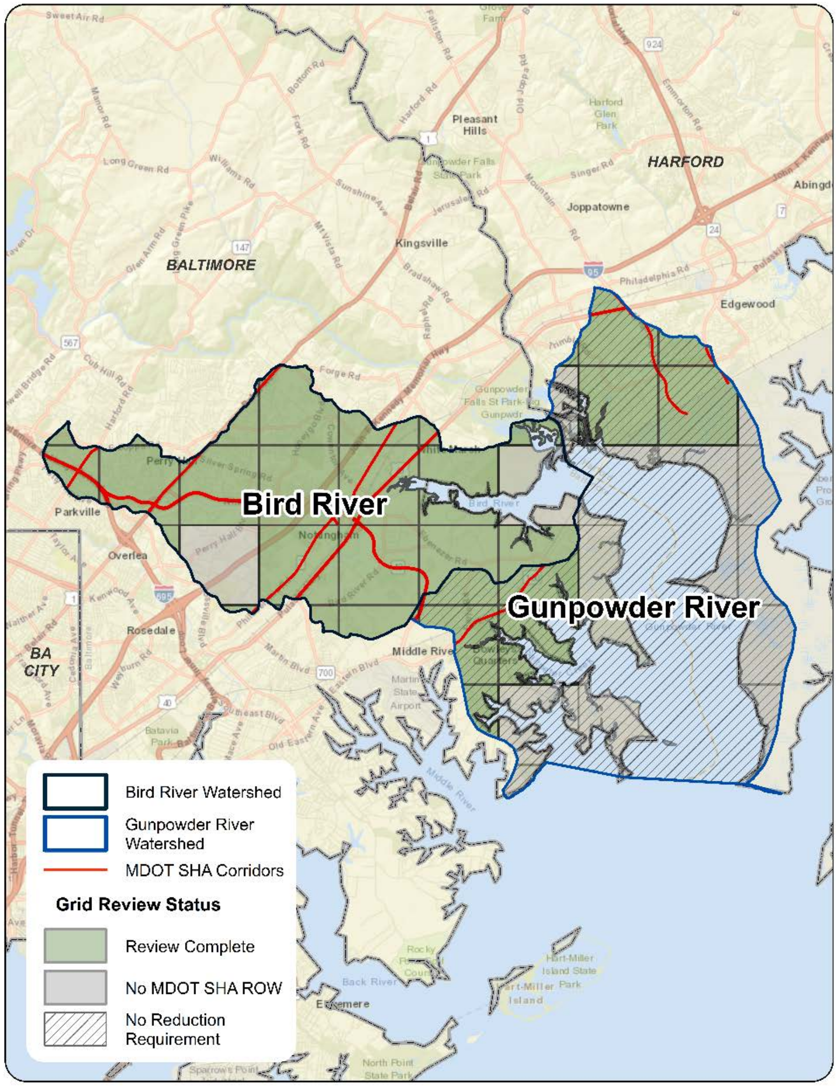


Figure 4-32: Gunpowder River & Bird River Subsegments Site Search Grids

K.4. Summary of County Assessment Review

The designated use of the waters of the Bird River (8-digit Basin Code: 02130803) is Use II – Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting (MDE, 2016c). The Bird River is subject to the following impairments as noted on MDE's 303(d) List:

- PCB in Fish Tissue

The Baltimore County Department of Environmental Protection and Sustainability completed a SWAP for the Bird River watershed (Versar et al., 2014). The Bird River SWAP provides guidance on the restoration of the Bird River watershed. It includes strategies and project prioritizations for watershed restoration and management for each of the eight subwatersheds within the Bird River watershed, namely Whitemarsh Run, Whitemarsh Run (N. Fork), Whitemarsh Run (S. Fork), Honeygo Run, Windlass Run, Bird River-D, Bird River-B, and Railroad Creek_Bird River-A. Maryland Route 43 predominantly runs through the "Whitemarsh Run" subwatershed and separates the "Whitemarsh Run (N. Fork)" and "Whitemarsh Run (S. Fork)" subwatersheds: Whitemarsh Run (N. Fork) is located above MD Route 43 and Whitemarsh Run (S. Fork) is located below MD Route 43. "Bird River-D" and "Bird River-B" surround Bird River: Bird River-D is predominantly the drainage area directly above Bird River and Bird River-B is predominantly the drainage area directly below Bird River. The "Railroad Creek_Bird River-A" subwatershed surrounds Railroad Creek.

Land use/land cover within the Bird River watershed is predominantly urbanized (approximately 50 percent) and forested (approximately 29 percent). Impervious urban land cover comprises 3,058 acres (18.6

percent) of the watershed, and approximately 12 percent of the soils within the watershed are considered as high runoff potential.

The County estimates that impervious urban land use is responsible for contributing 28,269 lbs. of nitrogen, 4,260 lbs. of phosphorus, and 1,729,028 lbs. of sediment in the Bird River watershed each year. Stormwater runoff was identified as the primary contributor of nutrient (nitrogen and phosphorus) and sediment inputs to the Bird River watershed. Trash is another significant source of impairment; the Bird River SWAP states, "Trash is one of the most noticeable pollutants in the Bird River" (Versar et al., 2014, p. 2-3).

Restoration actions are needed throughout the entire Bird River watershed to meet environmental goals and requirements. However, using ranking criteria to prioritize the eight subwatersheds within the Bird River watershed, Baltimore County supports a focused framework to identify which subwatersheds have the greatest need and potential for restoration.

The Bird River SWAP describes the ranking methodology used to prioritize the subwatersheds as follows: The subwatersheds were represented by an overall prioritization score on a scale of 48, based on a set of 12 criteria (listed below) each worth a maximum of four points. A total score of 0 means the subwatershed has the least significant impacts to water quality and a total score of 48 corresponds to a subwatershed with the greatest water quality improvement potential. The total prioritization score for each of the Bird River subwatersheds was determined using the following 12 ranking criteria:

- Phosphorus Loads;
- Nitrogen Loads;
- Impervious Surfaces;
- Neighborhood Restoration Opportunity/Pollution Source Indexes;
- Neighborhood Downspout Disconnection;
- Institutional Site Investigations;
- Pervious Area Assessments;
- Municipal Street Sweeping;
- Municipal Stormwater Conversions;
- Illicit Discharge Data;
- Stream Buffer Improvement; and
- Stream Restoration Potential.

The scoring resulted in the Whitemarsh Run and Honeygo Run subwatersheds being rated as "very high" and the Whitemarsh Run (N. Fork) and Whitemarsh Run (S. Fork) subwatersheds being rated as "high" in terms of restoration need and potential. **Table 4-41** shows the total score of each watershed and its corresponding ranking and prioritization for treatment category.

Table 4-41: County Identified Priority Areas for Treatment in the Bird River Watershed

Rank	Subwatershed	Total Score	Prioritization Category
1	Whitemarsh Run	41	Very High
2	Honeygo Run	31	Very High
3	Whitemarsh Run (N. Fork)	28	High
4	Whitemarsh Run (S. Fork)	28	High
5	Bird River-D	24	Medium
6	Railroad Creek_Bird River-A	17	Medium
7	Bird River-B	14	Low
8	Windlass Run	11	Low

Source: Versar et al. (2014)

The subwatersheds were also ranked by protection priorities (**Table 4-42**). This was done to highlight the importance of protecting areas that are in good condition from any degradation that could occur. This ranking was established by reversing the subwatershed restoration prioritization as listed in **Table 4-41**. Therefore, Windlass Run and Bird River-B were listed as "very high," while Railroad Creek_Bird River-A and Bird River-D were listed as "high" in terms of protection priority.

Table 4-42: County Identified Priority Areas for Protection in the Bird River Watershed

Rank	Subwatershed	Total Score	Protection Category
1	Windlass Run	11	Very High
2	Bird River-B	14	Very High
3	Railroad Creek_Bird River-A	17	High
4	Bird River-D	24	High
5	Whitemarsh Run (N. Fork)	28	Medium
6	Whitemarsh Run (S. Fork)	28	Medium
7	Honeygo Run	31	Low
8	Whitemarsh Run	41	Low

Source: Versar et al. (2014)

Table 4-43 presents Baltimore County-suggested BMPs to aid in meeting the restoration goals within the Bird River watershed. The recommended BMPs are separated out by applicable BMPs for developed and agricultural areas. Several other BMP suggestions such as citizen awareness activities are applicable to all areas of the watershed. The Bird River SWAP indicates that the Bird River-B and Windlass Run watersheds have the most agricultural land (cropland). The largest area of commercial and industrial land use is concentrated around the White Marsh Mall and The Avenue at White Marsh within the Whitemarsh Run watershed.

<table>
<tr><th colspan="2">Table 4-43: County Suggested BMPs for the Bird River Watershed</th></tr>
<tr><th>Developed Areas</th><th>All Areas</th></tr>
<tr><td>• Stormwater Management Upgrades
– conversions (ponds # 883 & # 1633 in the Whitemarsh Run, pond # 951 in Whitemarsh Run (N. Fork), and pond # 1166 in Whitemarsh Run (S. Fork) subwatersheds were recommended for conversion because water quality benefits could be significantly increased in these ponds with minimal effort)
– retrofits
• Stream Corridor Restoration
– stream restoration (data from SCAs indicates that a total of 6,924 linear feet of stream in the Bird River-D, Honeygo Run, and Whitemarsh Run subwatersheds are in need of restoration due to significant erosion and channel alteration)
– buffer restoration
– wetland creation
• Trash and Recycling
– single stream recycling
– household hazardous waste collection
– waterway trash boom
• Reforestation
• Street Sweeping
• Inlet Cleaning
• Illicit Discharge Detection and Elimination (IDDE) Program
• Waterway Dredging
• Land Development Review (including follow-up inspections post construction)</td>
<td rowspan="3">• Citizen Awareness Activities
– Stormwater Runoff
– Pet Waste/Bacteria Awareness
– Fertilizer Reduction
– Trash and Recycling (compost bins, stewardship projects, Baltimore County's Reuse Directory, and the Re-source Newsletter)
– Environmental Awareness and Education

• Volunteer Restoration Programs
– Downspout Disconnection
– Bayscaping
– Tree Canopy Improvement
– Fertilizer Reduction/Education
– Stream Watch Program
– Open Space Trees

• Institutional Initiatives
– Parking Lot Retrofits
– Open Space Planting

• Land Preservation
– Maryland and County Rural Legacy Programs
– Maryland Environmental Trust and Local Land Trusts
– Maryland Agricultural Land Preservation Foundation
– Baltimore County Agricultural Land Preservation Program</td></tr>
<tr><th>Agricultural Areas</th></tr>
<tr><td>• Farm Conservation Plans
– Cover Crop
– Nutrient Management
– Integrated Pest Management
– Residue and Tillage Management
– Conservation Crop Rotation
– Stripcropping

• Nutrient Management Plans</td></tr>
<tr><td colspan="2">Source: Versar et al. (2014)</td></tr>
</table>

The Bird River SWAP also established restoration strategies for each subwatershed as presented in **Table 4-44**. These strategies were based on the individual conditions and needs of each subwatershed.

Table 4-44: County Suggested BMPs for Subwatersheds within the Bird River Watershed

Subwatershed	Recommended Actions												
	Remove Impervious Cover	Stormwater Retrofit	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Tree Planting	Downspout Disconnection	Pet Waste Education	Trash Management	Stream Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping
Bird River-B			✓	✓		✓	✓				✓	✓	
Bird River-D		✓	✓	✓	✓	✓	✓	✓			✓		
Honeygo Run			✓	✓	✓	✓	✓	✓			✓		
Railroad Creek_Bird River-A			✓	✓	✓	✓	✓		✓		✓		
Whitemarsh Run	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Whitemarsh Run (N. Fork)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Whitemarsh Run (S. Fork)		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Windlass Run		✓	✓		✓	✓	✓	✓		✓			

Source: Versar et al. (2014)

K.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet the PCB reductions in the Bird River watershed are shown in **Table 4-45**. Projected PCB reductions using these practices are shown in **Table 3-2**.Four timeframes are :

- BMPs built before the TMDL baseline. In this case, the baseline is 2010;
- BMPs built after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025, and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the PCB TMDL, MDOT SHA will meet 7.4 percent of the MDE 70 percent load reduction requirement through implementation of BMPs shown in **Table 4-45**. MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in Part III Section E.

Estimated capital budget costs to design, construct, and implement annual practices such as inlet cleaning and street sweeping within the Bird River watershed total $1,083,000. These projected costs are based on an average cost per impervious acre treated that is derived from cost history for a group of completed projects for each BMP category. Please see **Table 4-46** for a BMP strategy cost breakdown

Figure 4-33 shows a map of MDOT SHA's restoration practices in the segmentshed and includes those that are under design or construction. Inlet cleaning is not reflected on this map.

Table 4-45: Bird River PCB BMP Implementation						
BMP	**Unit**	**Baseline (Before 2010)**	**Restoration BMPs**			**Total BMPs**
			2020	**2025**	**Future**	
New Stormwater	drainage area acres	209.6	2.1	9.8	TBD	221.5
Retrofit	drainage area acres		11.2		TBD	11.2
Inlet Cleaning[1]	dry tons		9.5	25.7	TBD	35.2
Load Reductions	PCB g/yr.		0.08	0.09	0.88	
				Total Projected Reduction	**0.88**	

[1] Inlet cleaning and street sweeping are annual practices.

Table 4-46: Bird River Restoration BMP Cost			
BMP	**2020**	**2025**	**Total**
New Stormwater	$96,000	$387,000	$483,000
Retrofits	$408,000		$408,000
Inlet cleaning	$45,000	$147,000	$192,000
Total			$1,083,000

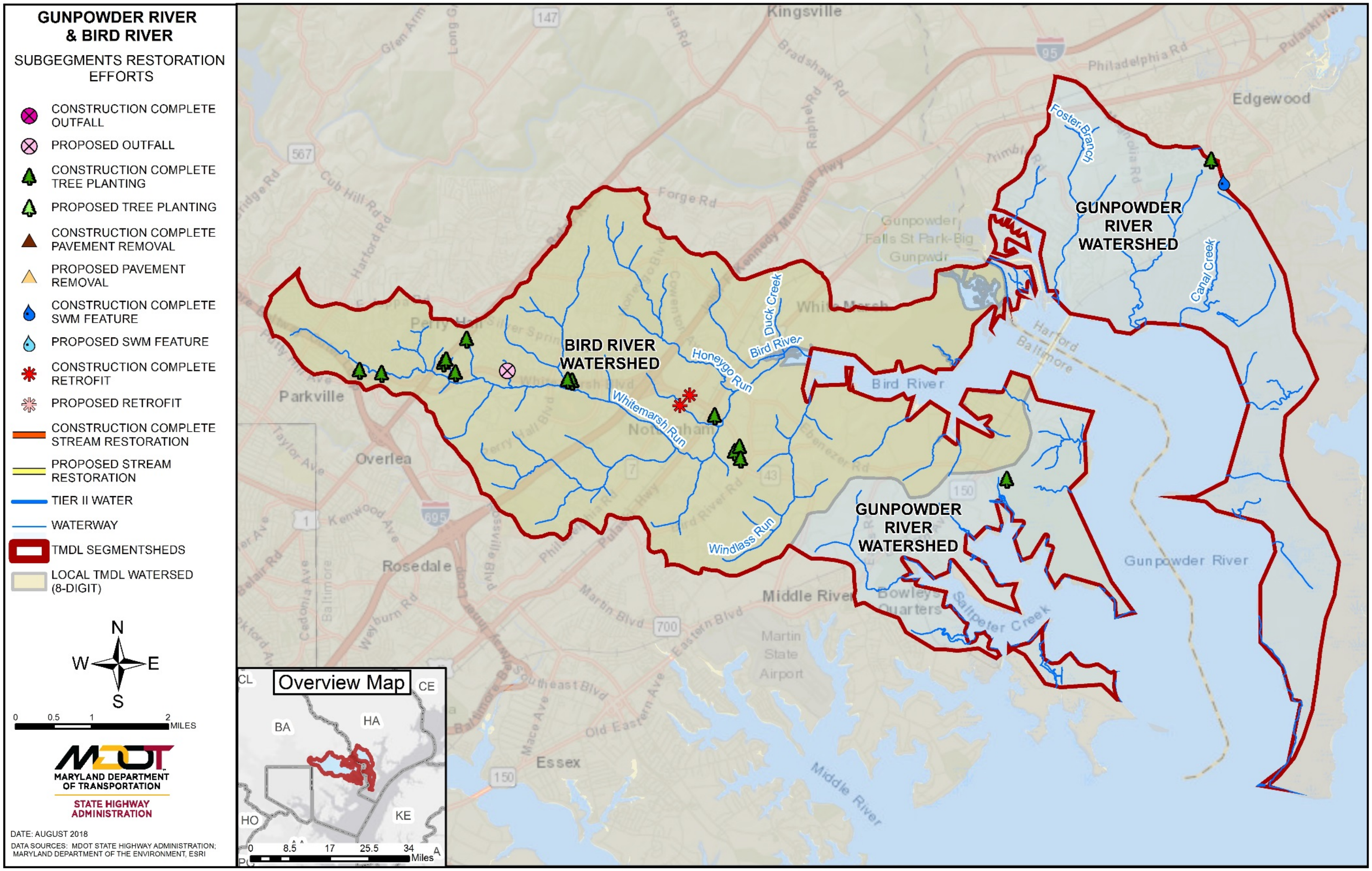


Figure 4-33: MDOT SHA Restoration Strategies within the Gunpowder River & Bird River Subsegments

L. GWYNNS FALLS WATERSHED

L.1. Watershed Description

The Gwynns Falls watershed encompasses 43 square miles within Baltimore County and the City of Baltimore. The Gwynns Falls flows from Baltimore County for 25 miles in a southeasterly direction to City of Baltimore where it empties into the Patapsco River, which runs into the Chesapeake Bay. Tributary creeks and streams of the Gwynns Falls include Dead Run, Horsehead Ranch, Maidens Choice Run, Powder Mill Branch, Red Run, and Scotts Level Run.

There are 1,055.7 centermiles of MDOT SHA roadway located within the Gwynns Falls watershed. The associated ROW encompasses 1,515.7 acres, of which 892.5 acres are impervious. MDOT SHA facilities located within the Gwynns Falls watershed consist of one (1) park and ride facility, one (1) highway garage or shop facility and two (2) salt storage facilities. See **Figure 4-34** for a map of the watershed.

L.2. MDOT SHA TMDLs within Gwynns Falls Watershed

MDOT SHA is included in the sediment (TSS) TMDL (MDE, 2010b) and has a reduction requirement of 36.4 percent within Baltimore County as shown in **Table 3-2.**

The Gwynns Falls is also included in the Middle Branch and Northwest Branch Patapsco TMDL for Trash (MDE, 2015c). The allocated trash baseline for MDOT SHA is to be reduced by 100% (this does not mean that trash within the watershed will be reduced to zero).

L.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Gwynns Falls watershed is shown in **Figure 4-35** which illustrates that 34 grid cells have been reviewed, encompassing portions of 13 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 177 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 140 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 37 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 108 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 56 sites constructed or under contract.
- 18 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.

- 34 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified five (5) sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Five (5) sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 57 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Two (2) new structural SW controls constructed or under contract.
- 55 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 12 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Three (3) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- Nine (9) retrofit sites deemed not viable for retrofit and have been removed from consideration.

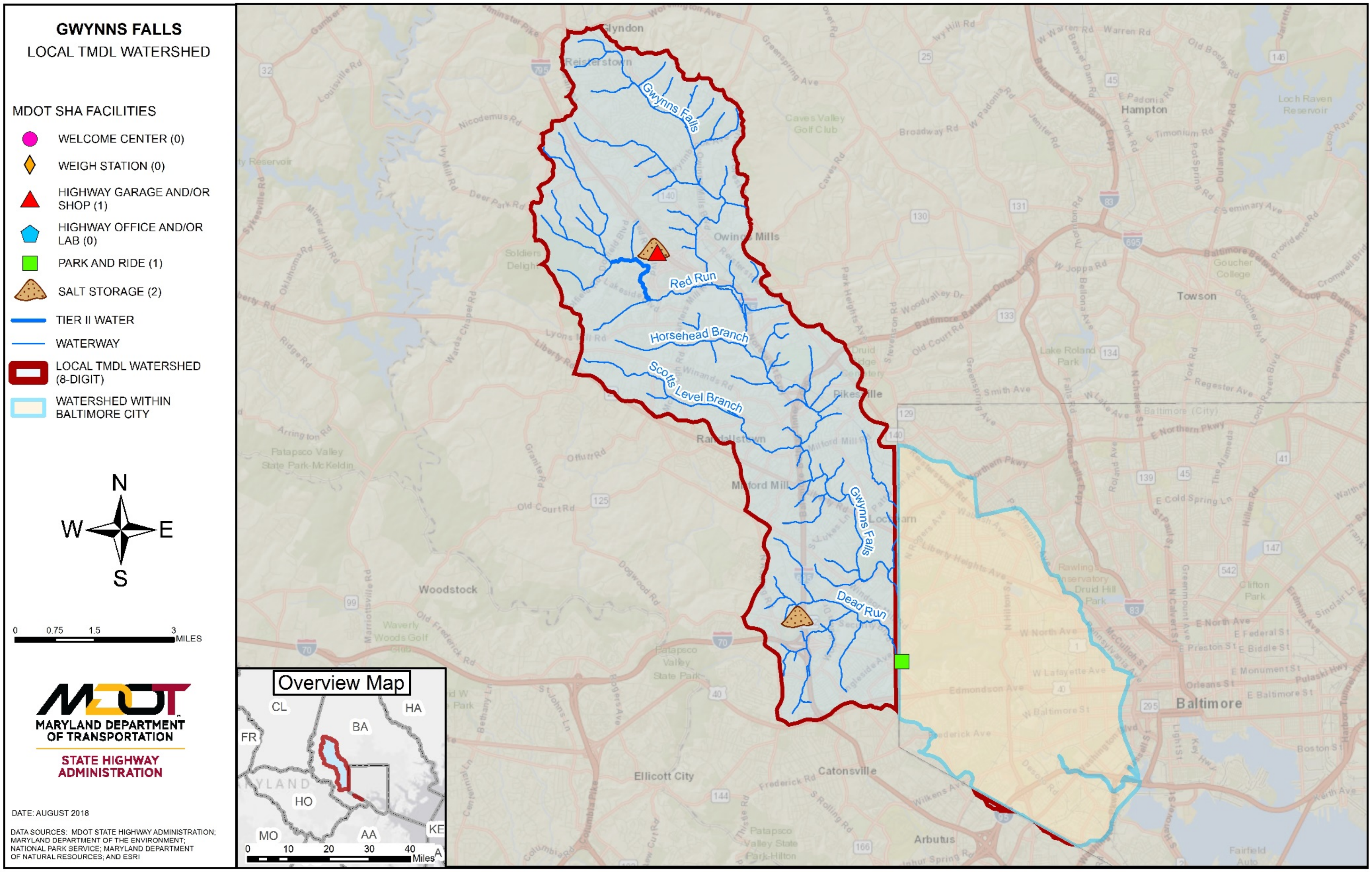


Figure 4-34: Gwynns Falls Watershed

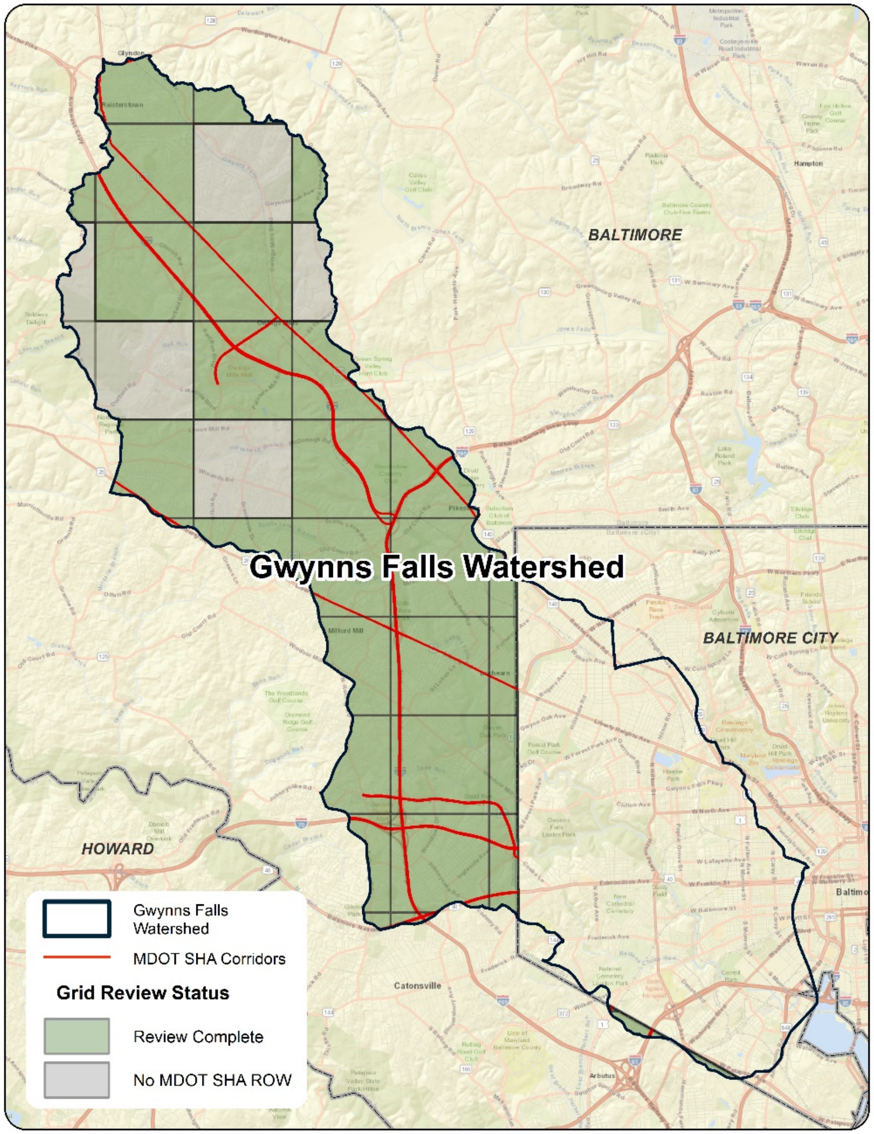


Figure 4-35: Gwynns Falls Site Search Grids

L.4. Summary of County Assessment Review

Waters within the Gwynns Falls watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- Fecal Coliform;
- PCB in Fish Tissue;
- Temperature, water; and
- TSS.

The Baltimore County Department of Environmental Protection and Sustainability completed SWAPs for the Gwynns Falls watershed's Upper Gwynns Falls (UGF) subwatershed (A. Morton Thomas and Associates, Inc. [AMT, Inc.], 2011) and the Middle Gwynns Falls (MGF) subwatershed (PB, 2013), hereinafter referred to as the "UGF watershed" and "MGF watershed," respectively. Impervious land cover makes up 20 percent of the UGF watershed and 29 percent of the MGF watershed. Approximately 11 percent of soils within the UGF watershed and over 30 percent of the soils within the MGF watershed are considered of high runoff potential. The County estimates that impervious urban land use is responsible for contributing 39,029 lbs. of nitrogen and 6,256 lbs. of phosphorus in the UGF watershed per year and 74,468 lbs. of nitrogen, 6,502 lbs. of phosphorus, and 8,833,323 lbs. of sediment in the MGF watershed per year.

There are 28 NPDES-permitted facilities within the UGF watershed, including a MDOT SHA maintenance yard. There are five process water sources with explicit sediment limits within the watershed. The total sediment load from all process water sources within the watershed is estimated at 213.2 tons per year (AMT, Inc., 2011).

The County prioritized subwatersheds within the UGF and MGF watersheds based on ranking criteria to identify which subwatersheds have the greatest need and potential for restoration. For the UGF watershed, the "UGF-D" subwatershed was rated "very high" and the "UGF-B" and "Roche's Run" subwatersheds were rated "high" in terms of restoration need and potential (AMT, Inc., 2011). For the MGF watershed, the "Dead Run" subwatershed was rated "very high" and the "Gwynns Falls" subwatershed was rated "high" in terms of restoration need and potential (PB, 2013).

For the purposes of planning, the County selected the following generalized restoration strategies to aid in meeting restoration goals within the Gwynns Falls watershed:

- Using present SWM facilities;
- Converting SWM facilities;
- SWM retrofits;
- Impervious cover removal;
- Stormwater education and outreach;
- Stream restoration;
- Community Reforestation Program (CRP);
- Street sweeping;
- Illicit connection detection/disconnection;
- Sanitary sewer consent decree;
- MS4 retrofits;
- Credits for Fertilizer Act of 2011;
- Increased State owned property restoration;
- Redevelopment of urban areas;
- Reforestation;
- Downspout disconnection; and
- Urban nutrient management.

The County identified numerous potential restoration sites within each subwatershed by conducting neighborhood source assessments, hotspot site investigations, institutional site investigations, and pervious area assessments. The County also identified multiple potential stormwater conversions within each watershed: 28 for the UGF watershed (AMT, Inc., 2011) and 15 for the MGF watershed (PB, 2013). Detailed information on site locations can be found in the SWAPs.

The County identified 42 proposed project sites for stream restoration and stabilization. Additionally, the County proposed 15 "large projects" (>$300,000) in the UGF watershed. Details on project type and site location for potential restoration projects in the UGF watershed are not included in the SWAP.

The following sites were identified as high priorities for stream restorations in the MGF watershed as shown in **Table 4-47** below.

Table 4-47: County Identified Potential Stream Restoration Sites in Gwynns Falls Watershed

Reach	Number of Sites	Total Linear Feet	Conditions
Gwynns Falls	14	6,000	Severe bank erosion, severe buffer erosion, concrete channels, inadequate buffers, unstable aprons, unstable banks, unstable outfalls
Powder Mill Run	3	5,000	Erosion, unstable banks, inadequate buffers
Maiden Choice Run	2	2,100	Concrete channels, absent floodplains, unstable banks
Scotts Level	3	8,100	Concrete channels, absent floodplains, unstable banks
Source: PB (2013)			

L.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet the sediment and trash reductions in the Gwynns Falls watershed are shown in **Table 4-48** and **Table 4-49**. Projected reductions using these practices are shown in **Table 3-2**. Four timeframes are included in the table:

- BMPs implemented before the baseline year. In this case, the baseline for sediment is 2005 and the baseline for trash is 2010;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the sediment TMDL, MDOT SHA will meet 22.1 percent of the MDE 36.4 percent load reduction requirement through implementation of BMPs shown in **Table 4-48.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Gwynns Falls watershed total $4,482,000. They are based on average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-50** for a summary of estimated BMP costs.

Figure 4-36 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design or constructed. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-48: Gwynns Falls Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	66.4	3.6	17.1	TBD	87.1
Tree Planting	acres of tree planting		59.4	3.0	TBD	62.5
Stream Restoration	linear feet			912.8	TBD	912.8
Outfall Stabilization	linear feet		1.8	400	TBD	401.8
Inlet Cleaning[1]	dry tons		23.0	36.8	TBD	59.8
Load Reductions	TSS EOS lbs./yr.		37,415	110,058	498,014	
				Total Projected Reduction	**498,014**	

[1] *Inlet cleaning is an annual practice.*

Table 4-49: Patapsco-Gwynns Falls Trash & Debris Activities Implementation

BMP	Unit	Restoration BMPs			Total BMPs
		2020	2025	Future	
Stormwater BMP	drainage area acres	5		N/A	5
Stream Clean-Ups	pounds			N/A	
Media Relations (Use of Free Media)	each	4		N/A	4
Outreach: Community/School Children/ Youth	each			N/A	
Inlet Cleaning[1]	No. Inlets	257	200	N/A	457
Street Sweeping[1]	acres	109	164	N/A	273
Load Reductions	lbs./yr.	2,499	2,511	2,511	
			Total Projected Reduction	**2,511**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-50: Gwynns Falls Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$200,000	$580,000	$780,000
Tree Planting	$1,818,000	$92,000	$1,910,000
Stream Restoration		$610,000	$610,000
Outfall Stabilization		$791,000	$791,000
Inlet cleaning	$154,000	$210,000	$364,000
Street Sweeping	$11,000	$16,000	$27,000
Total			$4,482,000

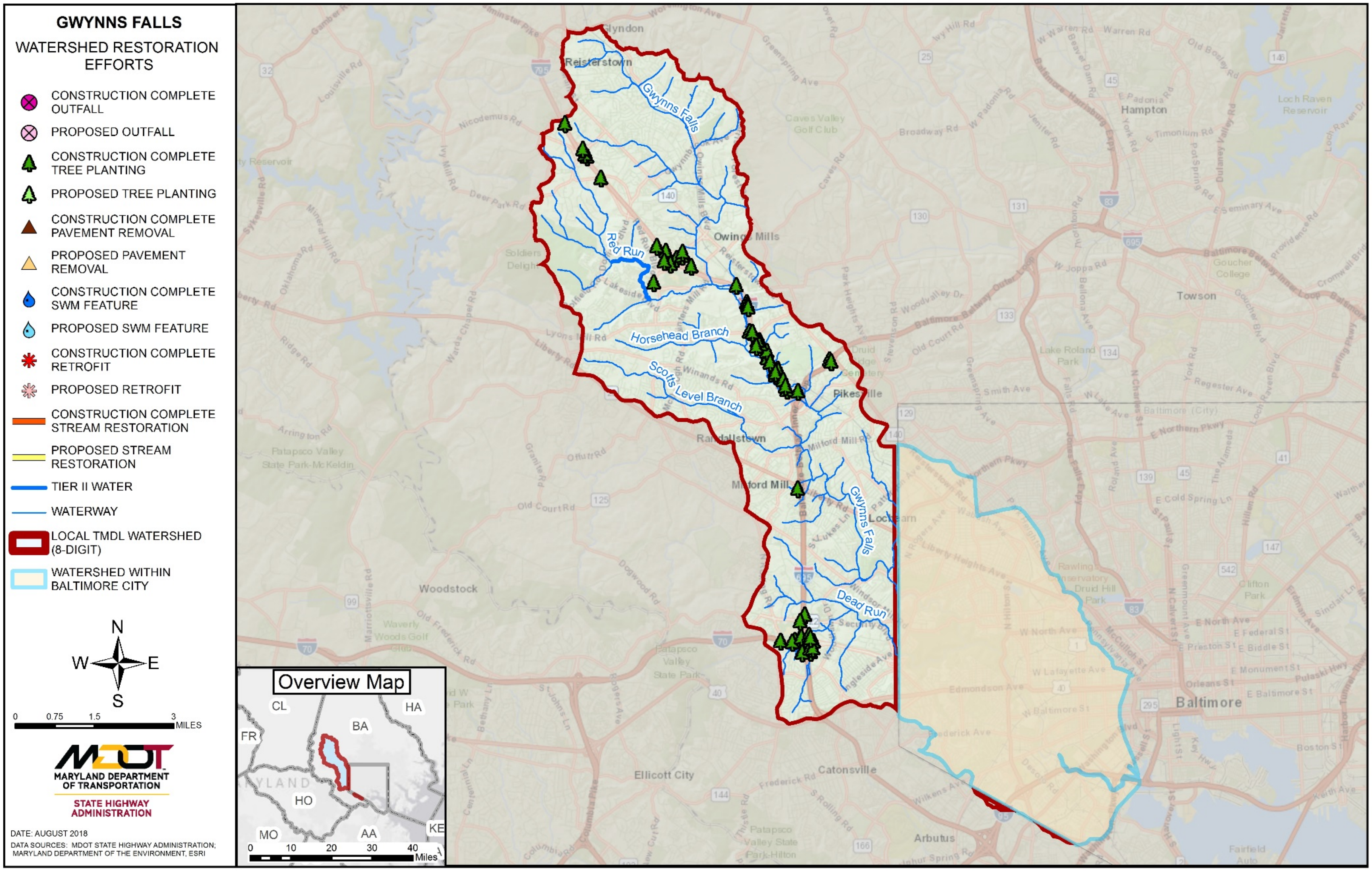


Figure 4-36: MDOT SHA Restoration Strategies within the Gwynns Falls Watershed

M. JONES FALLS WATERSHED

M.1. Watershed Description

The Jones Falls watershed encompasses 77 square miles within Baltimore County and the City of Baltimore. The headwaters of the Jones Falls are located near Garrison in Greenspring Valley, from which it flows east until it reaches Lake Roland, where it is impounded. From Lake Roland, the river merges with eastern tributaries and then continues south through the City of Baltimore to the Inner Harbor. The Jones Falls watershed is comprised of the Upper Jones Falls (UJF) watershed, Northeastern Jones Falls (NJF) watershed, and Lower Jones Falls (LJF) watershed. The UJF watershed makes up approximately 36 percent of the watershed, the NJF watershed makes up 19 percent of the watershed, and the LJF Watershed makes up the lower 45 percent of the watershed. Tributary creeks and streams of the Jones Falls watershed include Moores Branch, Roland Run, Towson Run, Western Run, and Stoney Run.

There are 790.9 centerline miles of MDOT SHA roadway located within the Jones Falls watershed. The associated ROW encompasses 857.9 acres, of which 583.2 acres are impervious. MDOT SHA facilities located within the Jones Falls watershed consist of one (1) salt storage facility and one (1) highway office or lab facility that is located outside of the MDOT SHA MS4 Permit coverage area. See **Figure 4-37** for a map of the watershed.

M.2. MDOT SHA TMDLs within Jones Falls Watershed

MDOT SHA is included in the sediment (TSS) TMDL (MDE, 2011e) and has a reduction requirement of 21.7 percent within Baltimore County as shown in **Table 3-2.**

The Jones Falls is also included in the Middle Branch and Northwest Branch Patapsco TMDL for Trash (MDE, 2015c). The allocated trash baseline for MDOT SHA is to be reduced by 100 percent (this does not mean that trash within the watershed will be reduced to zero).

The Lake Roland subwatershed within the Jones Falls watershed has a TMDL for PCBs (MDE, 2014f) with a reduction requirement of 29.3 percent as shown in **Table 3-2**.

M.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Jones Falls watershed is shown in **Figure 4-38** which illustrates that 29 grid cells have been reviewed, encompassing portions of 13 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 172 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 149 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 23 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 65 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 35 sites constructed or under contract.
- Three (3) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 27 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified seven (7) sites as potential stream restoration locations. Further analysis of these locations resulted in:

- One (1) site constructed or under contract.
- Six (6) sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 54 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Six (6) new structural SW controls constructed or under contract.
- Seven (7) additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 41 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 42 outfalls potential for stabilization. Further analysis of these sites resulted in:

- 42 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified six (6) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- One (1) retrofit site deemed potentially viable for retrofit and pending further analysis may be a candidate for future restoration opportunities.
- Five (5) retrofit site deemed not viable for retrofit and have been removed from consideration.

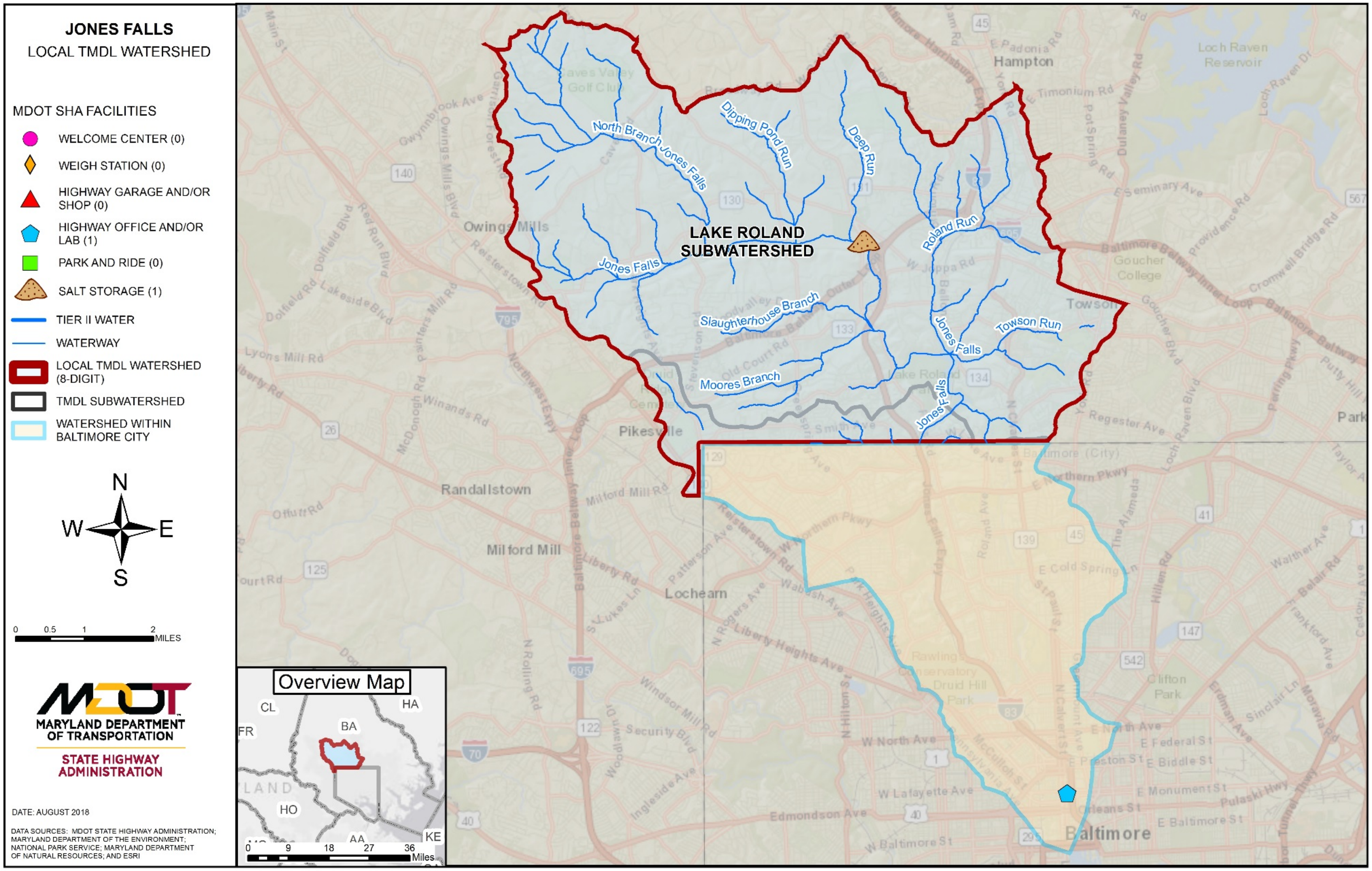


Figure 4-37: Jones Falls Watershed

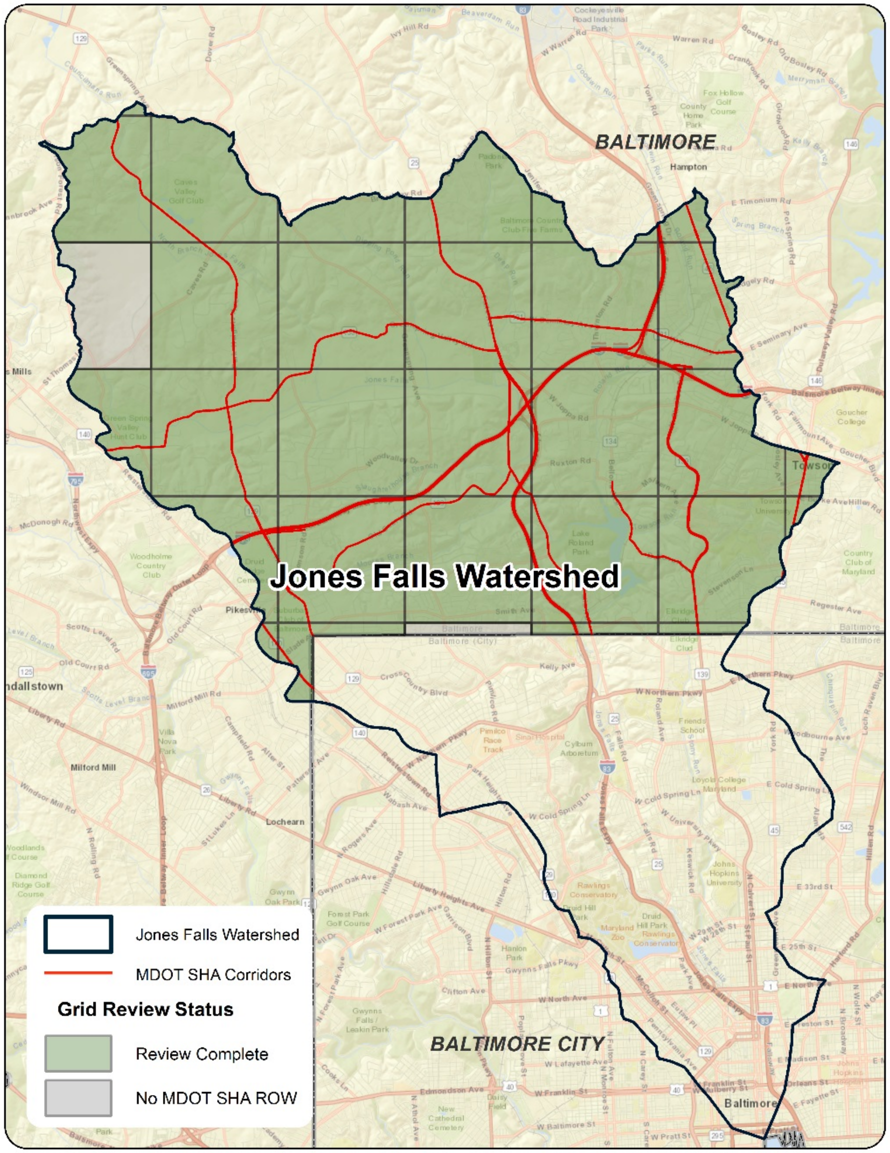


Figure 4-38: Jones Falls Site Search Grids

M.4. Summary of County Assessment Review

Waters within the Jones Falls watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- Fecal Coliform;
- PCB in Fish Tissue;
- Sulfates;
- Temperature, water; and
- TSS.

The Baltimore County Department of Environmental Protection and Sustainability completed SWAPs for the UJF watershed (CWP et al., 2015), the NJF watershed (BA-EPS, 2012), and the LJF watershed (CWP, 2008b). Impervious land cover comprises 9% of the UJF watershed, 25 percent of the NJF watershed, and 32 percent of the LJF watershed. Approximately 7 percent of the soils within the UJF watershed, 9 percent of the soils within the NJF watershed, and 60 percent of the soils within the LJF watershed are considered of high runoff potential. Urban impervious and cropland are the land uses responsible for the greatest nitrogen, phosphorus, and sediment loads within the UJF and NJF watersheds.

Jones Falls currently has completed TMDLs for sediment and fecal coliform in the mainstem and PCBs in an impoundment (Lake Roland). Jones Falls also has Category Five impairment listings (i.e., TMDL required) for chlorides and sulfates in the mainstem and temperature in the Slaughterhouse Branch and two unknown tributaries. The Jones Falls watershed also falls within the Patapsco River Mesohaline segment-shed of the Chesapeake Bay, which has TMDLs for nitrogen, phosphorus, and sediment and Category Five impairment listings for zinc and lead in the Northwest Branch and trash and Enterococcus in the Middle Branch/Northwest Harbor.

The County prioritized subwatersheds within the UJF and NJF watersheds based on ranking criteria in order to identify which subwatersheds have the greatest need and potential for restoration. For the UJF watershed, Jones Falls was the only subwatershed rated "high" in terms of restoration potential. For the NJF watershed, Roland Run was rated "very high" and Towson Run was rated "high" in terms of restoration need and potential. For the LJF watershed, the SCA identified Moore's Branch as the most impacted subwatershed based on stream erosion and inadequate buffer. In the NJF watershed, 20 of the 22 sites assessed by the County had BIBI scores in the "poor" or "very poor" categories. In the LJF watershed, 31 of the 32 sites assessed by the City and 13 of the 15 sites assessed by the County had BIBI scores in the "poor" or "very poor" categories.

For the purposes of planning, the County has selected the following generalized restoration strategies to aid in meeting restoration goals within the Jones Falls watershed:

- SWM for new development and redevelopment;
- Existing SWM facility conversions;
- SWM retrofits;
- Stream corridor restoration;
- Street sweeping and storm drain inlet cleaning;
- Illicit connection detection and disconnection program and hotspot remediation;
- Sanitary sewer consent decrees;
- Downspout disconnection;
- Citizen awareness (fertilizer application and pet waste);
- Pervious Area Restoration (reforestation and tree planting); and
- Agricultural BMPs (stream protection via fencing and conservation tillage).

The County identified numerous potential restoration sites within each subwatershed by conducting neighborhood source assessments, hotspot site investigations, institutional site investigations, and pervious area assessments. The County also identified multiple potential stormwater retrofits and conversions within each watershed: Thirteen in the UJF watershed, 16 in the NJF watershed, and 43 in the LJF watershed. Detailed information on site locations can be found in the SWAPs. The County identified five potential stormwater dry pond conversions in the NJF watershed as "high" priorities for improving water quality. The County also identified 18 potential stream restoration project sites in the NJF watershed, however, location information for these sites is not included in the SWAP.

The following potential stream restoration sites within the Jones Falls watershed are identified in the SWAPs as shown in **Table 4-51.**

Table 4-51: County Identified Potential Stream Restoration Sites in Jones Falls Watershed

Watershed	Reach	Number of Sites	Total Linear Feet	Conditions
UJF	Deep Run	1	-	Fish Barrier
UJF	Dipping Pond Run	10	2,214	Severe erosion, fish barrier, unstable outfalls, inadequate buffers
NJF	Towson Run	1	-	Inadequate buffers, requires naturalization
LJF	Jones Falls	1	-	Inadequate buffers, requires naturalization
LJF	Western Run	1	-	Runoff of I-695
LJF	Lower Jones Falls	1	-	Runoff from upstream urbanization
Sources: CWP et al. (2015); BA-EPS (2012); and CWP (2008b)				

M.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment, PCB, and trash reduction in the Jones Falls watershed are shown in **Table 4-52, Table 4-53,** and **Table 4-54** respectively. Projected sediment, PCB, and trash reductions using these practices are shown in **Table 3-2**. Four timeframes are included in the table:

- BMPs built before the TMDL baseline. In this case, the baseline for sediment is 2005 and the PCB and trash baseline are both 2010;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025;
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the PCB TMDL, MDOT SHA will meet 6.3 percent of the MDE 29.3 percent load reduction requirement through implementation of BMPs shown in **Table 4-53.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated Capital Budget costs to design, construct, and implement trash reduction activities within the Jones Falls watershed total $5,206,000. These projected costs are based on an average cost per impervious acre treated that is derived from cost history for a group of completed projects for each BMP category. Please see **Table 4-55** for a BMP strategy cost breakdown.

Figure 4-39 shows a map of MDOT SHA's restoration practices throughout the Jones Falls Watershed. The practices shown include those that are under design or constructed. Inlet cleaning is not reflected on this map.

Table 4-52: Jones Falls Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	106.3	3.2	14.7	N/A	124.2
Tree Planting	acres of tree planting		18.2	2.6	N/A	20.8
Stream Restoration	linear feet		1264.0	1,982.4	N/A	3,246.4
Outfall Stabilization	linear feet		1.6	400.0	N/A	401.6
Inlet Cleaning[1]	dry tons		11.9		N/A	11.9
Load Reductions	TSS EOS lbs./yr.		64,214	175,689	0	
				Total Projected Reduction	**175,689**	

[1] Inlet cleaning is an annual practice.

Table 4-53: Lake Roland Restoration PCB BMP Implementation

BMP	Unit	Baseline (Before 2010)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	107.6	3.2	14.7	TBD	125.5
Inlet Cleaning[1]	dry tons		10.6	14.6	TBD	25.2
Load Reductions	PCB g/yr.		0.22	0.30	4.71	
				Total Projected Reduction	**4.71**	

[1] *Inlet cleaning is an annual practice.*

Table 4-54: Patapsco-Jones Falls Trash & Debris Activities Implementation

BMP	Unit	Restoration BMPs			Total BMPs
		2020	2025	Future	
Stormwater BMP	drainage area acres	243		N/A	243
Stream Clean-Ups	pounds			N/A	
Media Relations (Use of Free Media)	each	4		N/A	4
Outreach: Community/School Children/ Youth	each			N/A	
Inlet Cleaning[1]	No. Inlets	209		N/A	209
Street Sweeping[1]	acres	218	328	N/A	546
Load Reductions	lbs./yr.	1,679	1,895	0	
			Total Projected Reduction	**1,895**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-55: Jones Falls Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$198,000	$1,152,000	$1,350,000
Tree Planting	$555,000	$80,000	$635,000
Stream Restoration	$828,000	$1,340,000	$2,168,000
Outfall Stabilization		$790,000	$790,000
Inlet cleaning	$125,000	$83,000	$208,000
Street Sweeping	$22,000	$33,000	$55,000
Total			$5,206,000

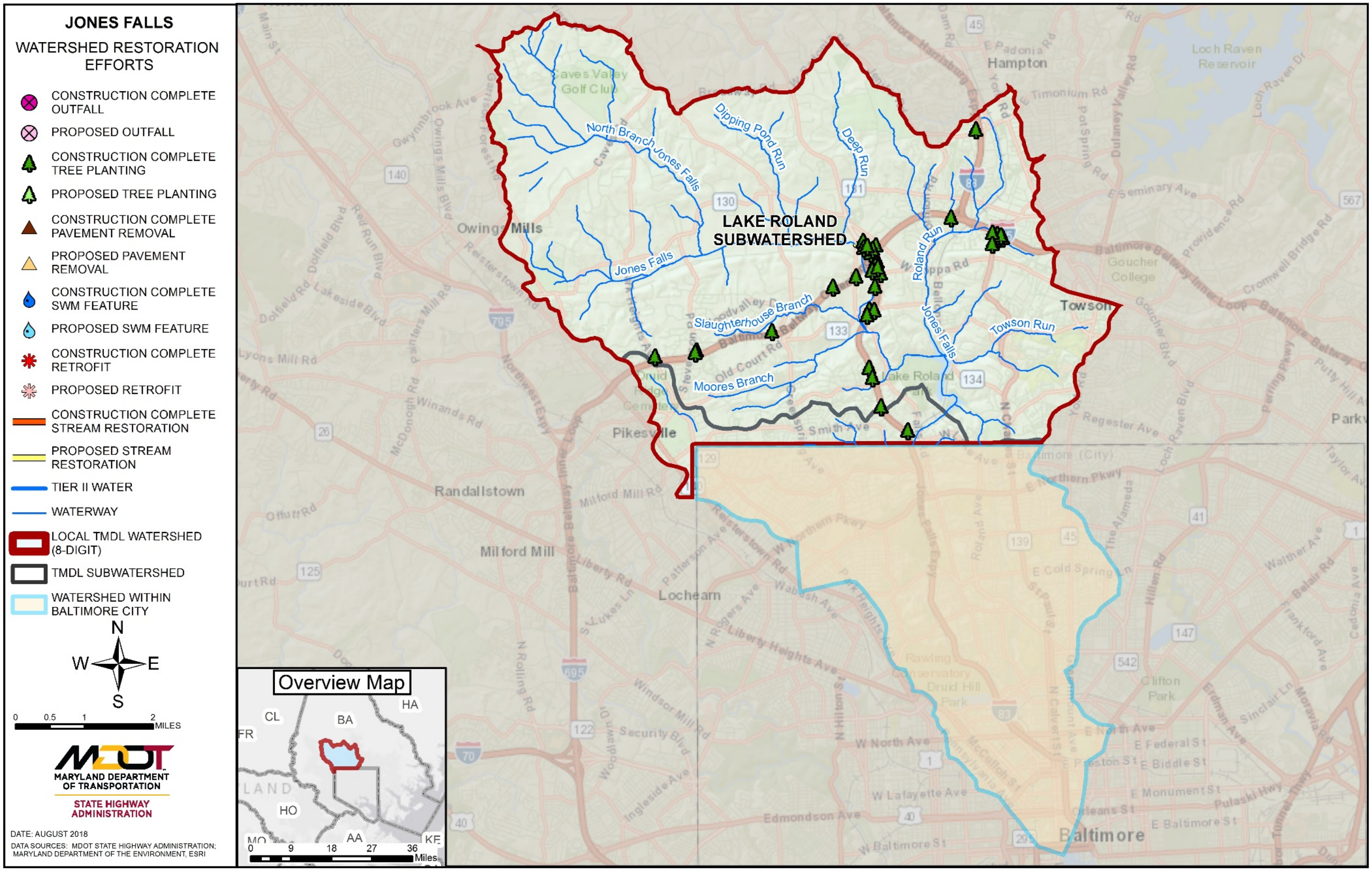


Figure 4-39: MDOT SHA Restoration Strategies within the Jones Falls Watershed

N. LIBERTY RESERVOIR WATERSHED

N.1. Watershed Description

The Liberty Reservoir watershed encompasses 164 square miles within eastern Carroll County and western Baltimore County. The North Branch Patapsco River is the main tributary flowing into the watershed, which empties in the Lower Patapsco River watershed. Liberty Reservoir itself is located to the south of the watershed. Tributary creeks and streams of the Liberty Reservoir watershed include Aspen Run, Beaver Run, Cooks Branch, Deep Run, East Branch North Branch Patapsco, Little Morgan Run, Middle Run, Morgan Creek, Morgan Run, North Branch Patapsco, Norris Run, and Roaring Run.

There are 621.2 centerline miles of MDOT SHA roadway located within the Liberty Reservoir watershed. The associated ROW encompasses 1,979.0 acres, of which 633.1 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) highway garage or shop facility, two (2) park and rides, and two (2) salt storage facilities. See **Figure 4-40** for a map of the watershed.

N.2. MDOT SHA TMDLs within Liberty Reservoir Watershed

MDOT SHA is included in the phosphorus and sediment TMDL (MDE, 2014f) with a reduction requirement of 45.0 percent for both pollutants as shown in **Table 3-2**.

N.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Liberty Reservoir watershed is shown in **Figure 4-41** which illustrates that 75 grid cells have been reviewed, encompassing portions of 17 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 895 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- One (1) new structural SW control constructed or under contract.
- 518 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 376 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 179 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 29 sites constructed or under contract.
- 70 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.

- 80 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 24 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- One (1) site constructed or under contract.
- 23 sites deemed not viable for stream restoration.

Grass Swale Rehabilitation

Preliminary evaluation identified 47 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 10 new structural SW controls constructed or under contract.
- 37 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified four (4) outfalls potential for stabilization. Further analysis of these sites resulted in:

- Four (4) outfall sites constructed or under contract.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified seven (7) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Four (4) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- Three (3) retrofit sites deemed not viable for retrofit and have been removed from consideration.

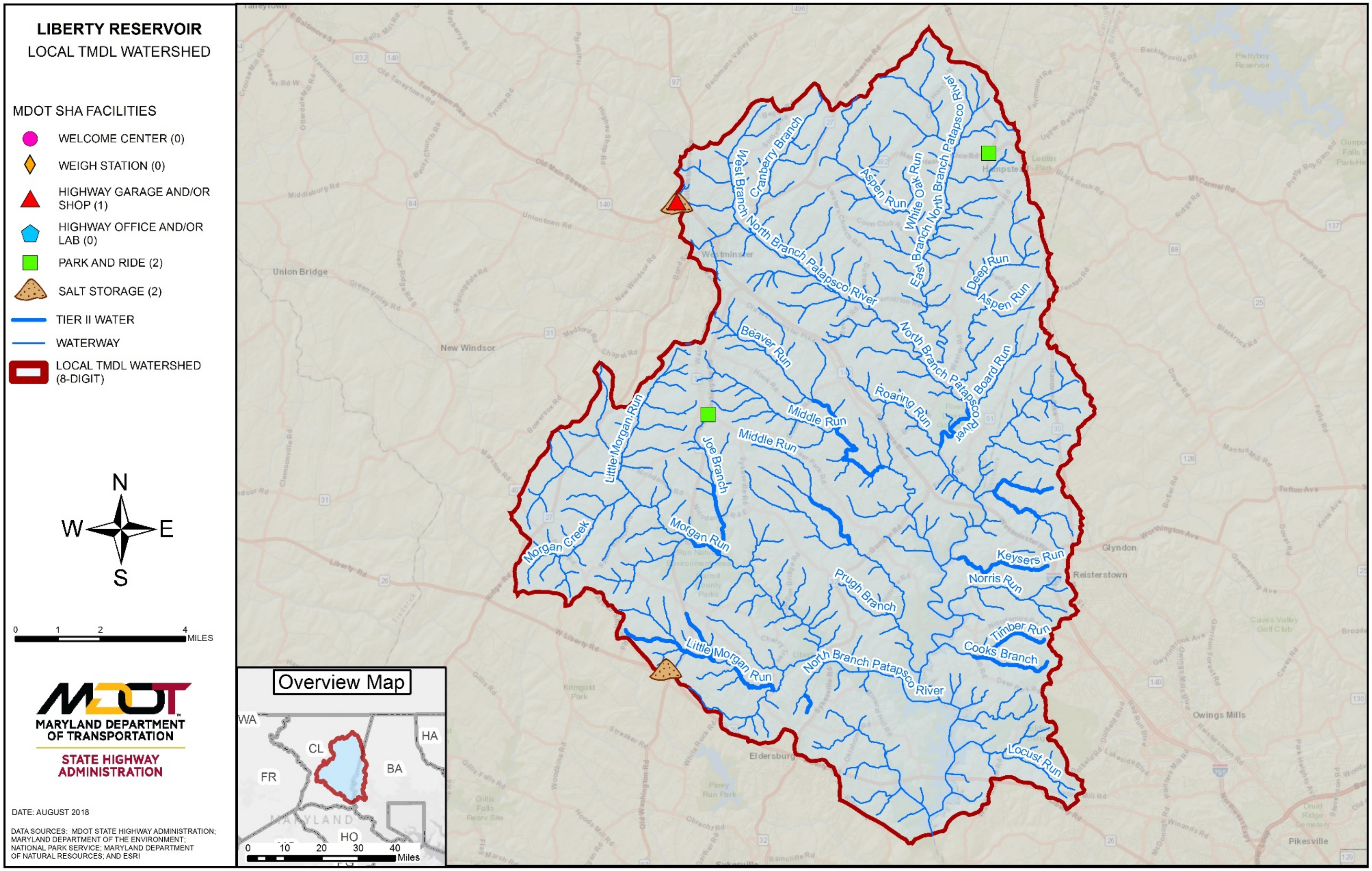


Figure 4-40: Liberty Reservoir Watershed

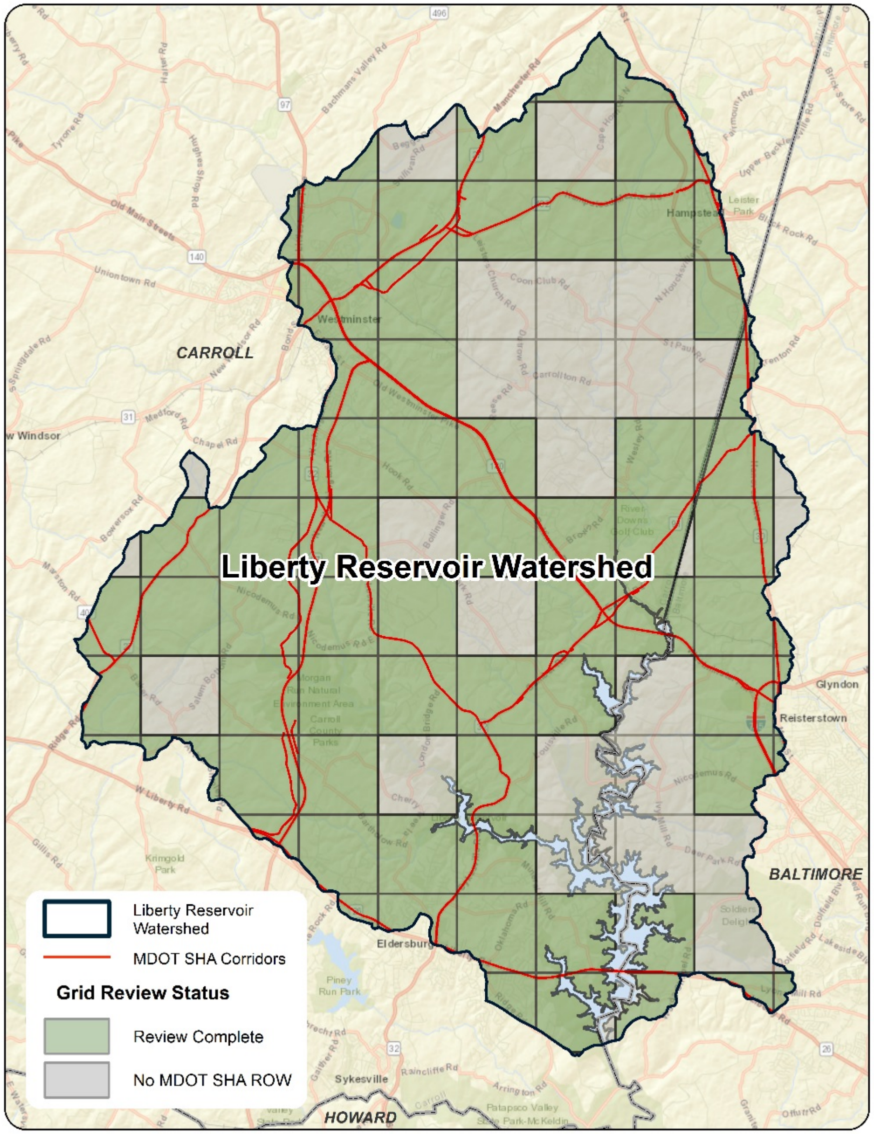


Figure 4-41: Liberty Reservoir Site Search Grids

N.4. Summary of County Assessment Review

Waters within the Liberty Reservoir watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- *Escherichia coli;*
- Phosphorus (Total);
- Sedimentation/siltation; and
- Temperature, water.

The Liberty Reservoir watershed is ranked by the Clean Water Action Plan Technical Workgroup (CWAPTW) in the *Maryland Clean Water Action Plan* as both a "Category 1 Priority" and a "Selected Category 3" (CWAPTW, 1998, p. 31). A Category 1 Priority classification indicates that a watershed needs restoration because it is not meeting clean water and other natural resource goals (CWAPTW, 1998, p. 3). A Selected Category 3 designation means that a watershed has four or more indicators related to the condition of the water (e.g., water chemistry, quality and quantity of physical habitat available for aquatic species, etc.) that meet the Category 3 classification of "pristine or sensitive" watershed needing "an extra level of protection" (CWAPTW, 1998, pp. 3-4, 22). Due to having both a Category 1 Priority and a Selected Category 3 listing, Liberty Reservoir also received the highest priority for restoration and protection under the *Maryland Clean Water Action Plan* (CWAPTW, 1998, p. 32). Six stream segments within this watershed are classified as Tier II waters, which are high quality waters with catchments under regulatory anti-degradation protection that exceed minimum WQSs (MDE, 2012d). Two Tier II segments are located in both Glenn Falls Run and Timber Run, with one in both Keyser Run and Cooks Branch. Impervious land cover comprises 6.3 percent of the watershed on average (DNR, 2002b). Approximately 43 percent of streams in the Liberty Reservoir lack tree buffers (DNR, 2002b).

The BA-EPS completed a SWAP for the Liberty Reservoir watershed (PB, 2015a), and the Carroll County Bureau of Resource Management (CL-BRM) released the *Liberty Reservoir Watershed Steam Corridor Assessment* (CL-BRM, 2012). Carroll County assessments were conducted in 17 subwatersheds, and found 286 inadequate buffer sites, 447 erosion sites, and 151 fish passage barriers, for a total of 93,992 feet of erosion, and 304,986 feet of inadequate buffers (linear footage includes both banks). Site locations were not specified—only included as points on maps in the Liberty Reservoir SCA (CL-BRM, 2012). Most recently, in 2015, Carroll County completed the *Liberty Reservoir Watershed Characterization Plan* (CL-BRM, 2015). According to this characterization plan, the current impairments within the Liberty Reservoir watershed are bacteria, phosphorus, and sediment (CL-BRM, 2015). The Liberty Reservoir watershed is mostly rural with mixed urban uses accounting for less than five percent of the total land use; agriculture is the dominant land use with the Liberty Reservoir watershed (CL-BRM, 2015). Within the watershed, the West Branch Patapsco subwatershed has the highest percentage (21.8 percent) of total impervious area for the entire watershed (West Branch Patapsco subwatershed originates with the city limits of Westminster) (CL-BRM, 2015).

Baltimore County assessments were conducted in three subwatersheds (Cliffs Branch, Keyser Run, and Norris Run), and found 91 inadequate buffer sites, 314 erosion sites, and 78 fish passage barriers, for a total of 26,561 ft. of erosion and 39,680 ft. of inadequate buffer (PB, 2015a). **Table 4-56** lists potential stream restoration sites that were identified by the Baltimore County SWAP, limited to those rated as “Moderate,” “Severe,” or “Very Severe” (PB, 2015a):

Table 4-56: Potential Stream Restoration Sites in Liberty Reservoir, Baltimore County

Subwatershed	Reach ID	Length (ft.)	Impact(s)	Severity
Cliffs Branch	039A1 21-ES	26	Stage I Incision	Moderate
Cliffs Branch	039A1 40-ES	78	Stage I Incision	Moderate
Cliffs Branch	039A1 48-ES	612	Stage I Incision	Moderate
Cliffs Branch	039A1 02-ES	69	Stage II Widening	Severe
Cliffs Branch	039A1 32-ES	18	Stage II Widening	Moderate
Cliffs Branch	031A2 02-ES	44	Stage I Incision	Severe
Cliffs Branch	031A2 03-ES	29	Stage I Incision	Severe
Cliffs Branch	031A2 12-ES	166	Stage I Incision	Moderate
Cliffs Branch	031A2 13-ES	107	Stage I Incision	Moderate
Cliffs Branch	031C3 07-ES	24	Stage I Incision	Moderate
Cliffs Branch	031C2 08-ES	246	Stage I Incision	Very Severe
Cliffs Branch	031C2 09-ES	238	Stage I Incision	Very Severe
Cliffs Branch	031C2 10-ES	257	Stage I Incision	Severe
Cliffs Branch	031C2 11-ES	257	Stage I Incision	Severe
Cliffs Branch	031C2 13-ES	106	Stage I Incision	Moderate
Cliffs Branch	031C2 14-ES	59	Stage I Incision	Moderate
Cliffs Branch	031C2 14-ES	24	Stage I Incision	Moderate
Cliffs Branch	031C2 13-ES	71	Stage I Incision	Moderate
Cliffs Branch	031C2 14-ES	53	Stage I Incision	Moderate
Cliffs Branch	031C2 14-ES	36	Stage I Incision	Moderate
Cliffs Branch	03182 58-ES	106	Stage I Incision	Moderate
Cliffs Branch	03182 57-ES	106	Stage I Incision	Moderate

Table 4-56: Potential Stream Restoration Sites in Liberty Reservoir, Baltimore County

Subwatershed	Reach ID	Length (ft.)	Impact(s)	Severity
Cliffs Branch	03182 54-ES	148	Stage I Incision	Moderate
Cliffs Branch	03182 55-ES	153	Stage I Incision	Moderate
Cliffs Branch	03183 03-ES	192	Stage II Widening	Moderate
Keyser Run	047C2 12-ES	86	Stage II Widening	Moderate
Keyser Run	048a2 52-ES	58	Stage II Widening	Moderate
Keyser Run	048a2 53-ES	83	Stage II Widening	Moderate
Keyser Run	048a2 61-ES	110	Stage II Widening	Moderate
Keyser Run	048a2 03-ES	39	Stage I Incision	Moderate
Keyser Run	048a2 04-ES	28	Stage I Incision	Moderate
Keyser Run	04881 07-ES	112	Stage I Incision	Severe
Keyser Run	04881 08-ES	120	Stage I Incision	Severe
Keyser Run	04881 10-ES	121	Stage I Incision	Moderate
Keyser Run	04881 09-ES	201	Stage I Incision	Moderate
Cliffs Branch	03981 09-FB	--	Fish passage block	Moderate
Cliffs Branch	03182 01-FB	--	Fish passage block – road crossing	Moderate
Cliffs Branch	03981 39-FB	--	Fish passage block – debris dam	Moderate
Cliffs Branch	03182 19-FB	--	Fish passage block – road crossing	Severe
Cliffs Branch	031A3 32-FB	--	Fish passage block	Moderate
Cliffs Branch	031C3 11-FB	--	Fish passage block – road crossing	Moderate
Cliffs Branch	03182 48-FB	--	Fish passage block – channelized	Moderate
Keyser Run	047C1 06-FB	--	Fish passage block – road crossing	Moderate
Keyser Run	047C2 10-FB	--	Fish passage block – road crossing	Very Severe

Table 4-56: Potential Stream Restoration Sites in Liberty Reservoir, Baltimore County

Subwatershed	Reach ID	Length (ft.)	Impact(s)	Severity
Keyser Run	048A2 27-FB	--	Fish passage block – road crossing	Severe
Keyser Run	048A2 57-FB	--	Fish passage block – dam	Severe
Keyser Run	048A2 62-FB	--	Fish passage block – natural falls	Moderate
Keyser Run	048A2 34-FB	--	Fish passage block – road crossing	Moderate
Keyser Run	048A2 36-FB	--	Fish passage block – debris dam	Moderate
Keyser Run	048B1 27-FB	--	Fish passage block – natural falls	Moderate
Keyser Run	078B1 30-FB	--	Fish passage block – natural falls	Moderate
Norris Run	047C2 02-FB	--	Fish passage block – road crossing	Moderate
Norris Run	048B3 17-FB	--	Fish passage block – debris dam	Severe
Norris Run	048A3 05-FB	--	Fish passage block - channelized	Moderate
Norris Run	048B3 33-FB	--	Fish passage block – debris dam	Moderate
Norris Run	048B3 34-FB	--	Fish passage block – debris dam	Moderate

Source: PB (2015a), Vol. II

N.5. MDOT SHA Pollutant Reduction Strategies

Liberty Reservoir is listed for both phosphorus and sediment with each TMDL having a baseline year of 2009. Proposed practices to meet the phosphorus and sediment reductions in the Liberty Reservoir watershed are shown in **Table 4-57**. Projected phosphorus and sediment reductions using these practices are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs built before the phosphorus and sediment TMDL baseline. In this case, the phosphorus and the sediment baseline is 2009;
- BMPs built after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025,

Estimated costs to design, construct, and implement annual practices such as inlet cleaning and street sweeping within the Liberty Reservoir watershed total $21,840,000. These projected costs are based on an average cost per impervious acre treated that is derived from cost history for a group of completed projects for each BMP category. Please see **Table 4-58** for a BMP strategy cost breakdown.

Figure 4-42 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design or construction. Inlet cleaning is not reflected on this map.

Table 4-57: Liberty Reservoir Restoration Phosphorus and Sediment BMP Implementation						
BMP	**Unit**	**Baseline (Before 2009)**	**Restoration BMPs**			**Total BMPs Total**
			2020	**2025**	**Future**	
New Stormwater	drainage area acres	240.5	145.1	77.7	N/A	463.3
Impervious Surface Elimination	acres removed		0.2		N/A	0.2
Tree Planting	acres of tree planting		122.8	13.6	N/A	136.4
Stream Restoration	linear feet			9,759.6	N/A	9,759.6
Outfall Stabilization	linear feet		1.0	1,037	N/A	1,038.0
Inlet Cleaning[1]	dry tons			2.3	N/A	2.3
Street Sweeping[1]	acres swept		51.2		N/A	51.2
Load Reductions	TP EOS lbs./yr.		82	891	0	
Load Reductions	TSS EOS lbs./yr.		68,649	575,302	0	
Phosphorus Total Projected Reduction					**891**	
Sediment Total Projected Reduction					**575,302**	

[1] *Inlet cleaning and Street Sweeping are annual practices.*

Table 4-58: Liberty Reservoir Restoration BMP Cost			
BMP	**2020**	**2025**	**Total**
New Stormwater	$7,618,000	$1,354,000	$8,972,000
Impervious Surface Elimination	$47,000		$47,000
Tree Planting	$3,757,000	$417,000	$4,174,000
Stream Restoration		$6,517,000	$6,517,000
Outfall Stabilization	$2,000	$2,040,000	$2,042,000
Inlet cleaning			$11,000
Street Sweeping	$77,000		$77,000
Total			$21,840,000

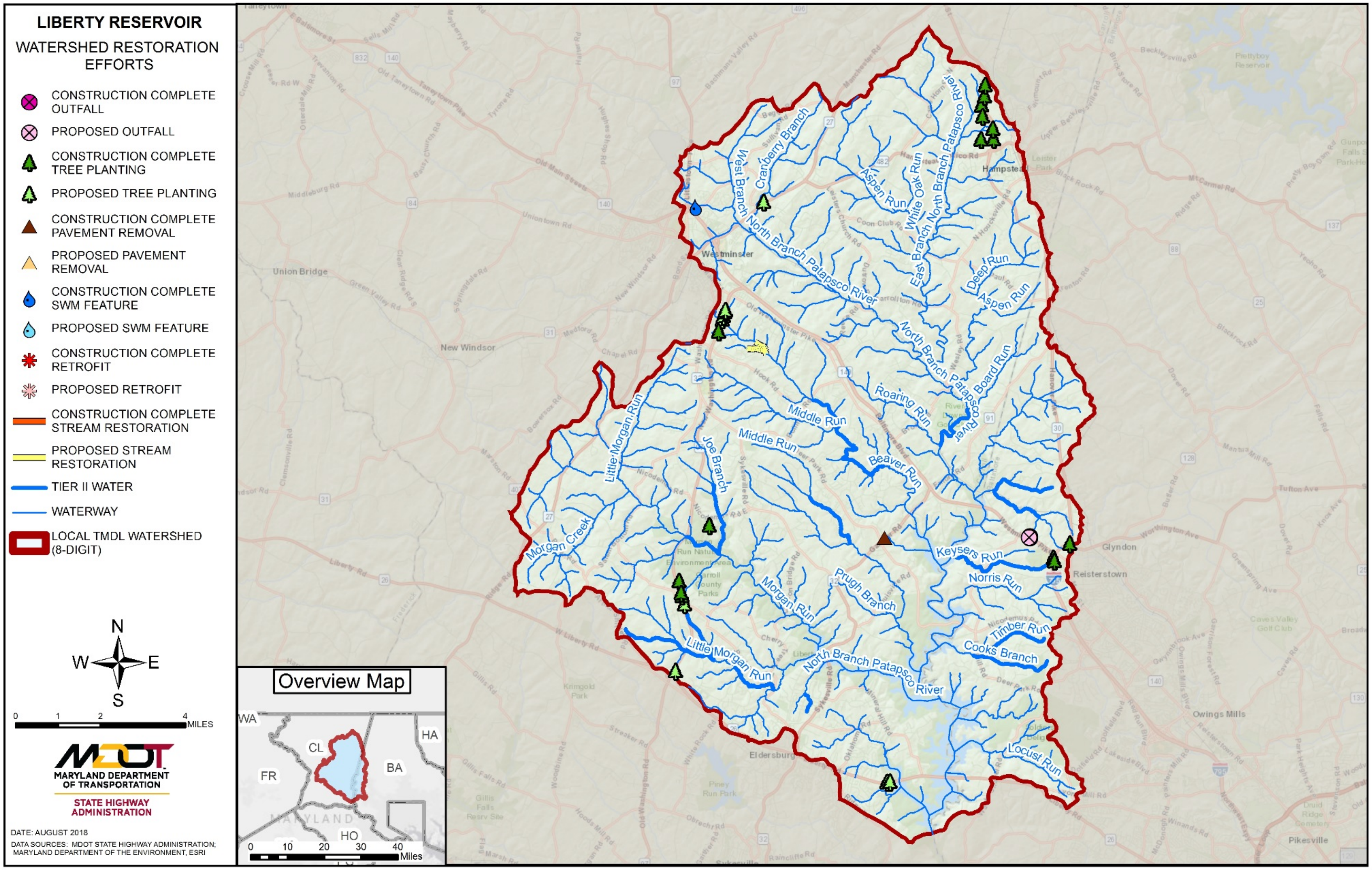


Figure 4-42: MDOT SHA Restoration Strategies within the Liberty Reservoir Watershed

O. LITTLE PATUXENT RIVER WATERSHED

O.1. Watershed Description

The Little Patuxent River watershed encompasses 103 square miles within Anne Arundel and Howard Counties. The Little Patuxent River begins near the Howard County Landfill north of Route 70. Little Patuxent River joins the Patuxent River between the towns of Bowie and Crofton, southeast of the Patuxent Research Refuge. Major tributaries of the Little Patuxent River include Hammond Branch and Midway Branch.

There are 857.9 centerline miles of MDOT SHA roadway located within the Little Patuxent River watershed. The associated ROW encompasses 3,427.4 acres, of which 1,262.9 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) salt storage facility, and five (5) park and ride facilities. See **Figure 4-43** for a map of the watershed.

O.2. MDOT SHA TMDLs within Little Patuxent River Watershed

MDOT SHA is included in the sediment TMDL (MDE, 2011f) with a reduction requirement of 36.1 percent, as shown in **Table 3-2**.

O.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Little Patuxent River watershed is shown in **Figure 4-44** which illustrates that 70 grid cells have been reviewed, encompassing portions of 27 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 472 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 36 new structural SW controls constructed or under contract.
- 250 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 186 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 274 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 94 sites constructed or under contract.
- 30 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 150 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 28 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Four (4) sites constructed or under contract.
- Two (2) additional sites deemed potentially viable for stream restoration and pending further analysis may be candidates for future restoration opportunities.
- 22 sites deemed not viable for stream restoration.

Grass Swale Rehabilitation

Preliminary evaluation identified 103 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 26 new structural SW controls constructed or under contract.
- Four (4) additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 73 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 95 outfalls potential for stabilization. Further analysis of these sites resulted in:

- Two (2) outfall sites deemed potentially viable for outfall stabilization efforts and pending further analysis, may be candidates for future restoration opportunities.
- 93 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 44 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of four (4) existing structural SW controls constructed or under contract.
- 12 retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- 28 retrofit sites deemed not viable for retrofit and have been removed from consideration.

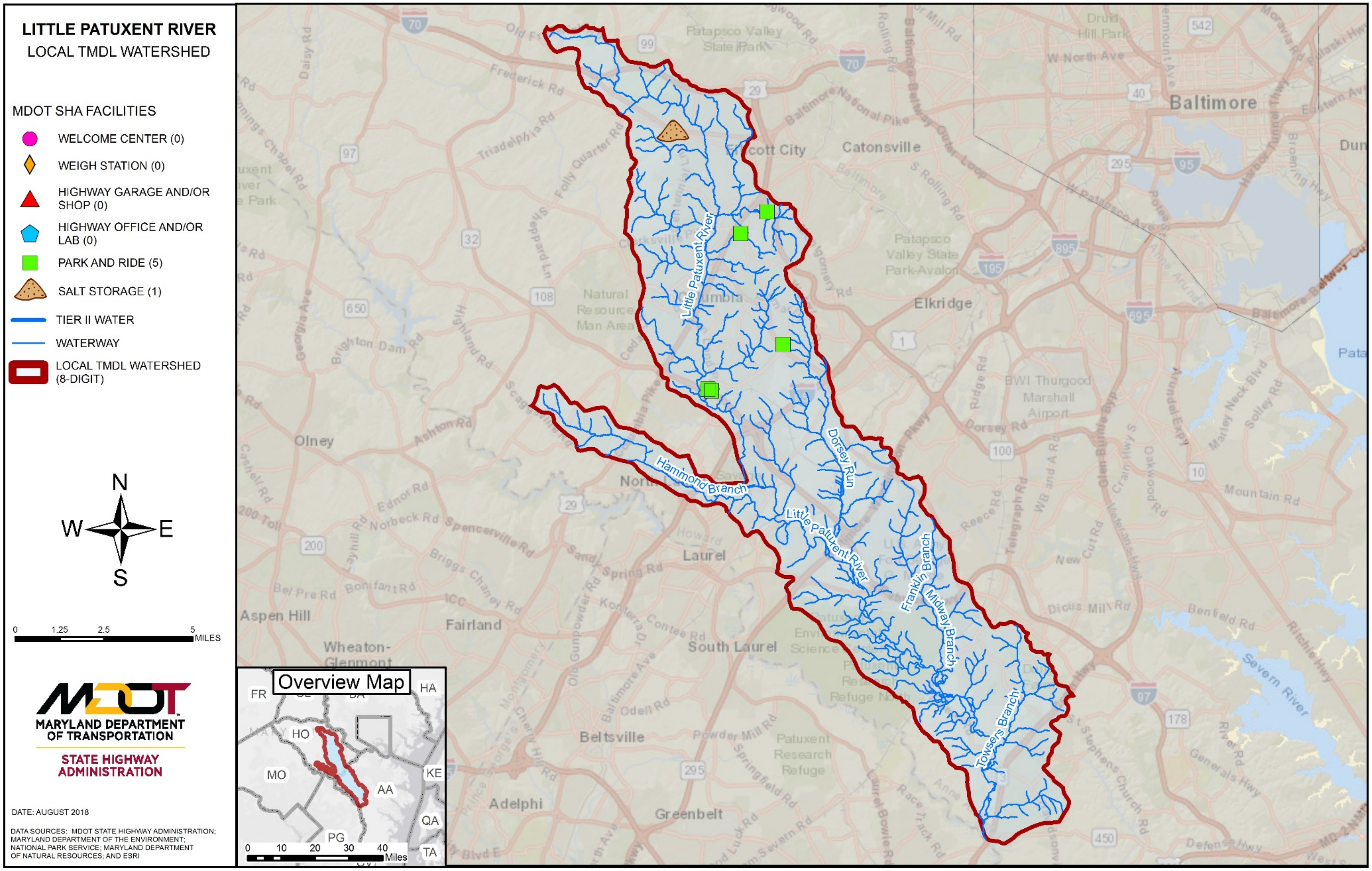


Figure 4-43: Little Patuxent River Watershed

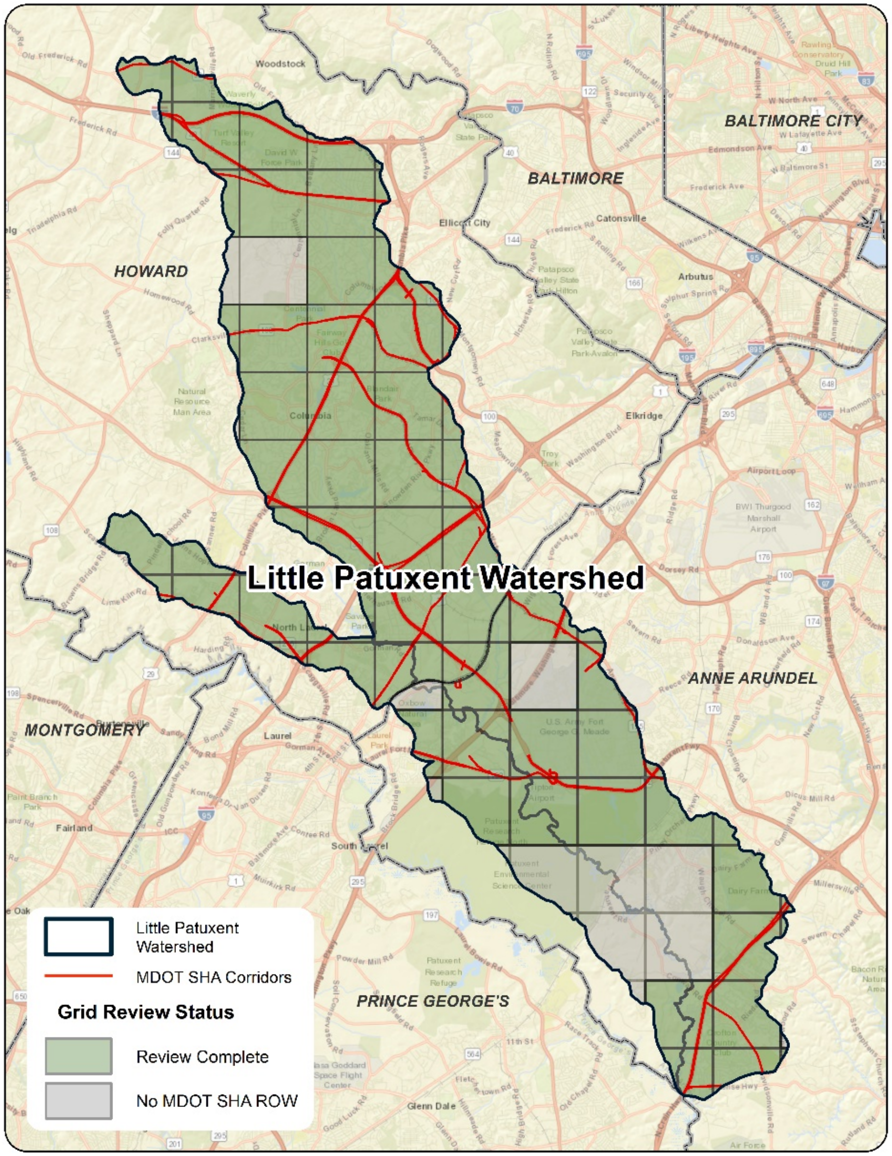


Figure 4-44: Little Patuxent River Site Search Grids

O.4. Summary of County Assessment Review

Waters within the Little Patuxent watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- Phosphorus (Total);
- Sedimentation/Siltation; and
- TSS.

In 2015, Howard County Department of Public Works prepared the *Little Patuxent River Watershed Assessment* (Versar, 2015a). In 2016, the Anne Arundel County Department of Public Works completed the *Little Patuxent Watershed Assessment Comprehensive Summary Report* (LimnoTech & Versar, 2016) in an effort to assess the conditions in the Little Patuxent watershed and to rate and prioritize restoration and protection activities.

Howard County Assessment

Howard County conducts biological monitoring at randomly selected stations in its Countywide monitoring program, which began in 2001. The Little Patuxent watershed consists of the Lower Little Patuxent, Middle Little Patuxent, and Upper Little Patuxent subwatersheds, as well as Dorsey Run and Hammond Branch. With the exception of Hammond Branch and Dorsey Run, which were last sampled in 2009, the watershed was sampled most recently in 2013 (Versar, 2015a).

Of the 281 sites in Little Patuxent watershed identified by Howard County, only 10 (4 percent) were in "good" condition, 31 (11 percent) were rated "fair," 79 (28 percent) were rated "poor," and 160 (57 percent) rated "very poor." Some "good" sites were found in the Upper Little Patuxent subwatershed and upper reaches of Hammond Branch. However, most sites in Lower Little Patuxent subwatershed and Dorsey Run were in "poor" to "very poor" condition. Stream habitat condition was also evaluated by Howard County using EPA's Rapid Bioassessment Protocol (RBP) for habitat assessment. Of the 124 sites assessed, only one site (less than 1%) was rated as "comparable to reference" condition (the highest scoring category). Seventeen (14 percent) sites were rated as "supporting," 48 (39 percent) as "partially supporting," and 58 (47 percent) as "not supporting" (the lowest scoring category), indicating that many streams in the Little Patuxent watershed show evidence of habitat degradation (Versar, 2015a).

In 2014-2015, Howard County's Stormwater Management Division sponsored an assessment of the Little Patuxent watershed within Howard County in order to assess current conditions and recommend watershed restoration opportunities. Employing GIS and field investigations, the project team recommended a suite of opportunities including upgrades to existing stormwater BMPs, new BMPs, tree plantings, stream restoration, and stabilization of stormwater outfalls. In all, this assessment yielded 760 potential projects and produced concept plans for 109 of the top-ranked opportunities identified (Versar, 2015a).

While stream conditions vary across the County, degradation is more prevalent in the heavily developed urban areas. This reflects the history of urban and suburban development prior to effective SWM regulations. Watershed condition is generally better in the more rural parts of the county, but stream degradation still occurs in these areas as a result of large lot development and agricultural impacts. By reducing the adverse effects of stormwater runoff throughout the county, the process of watershed assessment, restoration planning, and implementation of prioritized BMPs should improve the water quality condition in Little Patuxent watershed over time (Versar, 2015a).

For the purpose of planning, the County has developed the following project concepts within the Little Patuxent watershed:

- 15 BMP Conversions;
- Ten New BMPs;
- 19 Tree Plantings;
- 20 Outfall Stabilizations; and
- 45 Stream Restorations.

Howard County listed several stream reaches recommended for restoration due to active erosion, threatened infrastructure and limited habitat. Overall, 14 stream reaches in the Northern Middle Patuxent watershed and 13 stream reaches in the Dorsey Run watershed have high stream restoration potential. Of these high priority reaches, those with the most potential are listed below:

- DOR-SR-F906 is a heavily incised and actively eroding channel which is currently threatening private property as the stream continues to erode and meander.
- DOR-SR-F909, DOR-SR-F910, and DOR-SR-F911 are experiencing moderate to severe erosion, an abundance of depositional areas, and pools filled with fine sediment (primarily silt) indicating large sediment loads upstream.
- DOR-SR-F912 has moderate to severe erosion throughout including degradation and lateral migration. Restoration could include outfall stabilization and BMPs in several locations and the length may be extended further downstream.
- NMP-SR-F133, NMP-SR-F136, and NMP-SR-F145 have severe bank erosion, numerous tree falls, lack of riparian vegetation, and moderate bar deposition.
- NMP-SR-F135 has moderate to severe erosion including headcuts and is highly sinuous.

- NMP-SR-F152 is experiencing severe active erosion along the left bank. Homeowners mow to top of bank, but expressed interest in the County planting a stream buffer.

- NMP-SR-F168 and NMP-SR-F-169 are the mainstem of the Northern Middle Patuxent and a large tributary to the mainstem, both experiencing severe erosion throughout. This is likely a more expensive restoration opportunity than lower order streams.

Anne Arundel County Assessment

The Little Patuxent subwatersheds were assessed in the spring of 2012 to determine the conditions of the watershed and prioritize watershed management activities. A small fraction of soils within the Little Patuxent subwatersheds is highly erodible (10 percent), with most being low in erodibility (37 percent). Thirty-five percent of streams assessed had more than 25 percent impervious cover, with 33 percent of streams with 0-10 percent impervious cover (LimnoTech & Versar, 2016).

The County assessed 304 perennial stream reaches in the Little Patuxent River watershed. Out of the 304 reaches, 7 were rated at “High” priorities for restoration. ranked several stream reaches based on priority for restoration, with the value one being the highest priority as shown below in **Table 4-59** (LimnoTech & Versar, 2016).

Table 4-59: Anne Arundel County High Priority Stream Restoration Projects in Little Patuxent Watershed

Priority Rank	Supbwatershed Code	Subwatershed Name	Reach
1	LP3	Towsers Branch 1	LP3044
2 (tie)	LPC	Towsers Branch 3	LPC048
2 (tie)	LPE	Piney Orchard	LPE006
4 (tie)	LPG	Crofton Golf	LPG030
4 (tie)	LPC	Towsers Branch 3	LPC041
6 (tie)	LP3	Towsers Branch 1	LP3051
6 (tie)	LPC	Towsers Branch 3	LPC049

Source: LimnoTech & Versar (2016), Table 4.2 and Map 4.1

O.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment reduction in the Little Patuxent River watershed are shown in **Table 4-60**. Projected sediment reduction using these practices are shown in **Table 3-2**. Four timeframes are included in the table:

- BMPs built before the TMDL baseline. In this case, the baseline is 2005;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

MDOT SHA will accomplish the projected reduction to be achieved as a percent of the baseline load presented in **Table 3-2**.

Estimated costs to design, construct, and implement BMPs within the Little Patuxent River watershed total $25,689,000. These projected costs are based on an average cost per impervious acre treated derived from a cost history for each BMP type. Please see **Table 4-61** for a summary of estimated BMP costs.

Figure 4-45 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design or construction. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-60: Little Patuxent River Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs Total
			2020	2025	Future	
New Stormwater	drainage area acres	1,086.8	48.5	56.9	N/A	1192.2
Retrofit	drainage area acres		39.1		N/A	39.1
Impervious Surface Elimination	acres removed		0.3		N/A	0.3
Tree Planting	acres of tree planting		93.9	13.0	N/A	106.9
Stream Restoration	linear feet		13,581.0	3,033.2	N/A	16,614.2
Outfall Stabilization	linear feet			800.0	N/A	800.0
Inlet Cleaning[1]	dry tons		3.0		N/A	3.0
Street Sweeping[1]	acres swept		55.8		N/A	55.8
Load Reductions	TSS EOS lbs/yr.		687,501	885,242	0	
				Total Projected Reduction	885,242	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-61: Little Patuxent River Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$5,093,000	$2,627,000	$7,720,000
Retrofits	$1,834,000		$1,834,000
Impervious Surface Elimination	$95,000		$95,000
Tree Planting	$2,873,000	$398,000	$3,271,000
Stream Restoration	$9,069,000	$2,026,000	$11,095,000
Outfall Stabilization		$1,574,000	$1,574,000
Inlet cleaning	$8,000		$8,000
Street Sweeping	$92,000		$92,000
Total			$25,689,000

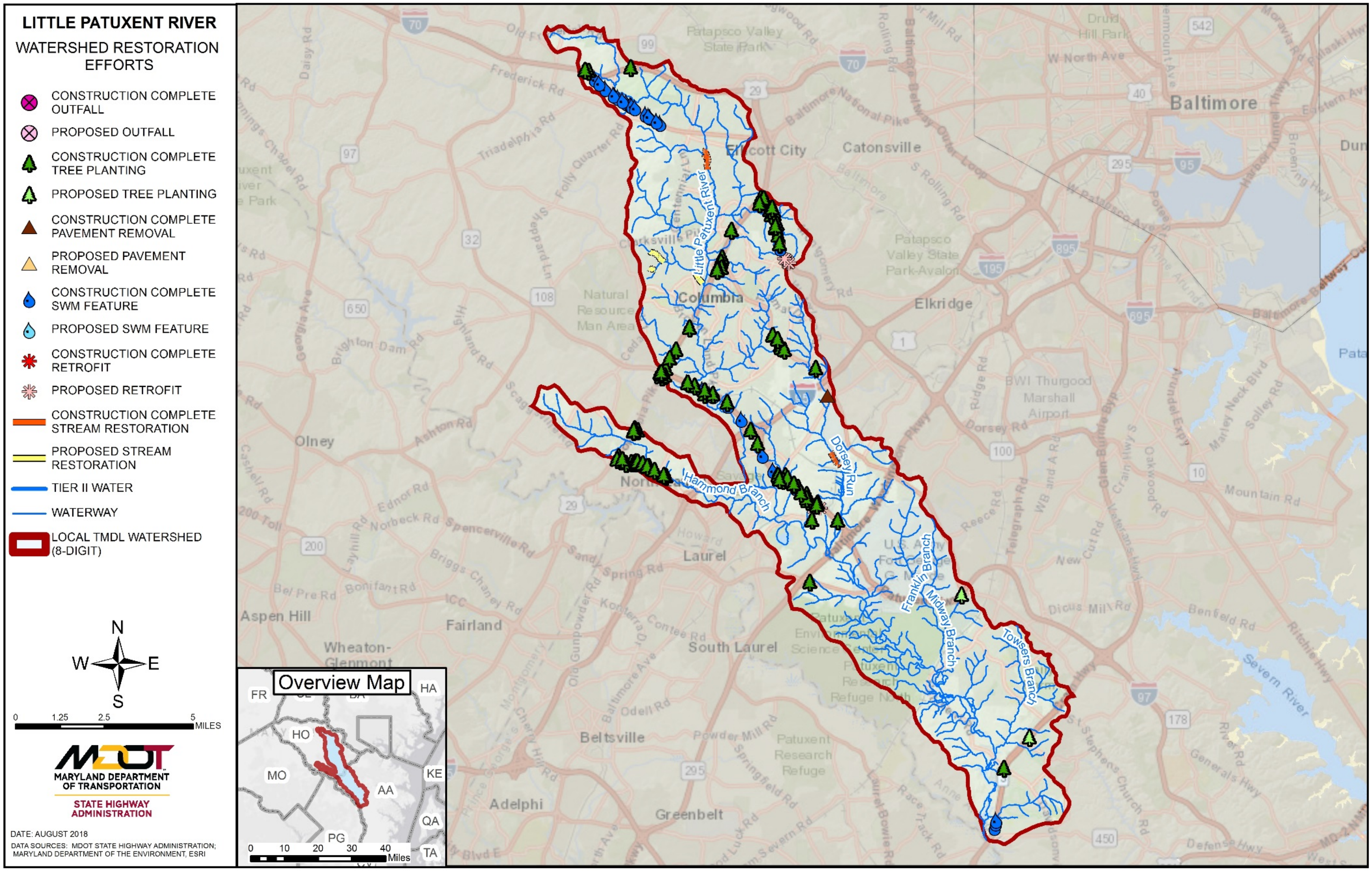


Figure 4-45: MDOT SHA Restoration Strategies within the Little Patuxent River Watershed

P. LOCH RAVEN RESERVOIR WATERSHED

P.1. Watershed Description

The Loch Raven Reservoir watershed encompasses 220 square miles within Maryland and Pennsylvania. In Maryland, the watershed is primarily located within Baltimore County, with small areas in Carroll and Harford Counties. Tributary creeks and streams of the Loch Raven Reservoir watershed include Beaverdam Run, Beetree Run, Blackrock Run, First Mine Branch, Gunpowder Falls, Little Falls, McGill Run, Piney Run, Second Mine Branch, Third Mine Branch, and Western Run.

There are 792.1 centerline miles of MDOT SHA roadway located within the Loch Raven Reservoir watershed. The associated ROW encompasses 1,581.0 acres, of which 825.7 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) highway garage or shop, one (1) highway office or lab, one (1) salt storage facility, one (1) weigh station, and four (4) park and ride facilities. See **Figure 4-46** for a map of the watershed.

P.2. MDOT SHA TMDLs within Loch Raven Reservoir Watershed

MDOT SHA is included in the bacteria TMDL (MDE, 2009d) with a reduction requirement of 87.6 percent, as shown in **Table 3-3**.

P.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Loch Raven watershed is shown in **Figure 4-47** which illustrates that 90 grid cells have been reviewed, encompassing portions of 20 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 361 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 20 new structural SW controls constructed or under contract.
- 246 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 95 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 93 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 51 sites constructed or under contract.
- Eight (8) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 34 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 20 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Three (3) sites constructed or under contract.
- 17 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 128 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 47 new structural SW controls constructed or under contract.
- Three (3) additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 78 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 223 outfalls potential for stabilization. Further analysis of these sites resulted in:

- Seven (7) outfall sites constructed or under contract.
- 13 outfall sites deemed potentially viable for outfall stabilization efforts and pending further analysis, may be candidates for future restoration opportunities.
- 203 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 15 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of two (2) existing structural SW controls constructed or under contract.
- Two (2) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- 11 retrofit sites deemed not viable for retrofit and have been removed from consideration.

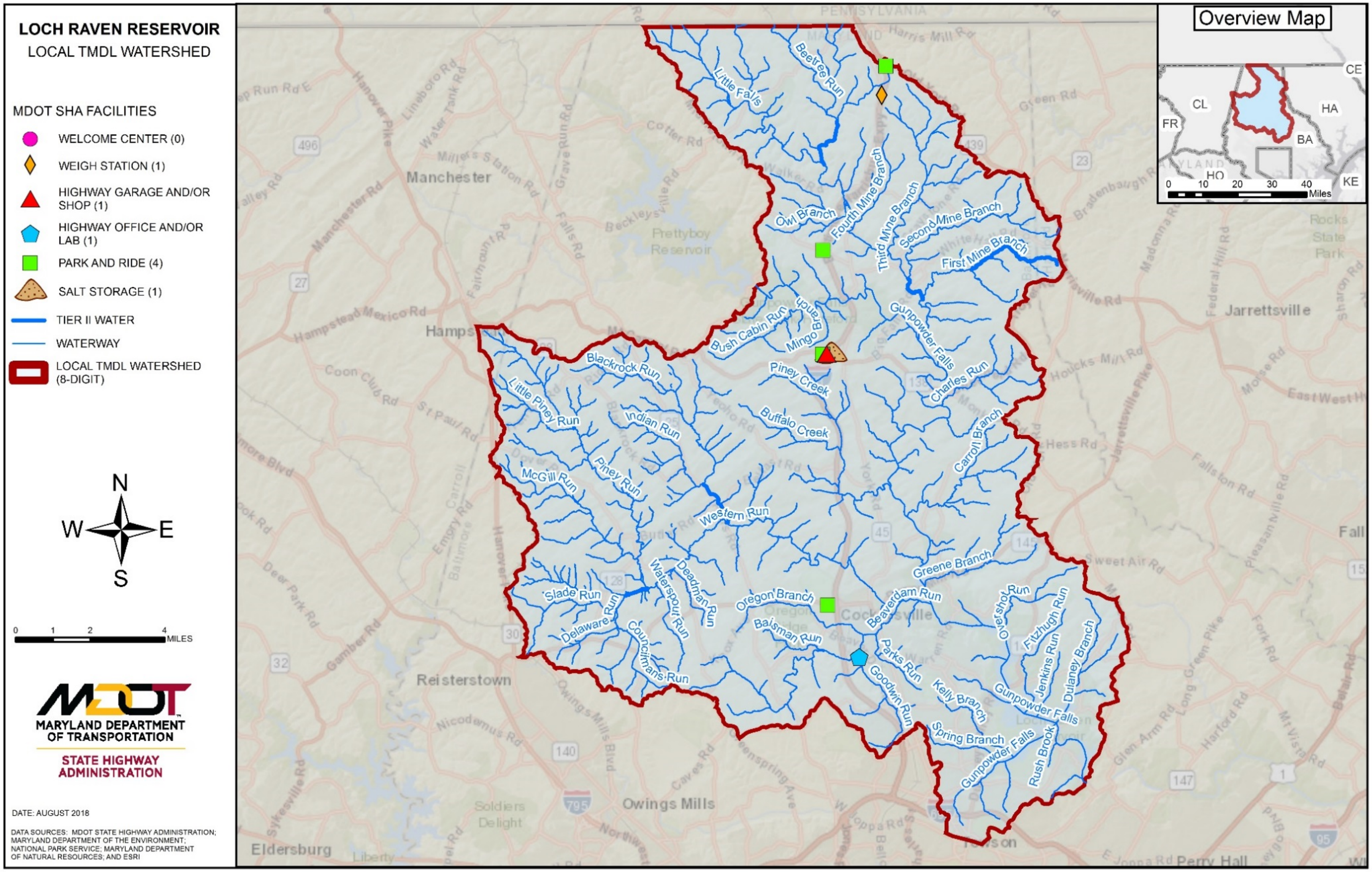


Figure 4-46: Loch Raven Reservoir Watershed

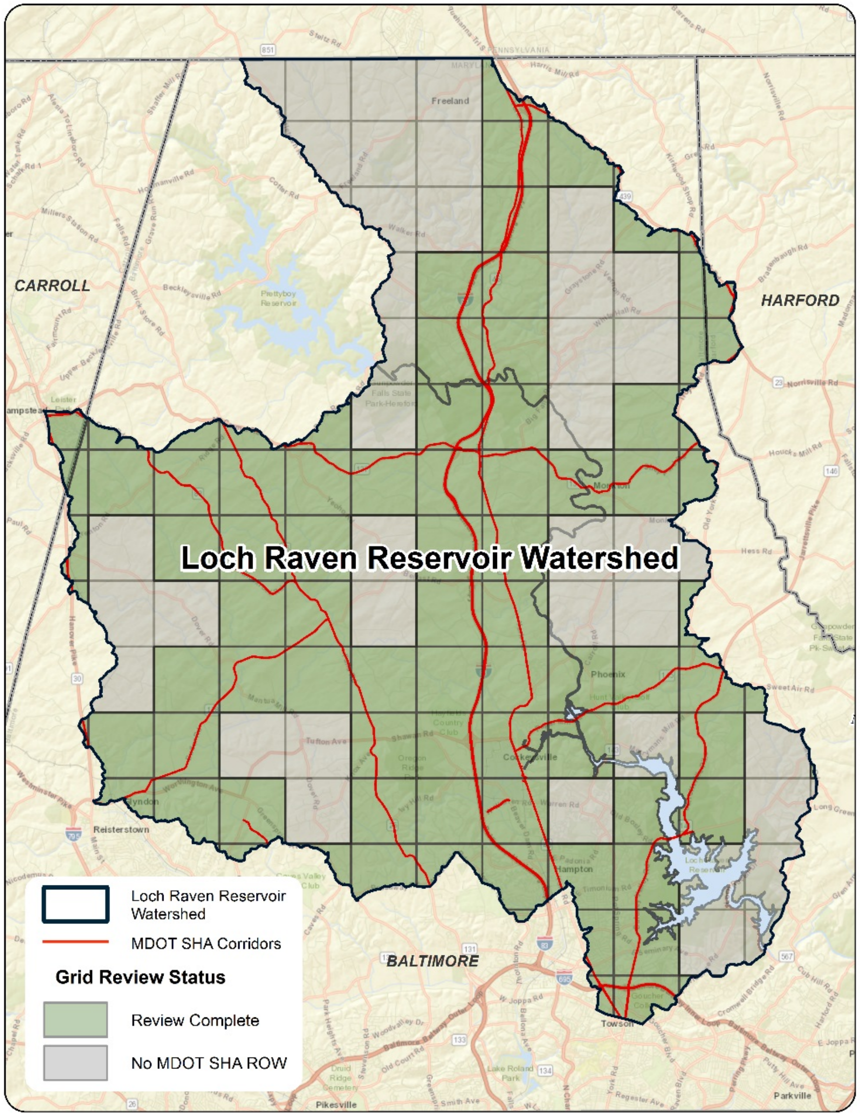


Figure 4-47: Loch Raven Reservoir Site Search Grids

P.4. Summary of County Assessment Review

Waters within the Loch Raven Reservoir watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- *Escherichia coli*;
- Mercury in Fish Tissue;
- Phosphorus (Total);
- Sedimentation/siltation;
- Sulfates; and
- Temperature, water.

As previously mentioned, the Loch Raven Reservoir watershed is predominantly located in Baltimore County; however, there are small areas that cross into Carroll and Harford Counties. In the Spring of 2016, Carroll County published the *Loch Raven Reservoir Watershed Characterization Plan* (CL-BRM, 2016b); the County will use this plan as a tool to develop a future watershed implementation plan for the Loch Raven Reservoir portion within Carroll County.

According to a notice posted on Harford County's "Restoration Plans" webpage, Harford County has a 0% reduction requirement under the Loch Raven Reservoir bacteria TMDL (MDE, 2009d); therefore, no restoration plan is required for this impairment (HA-DPW, 2016).

The Baltimore County Department of Environmental Protection and Sustainability completed SWAPs for the Loch Raven West subwatershed in 2017 (WSP, 2017); Loch Raven North subwatershed in 2015 (PB, 2015b); Beaverdam Run, Baisman Run, and Oregon Branch subwatersheds in 2011 (CWP et al., 2011); Loch Raven East subwatershed in 2014 (CWP et al., 2014); and the Spring Branch subwatershed (SB) in 2008 (BA-DEPRM, 2008b).

The Beaverdam Run, Baisman Run, and Oregon Branch subwatersheds (BBO) makes up approximately 6 percent of the drainage area to the Loch Raven Reservoir watershed. The Loch Raven East subwatershed (LRE) makes up approximately 8 percent of the Loch Raven Reservoir watershed drainage area. The SB makes up less than 1 percent of the Loch Raven Reservoir watershed drainage area (CWP et al., 2011).

Impervious land cover comprises 6.5 percent of the BBO subwatersheds, 4.8 percent of the LRE subwatershed, and 18.6 percent of the SB subwatershed. 16.6 percent of the soils within the BBO subwatershed, 14.8 percent within the LRE subwatershed, and 25.9 percent of the soils within the SB subwatershed are considered highly erodible. Impervious urban, livestock, and cropland are the land uses responsible for the greatest phosphorus loads within the BBO and SB subwatersheds, while cropland and stream channel scour are responsible for the greatest sediment loads. Impervious urban, livestock, and cropland are the land uses responsible for the greatest nitrogen, phosphorus, and sediment loads within the LRE subwatershed (CWP et al., 2011).

The BBO SWAP identified many moderate environmental problems, and several severe problems in Beaverdam Run, Baisman Run, and Oregon Branch based on channel alterations, erosion, and fish blockages (CWP et al., 2011). The LRE SWAP identified eight stream areas in Dulaney Valley Branch, totaling 5,381 feet of erosion, and 34 fish barriers, ten of which are categorized as “very severe” and “severe”. Biological assessments showed a generally unimpaired community in the BBO subwatersheds. While the majority of BIBI scores in the LRE subwatersheds were “good,” the majority of FIBI scores were “poor” (CWP et al., 2014).

For the purposes of planning, the various Loch Raven Reservoir SWAPs indicate that Baltimore County has selected the following generalized restoration strategies to aid in meeting restoration goals within the Loch Raven Reservoir watershed:

- SWM for new development and redevelopment;
- Existing SWM facility conversions;
- SWM retrofits;
- Stream corridor restoration;
- Illicit connection detection and disconnection program and hotspot remediation;
- Downspout disconnection;
- Citizen awareness (bayscaping, fertilizer application, and pet waste); and
- Pervious area restoration (reforestation and tree planting).

Baltimore County identified numerous potential restoration sites within each subwatershed, with the exception of SB where assessments were not completed. The County also identified 13 stormwater retrofit or conversion projects, seven of which fell in the BBO subwatersheds, and the remaining six within the LRE subwatersheds. Detailed information on site locations can be found in the SWAPs. Some of the potential stream restoration sites with very severe to severe erosion in the Loch Raven Reservoir watershed are shown in **Table 4-62**:

Table 4-62: Potential Stream Restoration Sites in Loch Raven Reservoir Watershed

Subwatershed	Site #	Erosion Length (ft)	Conditions
Dulaney Valley Branch	053A1-138ES	163	Stage I Incision caused by land use change
Dulaney Valley Branch	044A3-28ES	41	Stage I Incision
Dulaney Valley Branch	044A3-29ES	26,400	Stage I Incision
Beaverdam Run	BV050A1-ES12-1	852	Erosion with downcutting
Baisman Run	BS041B3-ES14-1	2,606	Erosion with downcutting

Sources: CWP et al. (2011), Vol. 2; CWP et al. (2014), Vol. 2

P.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet the bacteria reduction in the Loch Raven Reservoir watershed are shown in **Table 4-63**. Projected bacteria reduction using these practices are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs built before the TMDL baseline. In this case, the baseline is 2004;
- BMPs built after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2202 through fiscal year 2025,
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the PCB TMDL, MDOT SHA will meet 1.6 percent of the MDE 87.6 percent load reduction requirement through implementation of BMPs shown in **Table 4-63**. MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in Part III Section E.

Estimated Capital Budget costs to design, construct, and implement annual practices such as inlet cleaning and street sweeping within the Loch Raven Reservoir watershed total $3,298,000. These projected costs are based on an average cost per impervious acre treated that is derived from cost history for a group of completed projects for each BMP category. Please see **Table 4-64** for a BMP strategy cost breakdown.

Figure 4-48 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design or construction.

Table 4-63: Loch Raven Restoration Bacteria BMP Implementation

BMP	Unit	Baseline (Before 2004)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	62.2	38.8		TBD	101
Retrofits	drainage area acres		4.9		TBD	4.9
Load Reductions	Enterrococci Billion counts/ day		3,050	3,050	15,678	
				Total Projected Reduction	**15,678**	

Table 4-64: Loch Raven Reservoir Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$3,012,000		$3,012,000
Retrofits	$286,000		$286,000
Total			$3,298,000

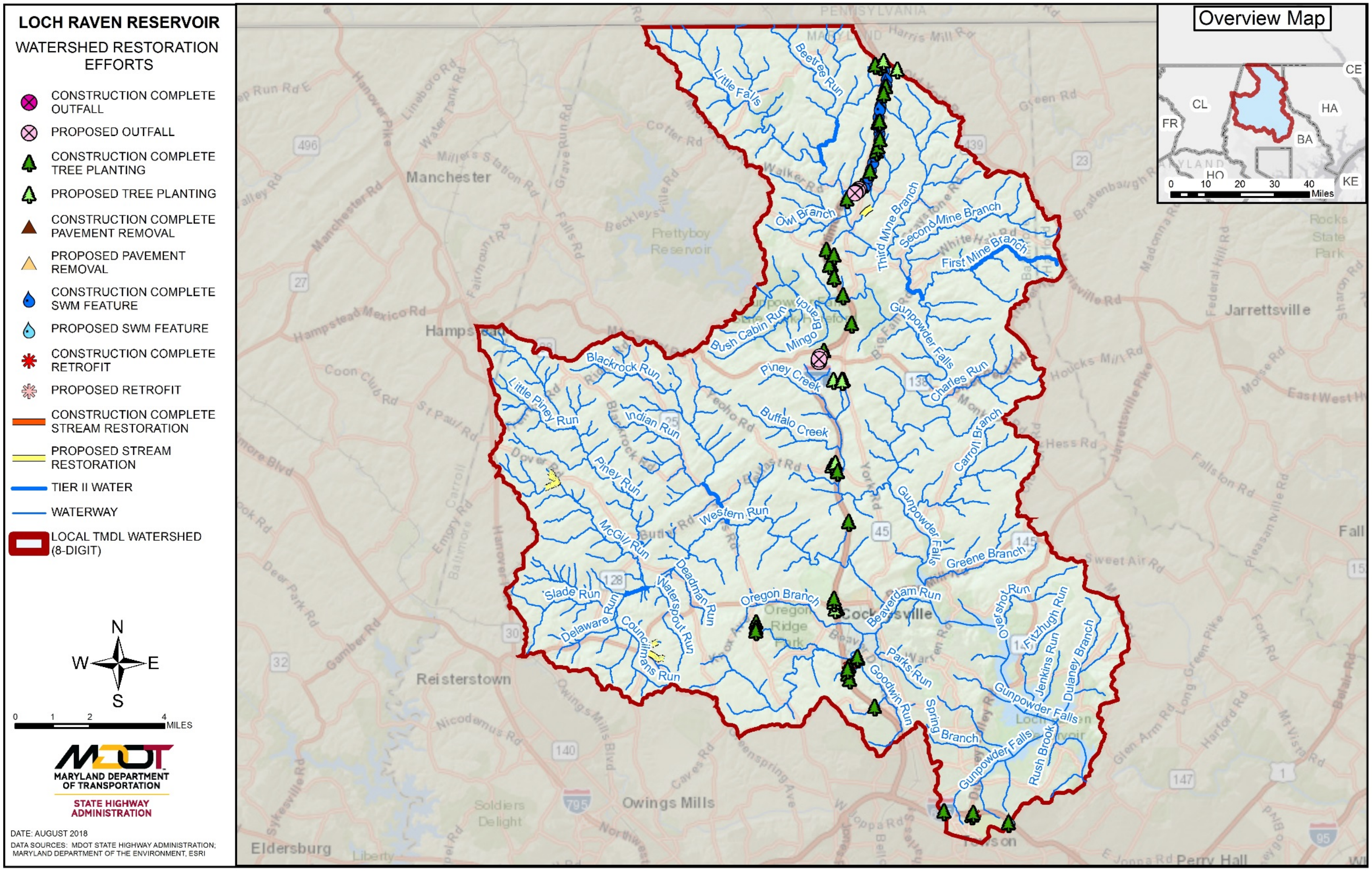


Figure 4-48: MDOT SHA Restoration Strategies within the Loch Raven Reservoir Watershed

Q. LOWER GUNPOWDER FALLS WATERSHED

Q.1. Watershed Description

Located entirely within the central eastern portion of Baltimore County, Maryland, the Lower Gunpowder Falls watershed (Maryland 8-digit Basin Code: 02130802) generally drains eastward toward the tidal portions of the Gunpowder River. The Gunpowder River is formed by the joining of two major tributaries: Little Gunpowder Falls and the mainstem or "Big" Gunpowder Falls (hereinafter referred to as the "mainstem Gunpowder Falls"). Streams within the Lower Gunpowder Falls watershed drain to the mainstem Gunpowder Falls, which joins the Little Gunpowder Falls before flowing into the Gunpowder River. The Gunpowder River, in turn, ultimately flows into the Chesapeake Bay.

The designated use of the non-tidal portion of the Lower Gunpowder Falls is a combination of Use Class I – Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life; Use Class III – Nontidal Coldwater Aquatic Life; and Use Class IV – Recreational Trout Waters (MDE, 2017b).

The Lower Gunpowder Falls watershed is approximately 46 square miles (29,000 acres), not including water/wetlands. The water/wetlands within the Lower Gunpowder Falls watershed comprises approximately 0.1 square miles (80 acres). While the lower portion of the watershed extends slightly into Maryland's Coastal Plain geologic province, the majority of the Lower Gunpowder Falls watershed lies within the Eastern Piedmont province. In addition to the mainstem Gunpowder Falls, other major tributaries in the watershed include Cowen Run, Long Green Creek, Haystack Branch, Sweathouse Run, Minebank Run, Jennifer Branch, and Bean Run.

There are 25.93 centerline miles of MDOT SHA roadway located within the Lower Gunpowder Falls watershed. The associated ROW encompasses approximately 222 acres, of which approximately 126 acres are impervious. MDOT SHA facilities located within the Lower Gunpowder Falls watershed consist of three (3) park and ride facilities.

See **Figure 4-49** for a map of MDOT SHA facilities within the Lower Gunpowder Falls watershed.

Q.2. MDOT SHA TMDLs within Lower Gunpowder Falls Watershed

Waters within the Lower Gunpowder Falls watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- Sulfates; and
- TSS.

MDOT SHA is included in the sediment TMDL (MDE, 2017b), with a reduction requirement of 67 percent, as shown in **Table 3-2**. This TMDL only applies to the non-tidal portion of the Lower Gunpowder Falls watershed. There are no other pollutants with TMDLs and MDOT SHA WLAs for this watershed.

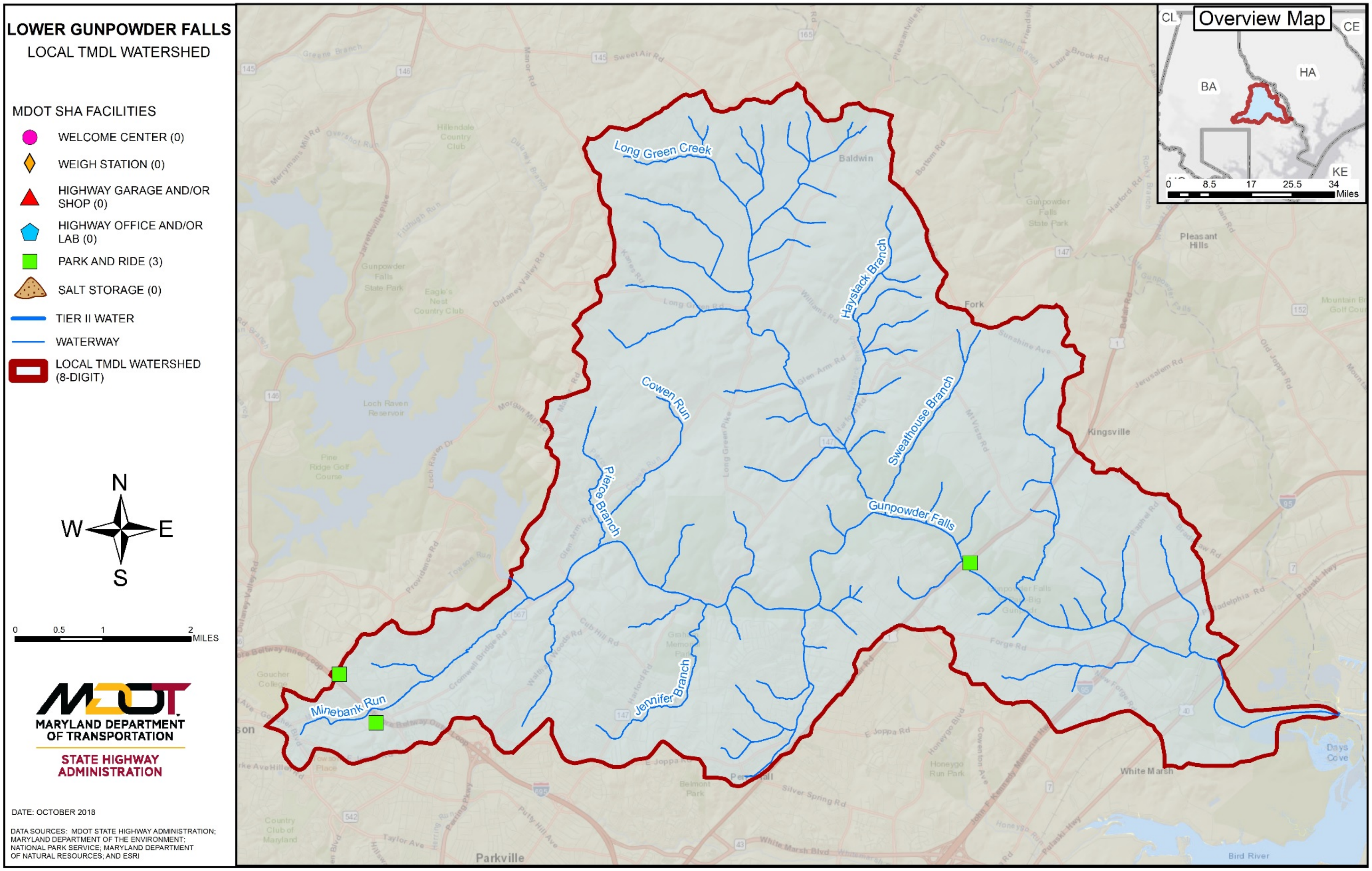


Figure 4-49: Lower Gunpowder Falls Watershed

Q.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan, Section C** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Lower Gunpowder Falls watershed is shown in **Figure 4-50** which illustrates that 29 grid cells have been reviewed, encompassing portions of nine (9) state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 79 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- Four (4) new structural SW controls constructed or under contract.
- 55 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 20 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 93 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 51 sites constructed or under contract.
- Eight (8) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 34 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified eight (8) sites as potential stream restoration locations. Further analysis of these locations resulted in:

- One (1) site constructed or under contract.
- Seven (7) sites deemed not viable for stream restoration.

Grass Swale Rehabilitation

No grass swale rehabilitation sites were identified within this watershed for potential restoration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified five (5) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Five (5) retrofit sites deemed not viable for retrofit and have been removed from consideration.

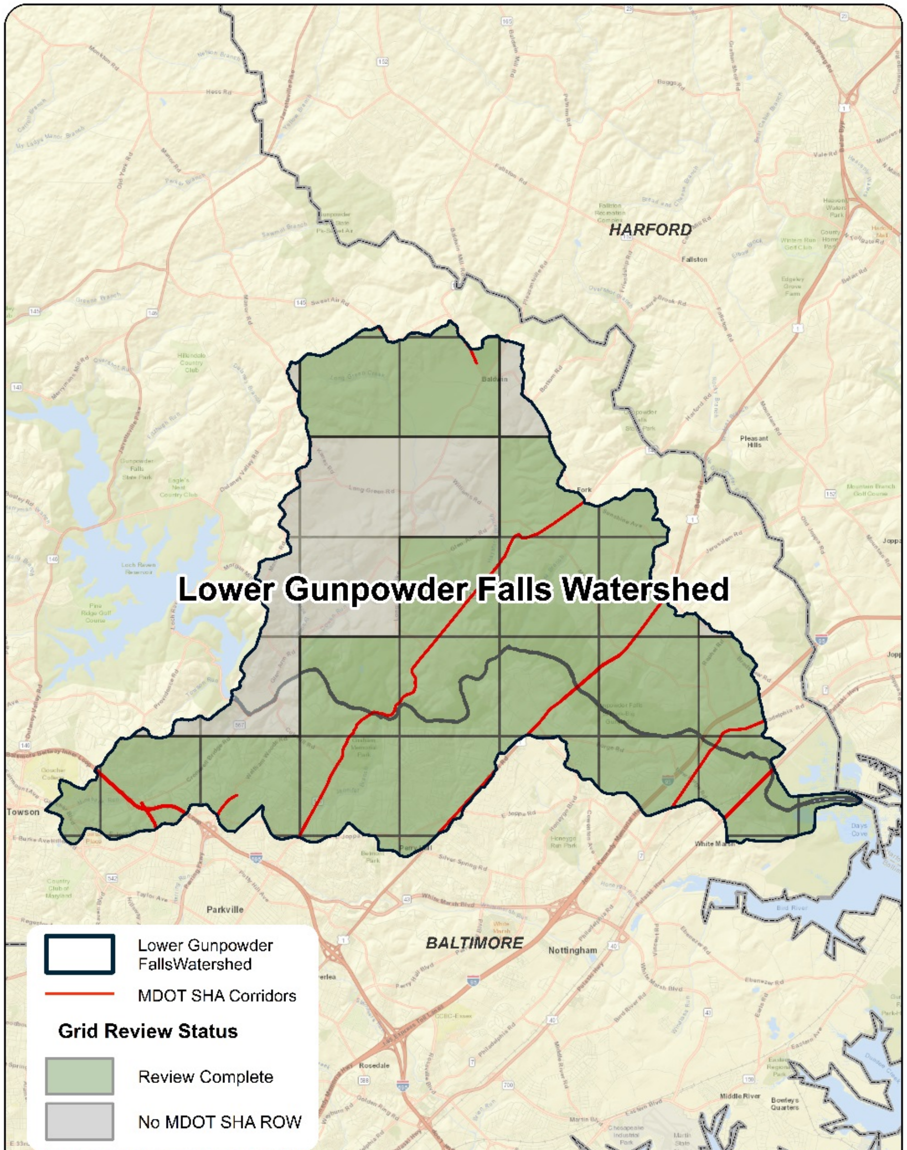


Figure 4-50: Lower Gunpowder Falls Site Search Grids

Q.4. Summary of County Assessment Review

Due to the unique geographic divide that the mainstem Gunpowder Falls creates within the Lower Gunpowder Falls watershed, the Baltimore County Department of Environmental Protection and Sustainability (BA-EPS) has completed two SWAPs for the watershed—one for the rural portion above the mainstem Gunpowder Falls (northern side) and one for the urban portion of the watershed below the mainstem Gunpowder Falls (southern side).

More specifically, according to BA-EPS, there is “very rural countryside to the north and a very urbanized area on the southern side” (BA-EPS, 2017, “Lower Gunpowder Falls,” para. 2). The BA-EPS further describes the northern and southern side of the mainstem Gunpowder Falls through the watershed as follows:

> *The land to the north is primarily agricultural in nature and includes the communities of Long Green, Hydes, Glen Arm, Fork, Kingsville and Upper Falls. Land south of the river consists of developed areas such as parts of Towson, Carney, and Parkville, the commercial corridor along Joppa Road, and newer, rapidly developing areas such as Perry Hall. The valley forming the Lower Gunpowder Falls main stem consists of heavily forested lands that are part of the Gunpowder Falls State Park. (BA-EPS, 2017, “Lower Gunpowder Falls,” para. 2)*

The following provides a summary of both the rural and urban SWAPS completed for the Lower Gunpowder Falls watershed in 2017 and 2016, respectively. It is important to note that Baltimore County has assigned a letter identifier to all Baltimore County watershed areas with an associated SWAP. Accordingly, Baltimore County has assigned the upper, rural portion of the Lower Gunpowder Falls watershed with the letter “Q” and the lower, urban portion of the Lower Gunpowder Falls watershed with the letter “N.”

BA-EPS SWAP for Lower Gunpowder Falls (Rural) – “Area Q”

Prepared by the Center for Watershed Protection (CWP), KCI Technologies, and Coastal Resources, Inc. for the BA-EPS, the 2017 *Lower Gunpowder Falls (Rural) Small Watershed Action Plan: Final Report* is Baltimore County’s SWAP for the rural portion of the Lower Gunpowder Falls watershed (CWP et al., 2017). According to Baltimore County’s letter identifier system discussed above, the rural/upper portion of the Lower Gunpowder Falls watershed is hereinafter referred to as “Area Q” and its associated SWAP as the “Area Q SWAP.”

The Area Q SWAP provides an assessment of the following six subwatersheds that compose Area Q:

- Cowen Run;
- Long Green Creek;
- Haystack Branch;
- Sweathouse Run;
- Lower Gunpowder Falls–West; and
- Lower Gunpowder Falls–East.

Each of the subwatersheds are located around its corresponding tributary. The Lower Gunpowder Falls–West subwatershed surrounds the upper, western half of the mainstem Gunpowder Falls while the Lower Gunpowder Falls–East subwatershed surrounds the upper, eastern half of the mainstem Gunpowder Falls. All of the subwatersheds drain south towards the mainstem Gunpowder Falls (see **Figure 4-49**).

Water quality within Area Q is largely affected by nitrogen, phosphorus, and sediment inputs. Using ranking criteria to prioritize the six subwatersheds within the rural Lower Gunpowder Falls watershed, Baltimore County numerically ranked the six subwatersheds based on their potential for restoration and need for protection (The final rankings are provided in **Table 4-65**).

Restoration ranks were assigned based on the following eleven criteria:

- Total Nitrogen and Total Phosphorus Loads;
- Biological Indicators;
- Impervious Surfaces;
- Institutional Site Investigation;
- Hotspot Site Investigation;
- Neighborhood Restoration Opportunity/Pollution Severity Indices;
- Neighborhood Lawn Fertilization Reduction/Awareness;
- Stream Buffer Improvement;
- Stream Restoration Potential;
- Septic Systems; and
- Pervious Area Assessment.

A brief description of each restoration ranking criterion and the results of the ranking are as follows (CWP et al., 2017):

<u>Total Nitrogen and Total Phosphorus Loads</u>: Annual total nitrogen and total phosphorous loads (lbs/year) were calculated using the pre-defined land use-based loading rates (lbs/acre/year) provided by the Baltimore County Land Cover Dataset and the CBP. The subwatersheds within Area Q that experience higher rates of nitrogen and phosphorus loading received higher restoration scores and lower protection scores for this criterion. Long Green Creek had the highest nitrogen loading rate and the highest phosphorus loading rate.

<u>Biological Indicators</u>: Both the FIBI and the BIBI were used to score for biological indicators. The data used for these calculations was provided by BA-EPS and the DNR-led Maryland Biological Stream Survey. Restoration scores for subwatersheds were higher when

biological indicators were lower. Long Green Creek was in the highest need of restoration based on this criterion.

Impervious Surfaces: Impervious surfaces cover 9 percent of Area Q; therefore, Area Q is classified as a “sensitive” watershed, just under the “impacted” classification threshold. Sensitive watersheds have less than 10 percent impervious surface and are typified by stable channels, good habitat, and good to high water quality. In contrast, impacted watersheds have between 10 and 25 percent impervious cover and generally show obvious signs of degradation such as channel widening and a decline in stream habitat. Accordingly, impervious surface cover was estimated for each of the six subwatersheds within Area Q. Lower Gunpowder Falls–West had the lowest amount of impervious surface at 6.5 percent, whereas Cowen Run had the highest amount of impervious surface at 11.6 percent. The Area Q SWAP notes that this relatively low impervious cover range of 6.5 to 11.6 percent may, however, be somewhat misleading because the estimates were provided at the subwatershed scale. This would, for example, not account for potential pockets of concentrated development with much higher impervious cover within Area Q. In addition, the Area Q SWAP cites research showing the inability of brook trout to survive in watersheds with impervious cover percentages above 4 percent.

Institutional Site Investigation: Several institutional sites within Area Q were assessed to identify privately managed properties that have restoration potential. Institutional properties have a high potential for public involvement in restoration activities like stormwater retrofitting and tree planting. Scores were assigned based on the total land area of institutional sites with identified restoration actions within a subwatershed. Containing 170 acres of institutional land sites with identified restoration activities, the Lower Gunpowder Falls–East received the highest score under this criterion. The Haystack Branch and Lower Gunpowder Falls–West subwatersheds did not receive a score under this criterion because they have no institutional land available for restoration activities.

Hotspot Site Investigation: According to the Area Q SWAP, a hotspot is a designated site where stormwater has a higher probability of transporting above average pollutant concentrations through runoff. Pollutants that may be present in hotspot areas include nutrients, hydrocarbons, metals, chloride, pesticides, bacteria, and trash. Sites that underwent these investigations are categorized as a “confirmed hotspot,” “potential hotspot,” or “not a hotspot.” With four potential hotspots, Long Green Creek contained the highest number of hotspots, thereby scoring the highest for restoration prioritization. The Lower Gunpowder Falls–East received the second highest restoration score and was the only subwatershed found to have a confirmed hotspot. The Area Q SWAP provides specific hotspot BMP recommendations for these two subwatersheds (see **Table 4-66** below).

Neighborhood Restoration Opportunity/Pollution Severity Indices: Thirty neighborhoods in the various subwatersheds of Area Q were investigated and rated according to a Pollution Severity Index (PSI) and Restoration Opportunity Index (ROI). The Lower Gunpowder Falls–East subwatershed had the most neighborhoods with a high or moderate PSI and ROI score; therefore, it is the most need of restoration based on this criterion.

Neighborhood Lawn Fertilization Reduction/Awareness: Residential lawns within each subwatershed underwent a visual survey to identify properties with high nutrient pollution through fertilizer use. Investigated properties were given a restoration ranking accordingly and are recommended for community engagement to reduce lawn fertilizer. Haystack Branch—the subwatershed with the greatest percentage of high maintenance lawns—received the greatest restoration potential score.

Stream Buffer Improvement: Stream buffer restoration opportunities were identified using GIS to classify the cover within 100-foot stream buffers into three categories: forests, impervious (e.g., roads and buildings), and open pervious (e.g., mowed lawns). Subwatersheds that contain a large amount of open pervious land within stream buffers are a higher priority for restoration. Long Green Creek contains the highest percentage of open pervious area within its stream buffers. Sweathouse Run received the highest protection score due to its high percentage of forested buffer.

Stream Restoration Potential: Subwatersheds were rated for stream restoration potential based on how many feet of potential stream restoration is present in each subwatershed. Subwatersheds with greater amounts of proposed stream restoration scored higher for potential restoration. Long Green Creek scored highest with a recorded 18,140 feet of proposed stream restoration.

Septic Systems: Septic systems are a potential source of pollution and should be monitored for functionality. The greater the number of septic systems in each subwatershed, the greater the restoration score assigned. There are approximately 2,684 septic systems in Area Q. With 860 septic systems, the Long Green Creek subwatershed scored the highest for potential restoration due to having the highest number of septic systems out of the six subwatersheds.

Pervious Area Assessment: A pervious area assessment was conducted in Area Q that identified parcels of land ideal for large scale tree planting. Tree planting activities can reduce runoff and increase community awareness of watershed management. Area Q has approximately 444 acres of planting opportunity. Subwatersheds were ranked based on the number of acres of tree planting opportunity available. Long Green Creek was ranked the highest priority for restoration as it contained the largest amount of land that would be ideal for tree planting.

In addition to restoration scores, protection scores were also assigned. The protection scores were based on the following five criteria:

- Total Nitrogen and Total Phosphorus Loads;
- Biological Indicators;
- Impervious Surfaces;
- Stream Buffer Improvement; and
- Agricultural Land in Easement.

The protection criteria include several of the same criterion and ranking methods as the restoration criteria. One notable exception is the “Agricultural Land in Easement” criterion:

Agricultural Land in Easement: The agricultural land protection scores were based on the amount of agricultural land not located in conservation easements. Conservation easements provide protection of agricultural lands as well as benefits to the land owners. Lower Gunpowder Falls–East has the highest amount of land located outside conservation easements; therefore, it scored the highest out of the six subwatersheds for protection.

Table 4-65 below provides the overall final ranking of each subwatershed based on the scores it received in each of the aforesaid priority restoration and protection criteria. The numeric scores in **Table 4-65** are provided to convey the degrees at which one subwatershed ranked higher or lower than another; details on the numeric scoring scale used to determine the overall final scores are provided in the Area Q SWAP.

Currently only 2.8 percent of urban land within Area Q is treated by stormwater BMPs. All suggested BMPs for the subwatersheds located in Area Q are shown in **Table 4-66**.

Table 4-65: County Identified Priority Areas for Restoration and Protection within the Lower Gunpowder Falls Watershed - Rural (Area Q)

Subwatershed	Total Restoration Score	Restoration Prioritization Category	Total Protection Score	Protection Prioritization Category
Cowen Run	60	Moderate	62	Moderate
Long Green Creek	88	High	40	Low
Haystack Branch	68	Moderate	58	Moderate
Sweathouse Run	51	Moderate	86	High
Lower Gunpowder Falls–West	33	Low	70	High
Lower Gunpowder Falls–East	74	High	81	High

Source: CWP et al. (2017)

Table 4-66: County Suggested BMPs for Subwatersheds within the Lower Gunpowder Falls Watershed - Rural (Area Q)

Recommended Action	Cowen Run	Long Green Creek	Haystack Branch	Sweathouse Run	Lower Gunpowder Falls–West	Lower Gunpowder Falls–East
Tree Planting	✓	✓	✓	✓	✓	✓
Trash Management	✓			✓		✓
Stream Restoration (channel restoration, bank stabilization)	✓	✓	✓	✓	✓	✓
Stream Buffer Improvement/Reforestation	✓	✓	✓	✓	✓	✓
Storm Drain Marking	✓	✓	✓	✓	✓	✓
Downspout disconnection (rain gardens/barrels)		✓	✓	✓		✓
Stormwater Retrofit (includes wetland/SWM pond creation and conversions)	✓	✓	✓		✓	✓
Outfall Retrofit					✓	✓
Fertilizer Reduction (promote proper lawn care, encourage residents to reduce fertilizer use)	✓	✓	✓	✓		✓
Bayscaping		✓		✓		✓
Lot Canopy Improvement		✓		✓		✓
Hotspot Education		✓				✓
Evaluate Hotspot site by reviewing existing Stormwater Pollution Prevention Plan		✓				✓
Refer Hotspot for Enforcement						✓
Test Hotspot for Illicit Discharge						✓
Hotspot Follow-up Inspection						✓
Source: CWP et al. (2017)						

BA-EPS SWAP for Lower Gunpowder Falls (Urban) – "Area N"

On behalf of BA-EPS, Versar, Coastal Resources, and McCormick Taylor completed the *Lower Gunpowder Falls (Urban) Small Watershed Action Plan* in March of 2016 (Versar et al., 2016). This document serves as the official Baltimore County SWAP for the urban portion (below mainstem Gunpowder Falls) of the Lower Gunpowder Falls watershed.

According to the aforementioned Baltimore County letter identifier system, the urban/lower portion of the Lower Gunpowder Falls watershed is hereinafter referred to as "Area N" and its associated SWAP as the "Area N SWAP."

According to the Area N SWAP, impervious land cover comprises 1,753 acres (16.6 percent) of Area N and 9.1 percent of the soils within Area N are considered high runoff potential. Agriculture makes up 7.1 percent of the land use in the watershed, while forest makes up 26.2 percent. Baltimore County estimates that impervious urban land use is responsible for contributing 28,536 lbs of nitrogen; 2,483 lbs of phosphorus; and 3,193,080 lbs of sediment in Area N per year. Stormwater runoff was the primary contributor of nutrient and sediment inputs to Area N.

The Area N SWAP is organized around the analysis of the following seven subwatersheds that compose Area N:

- Minebank Run;
- Jennifer Branch;
- Bean Run;
- Lower Gunpowder Falls–A;
- Lower Gunpowder Falls–B;
- Lower Gunpowder Falls–C; and
- Lower Gunpowder Falls–D.

Each of these subwatersheds are located around its corresponding tributary. The Lower Gunpowder Falls–A, B, C, D surround the mainstem Gunpowder Falls on its southern side in alphabetic order, with the Lower Gunpowder Falls–A on the far western side and the Lower Gunpowder Falls–D being the farthest east. All of the subwatersheds drain north towards the mainstem Gunpowder Falls (see **Figure 4-49**).

Water quality within Area N is largely affected by nitrogen, phosphorus, and sediment inputs. Using ranking criteria to prioritize the seven subwatersheds within the urban Lower Gunpowder Falls watershed, Baltimore County numerically ranked the seven subwatersheds based on their potential for restoration and need for protection.

Restoration and protection ranks were assigned based on the following ten criteria:

- Total Nitrogen and Total Phosphorus Loads;
- Impervious Surfaces;
- Institutional Site Investigation;
- Neighborhood Restoration Opportunity/Pollution Severity Indices;
- Stream Buffer Improvement;
- Stream Restoration Potential;
- Pervious Area Assessment;
- Neighborhood Downspout Disconnection;
- Stormwater Pond Conversions; and
- Illicit Discharge Data.

The ranking criteria for Area N shares several of the same criterion used to rank Area Q discussed above, with the exception of Neighborhood Downspout Disconnection; Stormwater Pond Conversions; and Illicit Discharge Data.

A brief description of each restoration ranking criterion and the results of the ranking are as follows (Versar et al., 2016):

Total Nitrogen and Total Phosphorus Loads: Lower Gunpowder Falls–B had the highest nitrogen loading rate; Lower Gunpowder–D had the highest phosphorus loading rate.

Impervious Surfaces: Lower Gunpowder Falls–B had the highest impervious cover at 21 percent, followed by Minebank Run with 19 percent impervious cover.

Institutional Site Investigation: The Lower Gunpowder Falls–B and Jennifer Branch subwatersheds have the most institutional site restoration opportunities.

Neighborhood Restoration Opportunity/Pollution Severity Indices: Minebank Run and Lower Gunpowder Falls–D contained the most neighborhood area ranked as high priority for restoration.

Stream Buffer Improvement: Lower Gunpowder Falls–C has the highest potential for stream buffer improvement.

Stream Restoration Potential: Stream restoration was recommended in four of the seven subwatersheds, with the Lower Gunpowder Falls–B subwatershed having the most linear feet of stream restoration potential. The three subwatersheds where no stream restoration was recommended were Jennifer Branch, Minebank Run, and Lower Gunpowder Falls–D. This is because Jennifer Branch and Minebank Run have already undergone extensive stream restoration, and there were no identified opportunities in Lower Gunpowder Falls–D.

Pervious Area Assessment: Pervious area assessments were conducted to find sites that were best suited for large-scale tree plantings. Only three subwatersheds contained acreage recommended for reforestation: Jennifer Branch, Lower Gunpowder Falls–B, and Minebank Run. Minebank Run had the most acres recommended for reforestation (13.8 acres).

Neighborhood Downspout Disconnection: Unlike connected downspouts that discharge rooftop runoff directly to the storm drain system or to impervious surfaces, disconnected downspouts allow rooftop runoff to drain to pervious areas such as yards, rain barrels, or rain gardens. Disconnected downspouts allow for slower flow and a reduction in pollution entering streams during storm events. All seven of the subwatersheds contained areas recommended for downspout disconnection.

Stormwater Pond Conversions: The County identified fifteen stormwater management facilities within the watershed that would be good candidates for detention pond conversion to improve water quality treatment. Before the completion of the SWAP, eleven of the fifteen ponds had already been converted, and the remaining four were planned for future conversion. The four planned future conversion projects would take place in Jennifer Branch and Lower Gunpowder Falls–B.

Illicit Discharge Data: Baltimore County tracks illicit discharges via an outfall screening program. Illicit discharges refer to any inputs into the storm sewer system that are not stormwater, or otherwise permitted. Jennifer Branch and Minebank Run were both ranked critical based on this criterion; therefore, illicit discharge in these two subwatersheds should be addressed first.

The subwatersheds were placed into one of four restoration priority categories based on the ranking results: very high, high, medium, and low. The Lower Gunpowder Falls–B subwatershed was ranked as the first priority for restoration, in the Very High prioritization category. The Jennifer Branch, Minebank Run, and Lower Gunpowder Falls–A subwatersheds were ranked second, third, and fourth, respectively, all in the High prioritization category. The remaining three subwatersheds were in the Low prioritization category: Lower Gunpowder Falls–C was ranked fifth priority, and Bean Run and Lower Gunpowder Falls–D were tied for sixth. Protection priority categories were also assigned. A summary of the final results of the restoration and priority protection rankings can be found in **Table 4-67**. The numeric scores are provided to convey the degrees at which one subwatershed ranked higher or lower than another; details on the numeric scoring scale are provided in the Area N SWAP.

Baltimore County suggested BMPs for Area N are shown in **Table 4-68**.

Table 4-67: County Identified Priority Areas for Restoration and Protection within the Lower Gunpowder Falls Watershed - Urban (Area N)

Subwatershed	Total Restoration Score	Restoration Prioritization Category	Total Protection Score	Protection Prioritization Category
Minebank Run	26	High	26	Medium
Jennifer Branch	29	High	29	Medium
Bean Run	18	Low	18	Very High
Lower Gunpowder Falls–A	25	High	25	Medium
Lower Gunpowder Falls–B	37	Very High	37	Low
Lower Gunpowder Falls–C	19	Low	19	Very High
Lower Gunpowder Falls–D	18	Low	18	Very High

Source: Versar et al. (2016)

Table 4-68: County Suggested BMPs for Subwatersheds within the Lower Gunpowder Falls Watershed - Urban (Area N)							
Recommended Action	Minebank Run	Jennifer Branch	Bean Run	Lower Gunpowder Falls–A	Lower Gunpowder Falls–B	Lower Gunpowder Falls–C	Lower Gunpowder Falls–D
Tree Planting	✓	✓	✓	✓	✓	✓	✓
Stormwater Retrofit	✓	✓		✓	✓		
Trash Management	✓	✓		✓	✓		
Stream Buffer Improvement	✓	✓	✓	✓	✓	✓	✓
Remove Impervious Cover	✓	✓		✓	✓		
Storm Drain Marking	✓	✓	✓	✓	✓	✓	✓
Downspout Disconnection (rain gardens/barrels)	✓	✓	✓	✓	✓	✓	✓
Bayscaping	✓	✓	✓	✓	✓	✓	✓
Parking Lot/Alley Retrofit	✓	✓		✓	✓		
Pet Waste Education		✓	✓	✓	✓		
Stream Restoration			✓	✓	✓	✓	
Source: Versar et al. (2016)							

Q.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment reduction in the Lower Gunpowder Falls watershed are shown in **Table 4-69**. Projected sediment reduction using these practices are shown in **Table 3-2**. Four timeframes are included in the table:

- BMPs implemented before the TMDL baseline. In this case, the baseline is 2009;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

MDOT SHA will accomplish the projected reduction to be achieved as a percent of the baseline load shown in **Table 3-2**

Estimated costs to design, construct, and implement BMPs within Lower Gunpowder Falls watershed total $11,628,000. These projected costs are based on an average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-70** for a summary of estimated BMP costs.

Figure 4-51 is a map of MDOT SHA's restoration practices in the watershed and includes those that are under design or construction. Inlet cleaning is not reflected on this map.

Table 4-69: Lower Gunpowder Falls Sediment BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	37.0	20.8	19.6	N/A	77.4
Tree Planting	acres of tree planting		48.5	3.4	N/A	52.0
Stream Restoration	linear feet		8,765.0	1,043.2	N/A	9,808.2
Outfall Stabilization	linear feet		2.1	400.0	N/A	402.1
Inlet Cleaning[1]	dry tons		3.5			3.5
Load Reductions	TSS EOS lbs/yr.		418,246	492,787	0	
				Total Projected Reduction	492,787	

[1] ***Inlet cleaning is an annual practice.***

Table 4-70: Lower Gunpowder Falls Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$2,293,000	$387,000	$2,680,000
Tree Planting	$1,485,000	$105,000	$1,590,000
Stream Restoration	$5,853,000	$697,000	$6,550,000
Outfall Stabilization	$4,000	$787,000	$791,000
Inlet cleaning	$17,000		$17,000
Total			$11,628,000

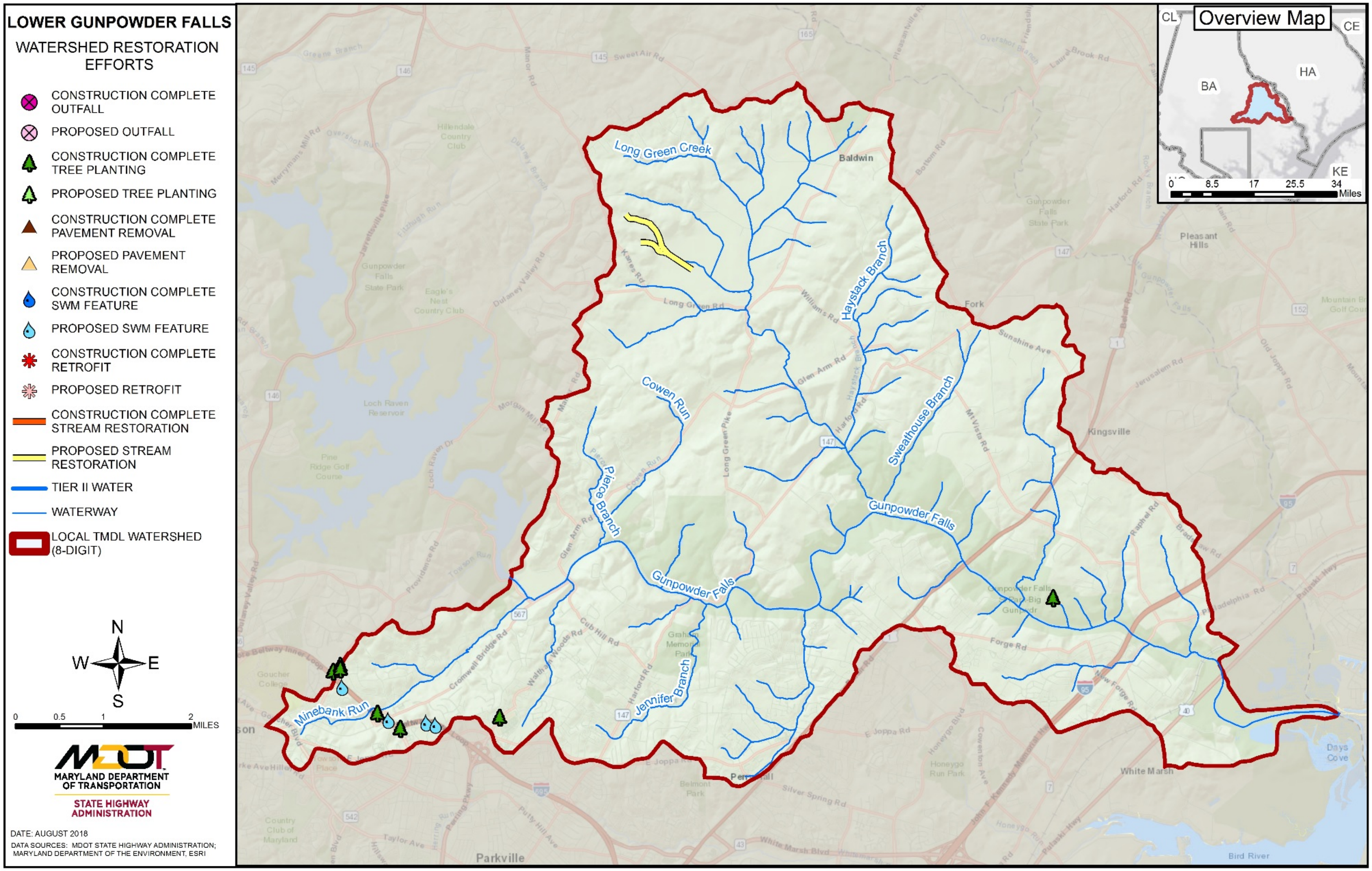


Figure 4-51: MDOT SHA Restoration Strategies within the Lower Gunpowder Falls Watershed

R. LOWER MONOCACY RIVER WATERSHED

R.1. Watershed Description

The Lower Monocacy watershed encompasses 495 square miles primarily within Frederick County as well as small areas of Montgomery and Carroll Counties. The Monocacy River originates in Pennsylvania and flows through Maryland ultimately into the Potomac River. The Lower Monocacy River flows south through Frederick, and ultimately into the Middle Potomac River near the town of Dickerson. Tributary creeks and streams of the Lower Monocacy Watershed include Israel Creek, Carroll Creek, Linganore Creek, Bush Creek, Bennett Creek, and Ballenger Creek. The Lower Monocacy River watershed land use consists of crops (29.4 percent), forest (29.4 percent), residential (17.5 percent), pasture (8.8 percent), commercial (5.2 percent), and water (0.4 percent).

There are 1,224.8 centerline miles of MDOT SHA roadway located within the Lower Monocacy watershed. The associated ROW encompasses 3,562.6 acres, of which 1,886.4 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) highway office or lab, two (2) salt storage facilities, three (3) weigh stations, and seven (7) park and ride facilities. See **Figure 4-52** for a map of the watershed.

R.2. MDOT SHA TMDLs within Lower Monocacy River Watershed

MDOT SHA is included in both the phosphorus (MDE, 2013d) and sediment (MDE, 2009e) TMDLs. Phosphorus is to be reduced by 25.0 percent in Carroll, Frederick, and Montgomery Counties. Sediment is to be reduced by 60.8 percent in Frederick and Montgomery Counties, as shown in **Table 3-2**.

R.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Lower Monocacy River watershed is shown in **Figure 4-53** which illustrates that 123 grid cells have been reviewed, encompassing portions of 23 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 1,345 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 25 new structural SW controls constructed or under contract.
- 737 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 583 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 154 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 130 sites constructed or under contract.

- Six (6) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 118 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 46 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Six (6) additional sites deemed potentially viable for stream restoration and pending further analysis may be candidates for future restoration opportunities.
- 40 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 175 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 82 new structural SW controls constructed or under contract.
- Five (5) additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 88 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 23 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of three (3) existing structural SW controls constructed or under contract.
- Nine (9) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- 21 retrofit sites deemed not viable for retrofit and have been removed from consideration.

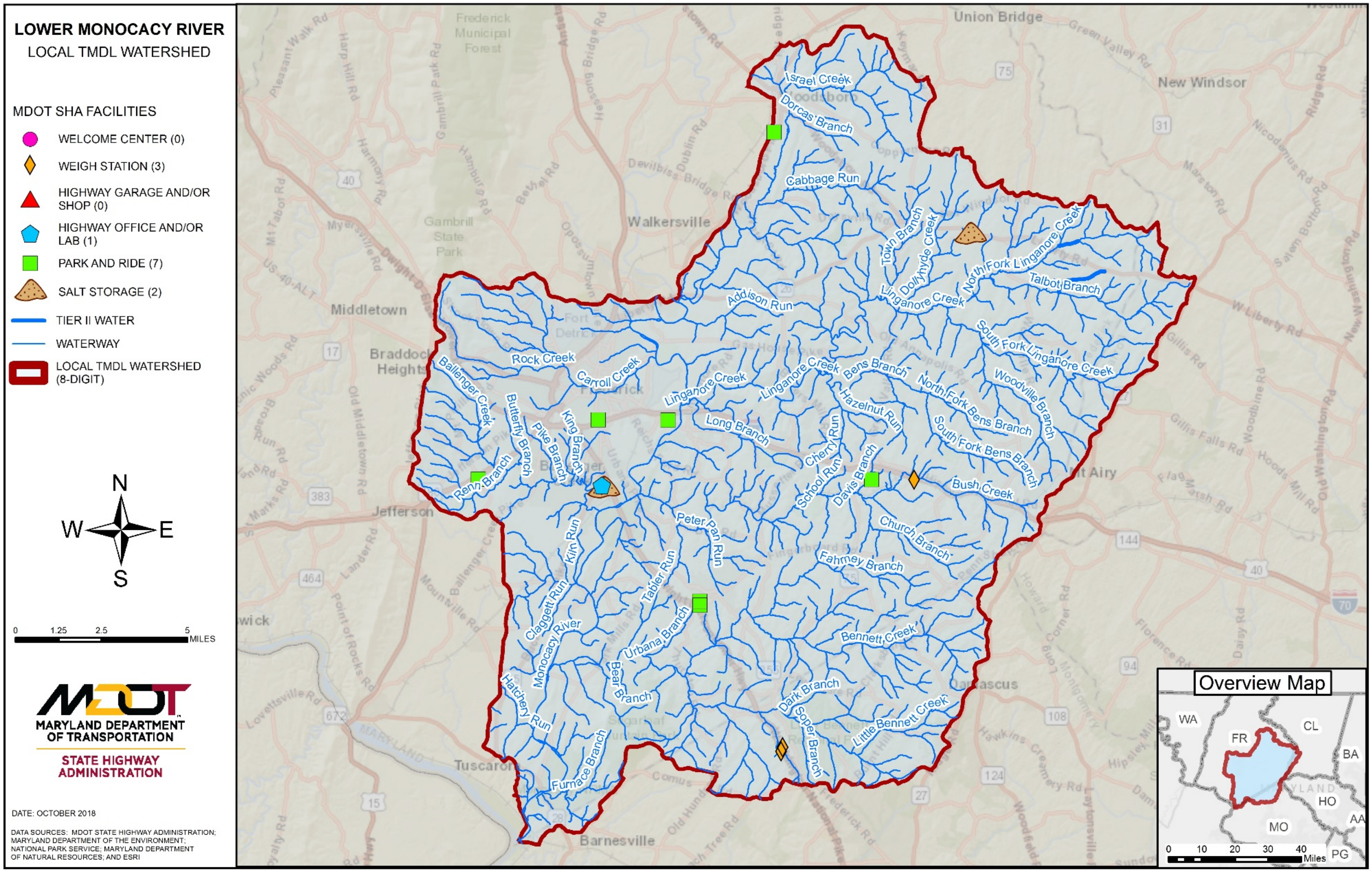


Figure 4-52: Lower Monocacy River Watershed

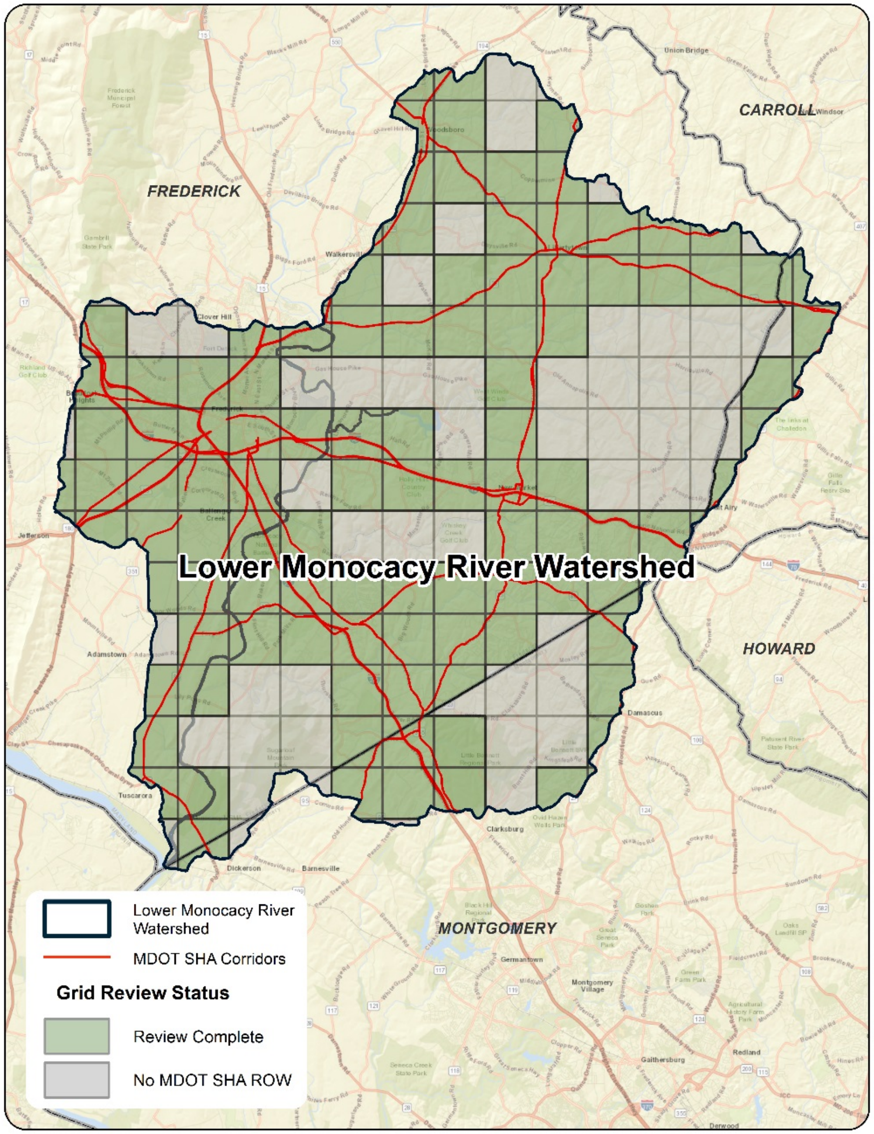


Figure 4-53: Lower Monocacy River Site Search Grids

R.4. Summary of County Assessment Review

Waters within the Lower Monocacy watershed are subject to the following impairments as noted on MDE's 303(d) List:

- *Escherichia coli;*
- Phosphorus (Total);
- Sedimentation/siltation;
- Temperature, water; and
- TSS.

The *Lower Monocacy River Watershed Restoration Action Strategy* (WRAS), prepared by the Frederick County Division of Public Works, was adopted in May 2004 (FR-DPW, 2004). The primary focus of the strategy is the portion of the drainage within Frederick County, which is 87 percent of the total area. The Lower Monocacy River watershed is ranked as a "Category 1 Priority" and "Selected Category 3" watershed in the *Maryland Clean Water Action Plan* (CWAPTW, 1998).

A *Stream Corridor Assessment Survey* (FR-DPW, 2004), to support the WRAS, found 247 potential environmental problem sites following a survey of 75 out of 600 miles. Issues identified included inadequate buffers, erosion, fish barriers, pipe outfalls, channel alterations, trash dumping, and exposed pipes.

An *Assessment of Stormwater Management Retrofit and Stream Restoration Opportunities in Bennett Creek Watershed* was published in 2009 (Tetra Tech, 2009). The assessment identified eleven potential restoration projects. Six of the potential sites are located in Fahrney subwatershed and the others are located in the Bennett Middle, Bennett Upper, Little Bennett, Pleasant, and Urbana subwatersheds.

Restoration approaches proposed across the watershed are primarily county-owned properties and residential properties outside of MDOT SHA ROW. The Bennett Creek Assessment identified three potential stream restoration projects (Tetra Tech, 2009):

- The channel downstream of the Englandtowne SWM pond site is experiencing bank erosion; the upstream channel is also eroding and is contributing to silt deposition within the stormwater pond, thus reducing the effectiveness of the stormwater pond. Stream restoration is proposed upstream and downstream.

- The stream corridor at Kemptown Park is experiencing severe erosion with widening and lateral migration also occurring. It is proposed this stream is restored.

- The stream corridor is located in close proximity to the Persimmon residential area and is experiencing severe erosion, habitat degradation, a fish barrier, and man-made channel alteration. It is recommended the stream corridor is restored.

More recently, the *Frederick County Stream Survey 2016 Countywide Results* found that the average BIBI score for Frederick County streams was "poor." The stream survey also indicated that 18% scored "very poor," 36% scored "poor," 28% scored "fair," and 18% scored "good" (Versar, 2017b). In addition, in July of 2017, Frederick County published the *Lower Monocacy Watershed Assessment*, which provides a comprehensive assessment of the entire Lower Monocacy River watershed within Frederick County (Dewberry, 2017). According to Dewberry (2017), the predominant land uses within the Lower Monocacy River watershed are agricultural (43%), urban (30%), and forest (25%). The urbanized areas within the watershed are found within the cities of Frederick, Mount Airy, New Market, Walkersville, and Woodsboro. The watershed has approximately 658 miles of stream and 1,230 miles of road. Dewberry (2017) identifies several proposed projects that can help achieve load reductions within the watershed. These projects were identified based on Dewberry's review of the watershed's existing stormwater BMPs and projects proposed in previous restoration/retrofit reports as well as the results of windshield surveys of untreated impervious areas within the watershed (Dewberry, 2017).

Montgomery and Carroll Counties have also assessed the Lower Monocacy River watershed portions within Montgomery and Carroll County, respectively. Montgomery County published the *Lower Monocacy Implementation Plan* in 2012 (Biohabitats et al., 2012b) and Carroll County published the *Lower Monocacy River Watershed Characterization Plan* in the Spring of 2016 (CL-BRM, 2016c). Montgomery County identified street sweeping and stream restoration as the most economically efficient practices for meeting sediment load reductions requirements (CL-BRM, 2016c). Carroll County's characterization plan was prepared to provide background water quality conditions in Carroll County's portion of the Lower Monocacy River watershed and to serve as a tool to direct future watershed restoration and protection efforts (CL-BRM, 2016c).

R.5. MDOT SHA Pollutant Reduction Strategies

Lower Monocacy is listed for both phosphorus and sediment with each TMDL having a different baseline year; 2000 for sediment and 2009 for phosphorus. Proposed practices to meet the phosphorus and sediment reduction in the Lower Monocacy River watershed are shown in **Table 4-71 and 4-72**. Projected phosphorus and sediment reductions using these practices are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs built before the phosphorus and sediment TMDL baseline. In this case, the phosphorus baseline is 2009 and the sediment baseline are 2000;

- BMPs implemented after the baseline through fiscal year 2020; and

- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the sediment TMDL, MDOT SHA will meet 83.3 percent of the MDE 60.8 percent load reduction requirement through implementation of BMPs shown in **Table 4-72.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Lower Monocacy River watershed total $42,853,000. They are based on average cost per impervious acre treated derived from a cost history for each BMP type.

Costs of BMPs used to treat the Lower Monocacy Phosphorus TMDL and Sediment TMDLs are reflected in tables **4-73 and 4-74**, respectively. Because the sediment TMDL is a segmentshed of the Lower Monocacy watershed, only a subset of BMPs implemented in this watershed are used for treatment as opposed to the phosphorus TMDL. The BMPs used to treat the sediment TMDL in this watershed after the baseline year of the phosphorus TMDL (i.e., 2009) are not in addition to the BMPs used to treat the phosphorus TMDLs. The costs to treat the sediment TMDL after 2009 are inherently included in the cost to treat the phosphorus TMDLs in this watershed.

Figure 4-54 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design or construction. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-71: Lower Monocacy River Restoration Phosphorus BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	1,295.0	35.8	94.1	N/A	1,424.9
Retrofit	drainage area acres		63.2		N/A	63.2
Impervious Surface Elimination	acres removed		1.6		N/A	1.6
Tree Planting	acres of tree planting	6.9	130.0	59.6	N/A	196.5
Stream Restoration	linear feet		14,097.4	14,038.1	N/A	28,135.5
Outfall Stabilization	linear feet			956.3	N/A	956.3
Inlet Cleaning[1]	dry tons		1.7	4.3	N/A	6.0
Street Sweeping[1]	acres swept		49.7		N/A	49.7
Load Reductions	TP EOS lbs./yr.		1,108	2,253	0	
				Total Projected Reduction	**2,253**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-72: Lower Monocacy River Restoration Sediment BMP Implementation						
BMP	**Unit**	**Baseline (Before 2000)**	**Restoration BMPs**			**Total BMPs**
			2020	**2025**	**Future**	
New Stormwater	drainage area acres	851.6	35.8	94.1	TBD	981.5
Retrofit	drainage area acres		63.2		TBD	63.2
Impervious Surface Elimination	acres removed		1.6		TBD	1.6
Tree Planting	acres of tree planting		134.1	47.9	TBD	182.0
Stream Restoration	linear feet		6,519	8,206.0	TBD	14,725.0
Inlet Cleaning[1]	dry tons		1.6	54	TBD	55.6
Street Sweeping[1]	acres swept		49.3		TBD	49.3
Load Reductions	TP EOS lbs./yr.		384,523	834,913	1,002,040	
				Total Projected Reduction	**1,002,040**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-73: Lower Monocacy River Restoration Phosphorus BMP Cost			
BMP	**2020**	**2025**	**Total**
New Stormwater	$5,371,000	$8,195,000	$13,566,000
Retrofits	$2,250,000		$2,250,000
Impervious Surface Elimination	$460,000		$460,000
Tree Planting	$3,983,000	$1,816,000	$5,799,000
Stream Restoration	$9,416,000	$9,373,000	$18,789,000
Outfall Stabilization		$1,882,000	$1,882,000
Inlet cleaning	$7,000	$25,000	$32,000
Street Sweeping	$75,000		$75,000
Total			$42,853,000

Table 4-74: Lower Monocacy River Restoration Sediment BMP Cost

BMP	2020	2025	Total
New Stormwater	$4,797,000	$8,769,000	$13,566,000
Retrofits	$2,250,000		$2,250,000
Impervious Surface Elimination	$460,000		$460,000
Tree Planting	$4,105,000	$1,464,000	$5,569,000
Stream Restoration	$4,354,000	$5,480,000	$9,834,000
Outfall Stabilization		$1,882,000	$1,882,000
Inlet cleaning	$7,000	$308,000	$315,000
Street Sweeping	$74,000		$75,000
Total			$33,950,000

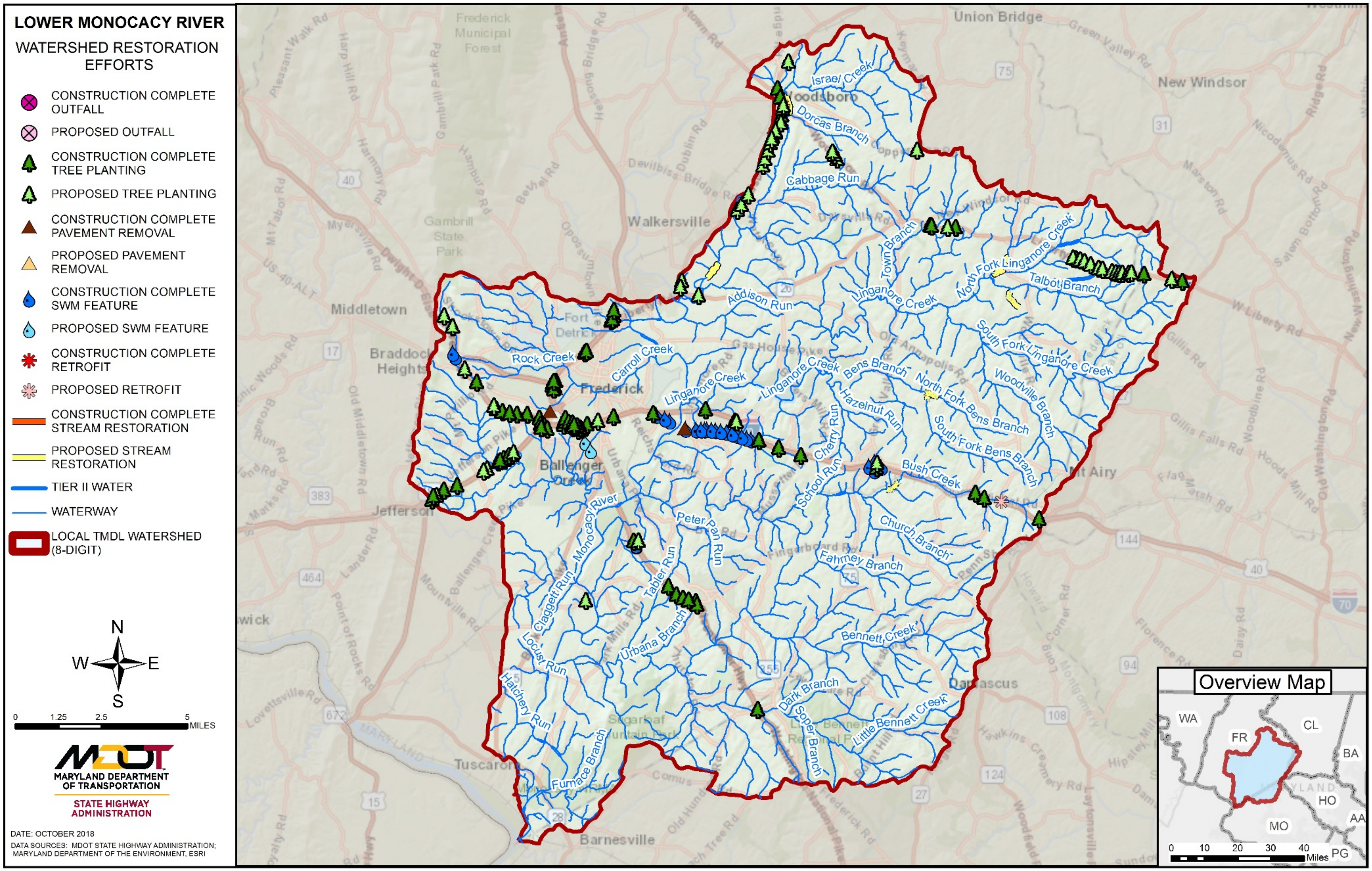


Figure 4-54: MDOT SHA Restoration Strategies within the Lower Monocacy River Watershed

S. PATAPSCO RIVER LOWER NORTH BRANCH WATERSHED

S.1. Watershed Description

The Patapsco River Lower North Branch watershed encompasses 115 square miles across Anne Arundel County, Baltimore County, City of Baltimore, Carroll County, and Howard County. The Patapsco River originates in Carroll County and flows to the Baltimore Harbor and ultimately to the Chesapeake Bay.

There are 1,019.8 centerline miles of MDOT SHA roadway located within the Patapsco River Lower North Branch watershed. The associated ROW encompasses 3,799.2 acres, of which 1,693.7 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) welcome center, one (1) highway office or lab, one (1) highway garage or shop, two (2) salt storage facilities, and two (2) park and ride facilities. See **Figure 4-55** for a map of the watershed.

S.2. MDOT SHA TMDLs within Patapsco River Lower North Branch Watershed

MDOT SHA is included in both bacteria (MDE, 2009f) and sediment (MDE, 2011g) TMDLs. Sediment is to be reduced by 18.0 percent in Anne Arundel, Baltimore and Howard Counties as shown in **Table 3-2**. Bacteria is to be reduced by 14.8 as shown in **Table 3-2.**

S.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Patapsco River Lower North Branch watershed is shown in **Figure 4-56** which illustrates that 77 grid cells have been reviewed, encompassing portions of 35 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 513 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 35 new structural SW controls constructed or under contract.
- 276 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 202 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 271 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 103 sites constructed or under contract.
- 18 additional sites deemed potentially viable for tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 150 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 37 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Eight (8) sites constructed or under contract.
- 12 additional sites deemed potentially viable for stream restoration and pending further analysis may be candidates for future restoration opportunities.
- 17 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 111 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 19 new structural SW controls constructed or under contract.
- 24 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 68 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified six (6) outfalls potential for stabilization. Further analysis of these sites resulted in:

- Five (5) outfall sites constructed or under contract.
- One (1) outfall site deemed potentially viable for outfall stabilization efforts and pending further analysis, may be a candidate for future restoration opportunities.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 33 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of four (4) existing structural SW controls constructed or under contract.
- Seven (7) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- 22 retrofit sites deemed not viable for retrofit and have been removed from consideration.

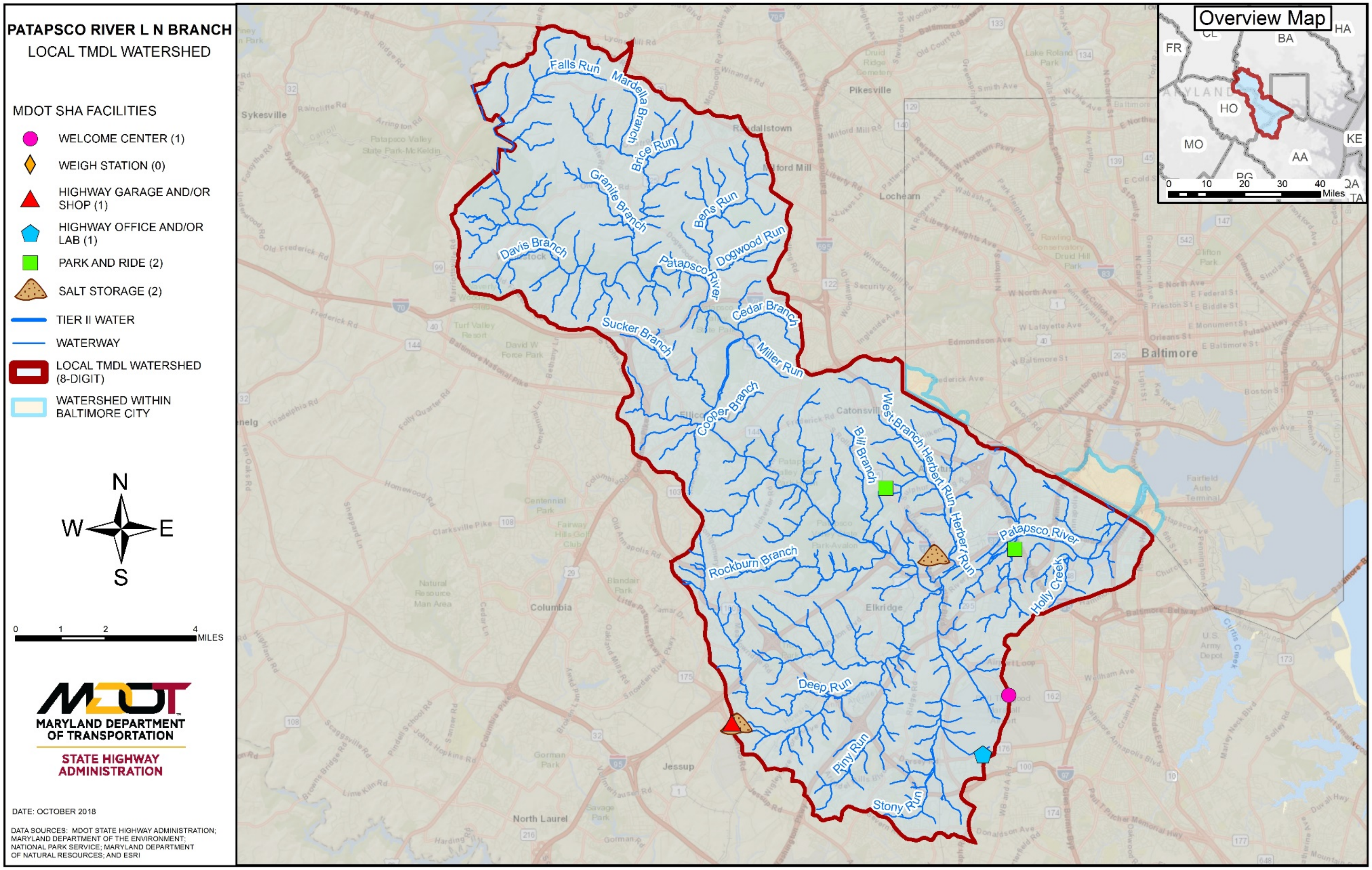


Figure 4-55: Patapsco River Lower North Branch Watershed

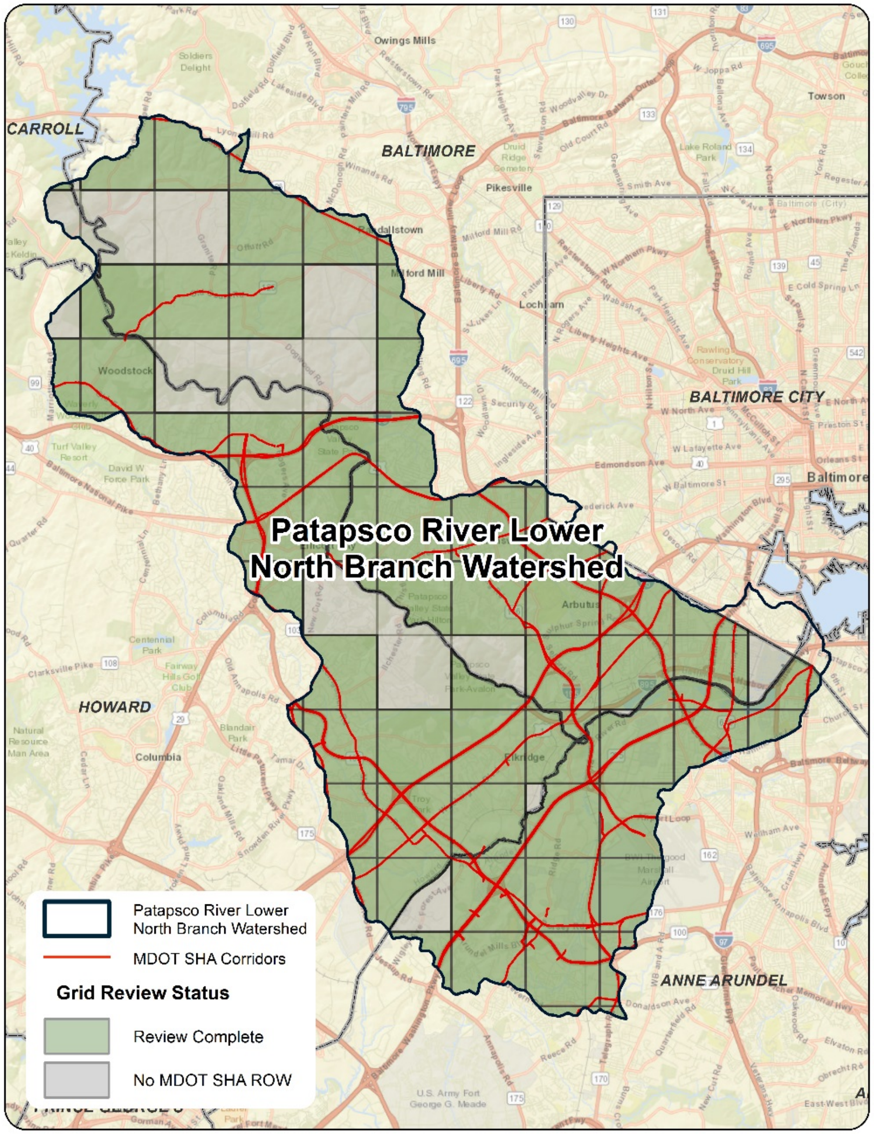


Figure 4-56: Patapsco River Lower North Branch Site Search Grids

S.4. Summary of County Assessment Review

Waters within the Patapsco River Lower North Branch watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- *Escherichia coli;*
- Sulfates; and
- TSS.

This summary reviews findings from Baltimore County's 2012 *Lower Patapsco River Small Watershed Action Plan* (Versar et al., 2012); Anne Arundel County's 2011 *Patapsco Non-Tidal Watershed Assessment Comprehensive Summary Report* (KCI/CH2M Hill, 2011); Carroll County's 2016 *Lower North Branch Patapsco River Watershed Characterization Plan* (CL-BRM, 2016d); and Howard County's 2012 *Tiber-Hudson & Plumtree Branch Stream Corridor Assessment* (S&S Planning and Design, 2012) and 2017 *Patapsco River South Branch and Lower North Branch Watershed Assessment* (KCI, 2017a). These reports discuss specific issues that contribute to overall watershed impairments and identify high priority restoration projects. The Patapsco River Lower North Branch 8-digit watershed currently has completed TMDLs for *E. coli* and sediment. The Patapsco River Lower North Branch also has Category 5 impairment listings (i.e., TMDL required) for sulfates and chlorides.

The Lower Patapsco River watershed, which is the lower portion of the Patapsco River Lower North Branch watershed that is located within Baltimore County, has 41.8% high/very highly erodible soils. Restoration assessments identified seven subwatersheds as "high" or "very high" priority for restoration. Patapsco River-A5, Herbert Run (E. Br.), and Herbert Run (W.Br.) received the highest scores and the prioritization category of "very high." Cooper Branch, Miller Branch, Dogwood Branch, and Cedar Branch received a priority categorization of "high." Surveys identified Soapstone Branch as a potential reference stream for future restoration projects. Twenty-five existing detention ponds were identified for conversion potential (Versar et al., 2012).

The Patapsco Non-Tidal watershed, which is the lower portion of the Patapsco River Lower North Branch watershed that is located within Anne Arundel County, has 39.7 percent of the soils classified as highly erodible and 44.5 percent classified as potentially highly erodible. There were six subwatersheds that were given Habitat Scores in the "severely degraded" category: Unnamed Tributary (PN4), Patapsco Mainstem (PN5), Stoney Run 3 (PN8), Stoney Run 4 (PN9), Deep Run (PNA), and Deep Run (PNC). The Patapsco Mainstem (PN1) was identified as the subwatershed with the highest priority for restoration based on the Anne Arundel County's subwatershed restoration assessment. Deep Run (PNA) and the Patapsco Mainstem (PN5) were ranked as the highest priority for preservation within the watershed (KCI/CH2M Hill, 2011).

A very small portion (565 acres) of the Patapsco River Lower North Branch watershed is in Carroll County (CL-BRM, 2016d). Carroll County will use the findings from its *Lower North Branch Patapsco River Watershed Characterization Plan* to develop a Watershed Restoration Plan that will define the CL-BRM's goals for addressing environmental impacts within the watershed (CL-BRM, 2016d).

Howard County's *Tiber-Hudson & Plumtree Branch Stream Corridor Assessment* identified areas of concern in the Ellicott City watershed that were highly susceptible to erosion/flooding and recommended BMPs to improve conditions and downstream watershed health. Only the Tiber-Hudson was considered, as Plumtree Branch falls in the Little Patuxent drainage. In the Tiber-Hudson, there were 4 severe and 10 moderate erosion sites, 19 debris blockages, and 7 sites with bank erosion from channelization (S&S Planning and Design, 2012).

Howard County's assessment of the Patapsco River Lower North Branch within Howard County yielded 269 potential projects and 130 concept plans for the top-ranked opportunities (KCI, 2017a). **Table 4-75** shows the breakdown of the 130 concept plans by project type. (The complete set of concept plans is available within Appendix G of document [KCI, 2017a]).

Table 4-75: Number of Projects by Type Developed for Concept Plans in Howard County's Portion of the Patapsco River Lower North Branch Watershed

Project Type	Number of Concept Plans Developed
BMP Conversion	41
New BMP	12
Tree Planting	10
Outfall Stabilization	23
Stream Restoration	44
Total	**130**

Source: KCI (2017a)

S.5. MDOT SHA Pollutant Reduction Strategies

Patapsco River Lower North Branch is listed for both bacteria and sediment with each TMDL having a different baseline year; 2003 for bacteria and 2005 for sediment. Proposed practices to meet the bacteria reduction in the Patapsco River Lower North Branch watershed is shown in **Table 4-76**. Projected bacteria reductions using these practices are shown in **Table 3-2**. Four time frames are included in the table below:

- BMPs implemented before the baseline year. In this case, the bacteria baseline is 2003 and the sediment baseline is 2005;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the bacteria TMDL, MDOT SHA will meet 5.3 percent of the MDE 14.8 percent load reduction requirement through implementation of BMPs shown in **Table 4-76.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Antietam Creek watershed total $34,346,000. They are based on average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-78** for a summary of estimated BMP costs.

Figure 4-57 is a map of the MDOT SHA restoration practices and includes those that are under design or construction. Inlet cleaning and street sweeping are not shown.

Table 4-76: Patapsco River Lower North Branch Restoration Bacteria BMP Implementation

BMP	Unit	Baseline (Before 2003)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	515.8	24.3		TBD	540.1
Retrofit	drainage area acres		31.2		TBD	31.2
Load Reductions	E. coli billion MPN/yr.		1,829	1,829	34,276	
				Total Projected Reduction	**34,276**	

Table 4-77: Patapsco River Lower North Branch Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	690.6	62.4	55.5	N/A	808.5
Retrofit	drainage area acres		31.2		N/A	31.2
Impervious Surface Removal	acres removed		0.2		N/A	0.2
Tree Planting	acres of tree planting		92.9	33.2	N/A	126.1
Stream Restoration	linear feet		5,056	17,266.5	N/A	22,322.5
Outfall Stabilization	linear feet		282.3	1,200	N/A	1,482.3
Inlet Cleaning[1]	dry tons		23.6		N/A	23.6
Street Sweeping[1]	acres swept		34.0		N/A	34.0
Load Reductions	TSS EOS lbs./yr.		309,836	1,161,879	0	
				Total Projected Reduction	**1,161,879**	

[1] Inlet cleaning and street sweeping are annual practices.

Table 4-78: Patapsco River Lower North Branch Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$7,551,000	$4,016,000	$11,567,000
Retrofits	$863,000		$863,000
Impervious Surface Elimination	$67,000		$67,000
Tree Planting	$2,843,000	$1,014,000	$3,857,000
Stream Restoration	$3,376,000	$11,530,000	$14,906,000
Outfall Stabilization	$556,000	$2,361,000	$2,917,000
Inlet cleaning	$108,000		$108,000
Street Sweeping	$61,000		$61,000
Total			$34,346,000

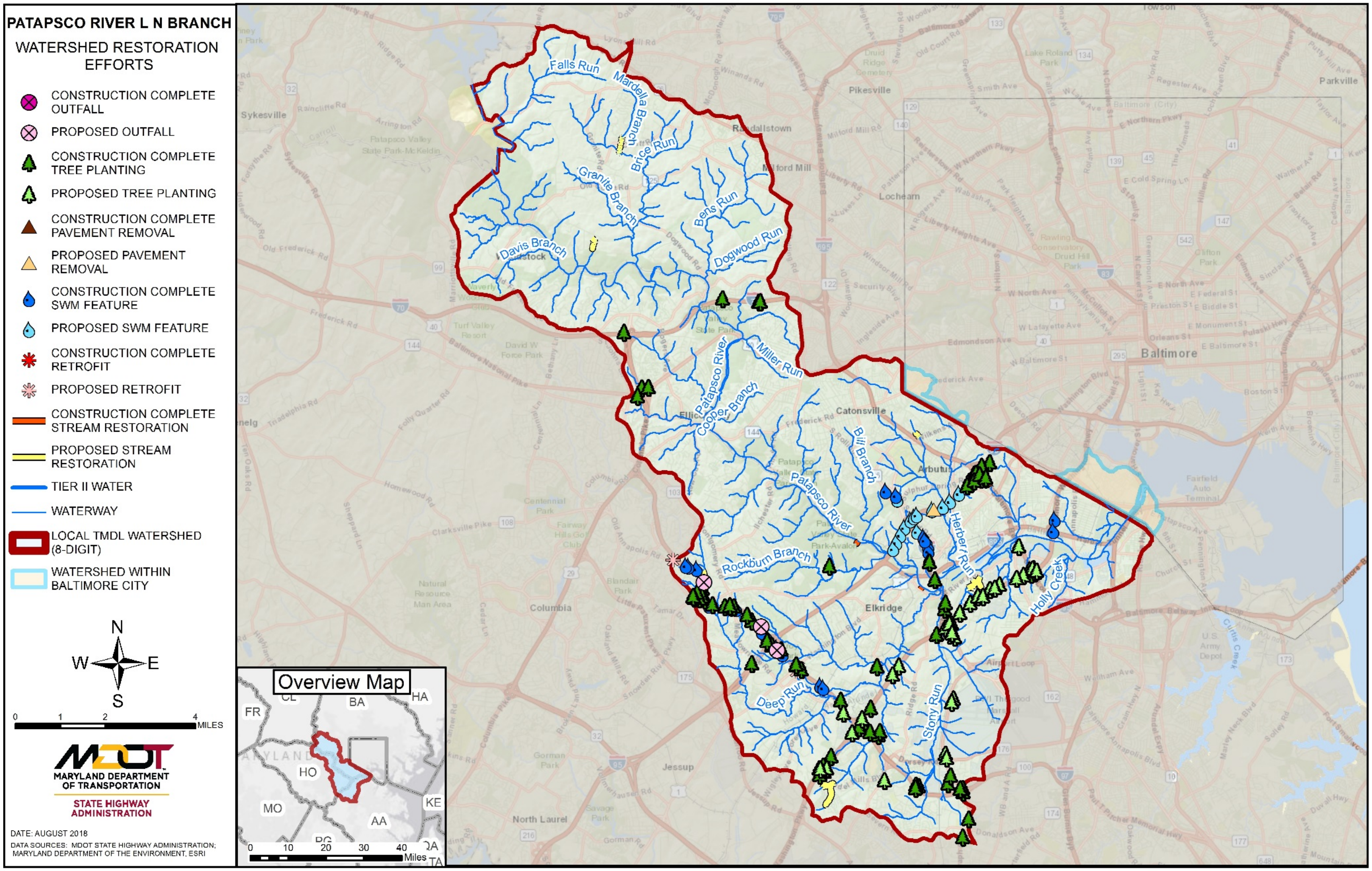


Figure 4-57: MDOT SHA Restoration Strategies within the Patapsco River Lower North Branch Watershed

T. PATUXENT RIVER SEGMENTSHEDS

T.1. Segmentsheds Description

Located in Maryland's Western Shore, the Patuxent River is a tributary of the Chesapeake Bay. The tidal portion of the Patuxent River is approximately 70 kilometers (43 miles) long and consists of three tidal segments: Mesohaline (PAXMH), Oligohaline (PAXOH), and Tidal Fresh (PAXTF). Together, the corresponding PAXMH, PAXOH, and PAXTF segmentsheds drain portions of eight Maryland Counties: Anne Arundel, Calvert, Charles, Frederick, Howard, Montgomery, Prince George's, and St. Mary's. In addition, several 8-digit watersheds are found within these three segmentsheds. PAXMF and PAXOH each contain a portion of the "Patuxent River Lower" 8-digit watershed (MD-02131101). PAXTF includes the following seven 8-digit watersheds: Brighton Dam (MD-02131108), Rocky Gorge Dam (MD-02131107), Middle Patuxent River (MD-02131106), Little Patuxent River (MD-02131105), Patuxent River Upper (MD-02131104), Western Branch (MD-02131103), and the Patuxent River Middle (MD-02131102). The PCB TMDL addressed in this plan (MDE, 2017a) includes the drainage area of the Western Branch Patuxent River Tidal Fresh (WBRTF) segment within the PAXTF boundary.

The designated use of the PAXMH, PAXOH, and PAXTF segments is Use Class II – Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting (MDE, 2017a).

Waters within the PAXMH, PAXOH, and PAXTF segments are subject to the following impairments as noted on MDE's 303(d) List:

- PAXMH
  - Fecal Coliform;
  - Nitrogen (Total);
  - PCB in Fish Tissue;
  - Phosphorous (Total); and
  - TSS.

- PAXOH
  - Fecal Coliform;
  - Nitrogen (Total);
  - PCB in Fish Tissue;
  - Phosphorous (Total); and
  - TSS.

- PAXTF
  - Biochemical Oxygen Demand (BOD)
  - Chlorides;
  - *Escherichia coli*;
  - Fecal Coliform;
  - Mercury in Fish Tissue;
  - Nitrogen (Total);
  - PCB in Fish Tissue;
  - Phosphorus (Total);
  - Sedimentation/siltation;
  - Sulfates;
  - Temperature (water); and
  - TSS.

The PAXMH, PAXOH, and PAXTF segmentshed areas are approximately 182 square miles (116,480 acres), 115 square miles (73,600 acres), and 581 square miles (371,840 acres), respectively, for a total watershed area of 878 square miles (561,920 acres). Each segmentshed contains several small tributaries of the Patuxent River. PAXTF includes three major tributaries as well: the Little Patuxent River, the Middle Patuxent River, and the Western Branch.

There are 18.16 centerline miles of MDOT SHA roadway located within PAXMH. The associated ROW encompasses 203.45 acres, of which 82.53 acres are impervious. MDOT SHA facilities located within the segmentshed consist of five (5) park and rides and one (1) salt storage facility.

There are 17.38 centerline miles of MDOT SHA roadway located within PAXOH. The associated ROW encompasses 131.66 acres, of which 64.47 acres are impervious. MDOT SHA facilities located within the segmentshed consist of one (1) highway garage or shop, one (1) park and ride, and (1) salt storage facilities.

There are 398.82 centerline miles of MDOT SHA roadway located within PAXTF. The associated ROW encompasses 9775.23 acres, of which 3712.54 acres are impervious. MDOT SHA facilities located within the segmentshed consist of two (2) welcome centers, three (3) weigh stations, five (5) highway garages or shops, 13 park and rides, and seven (7) salt storage facilities.

See **Figure 4-58** for a map of the MDOT SHA facilities located within the PAXMH, PAXOH, and PAXTF segmentsheds.

Figure 4-59 provides a close-up of the MDOT SHA facilities, the county boundaries, and the 8-digit watersheds within the PAXTF. Note that the Patuxent River follows the county boundary line between the counties from the top of the PAXTF downward towards the PAXOH.

T.2. MDOT SHA TMDLs within Patuxent Tidal Fresh Segmentshed

MDOT SHA is included in the PCB TMDL (MDE, 2017a). PCBs for PAXTF are to be reduced by 99.9 percent, as shown in **Table 3-2**. Because MDOT SHA does not have a reduction requirement in the PAXMH and PAXOH segmentsheds, **Section T.2.**, **Section T.3.**, and **Section T.4.** below only pertain to the PAXTF segmentshed.

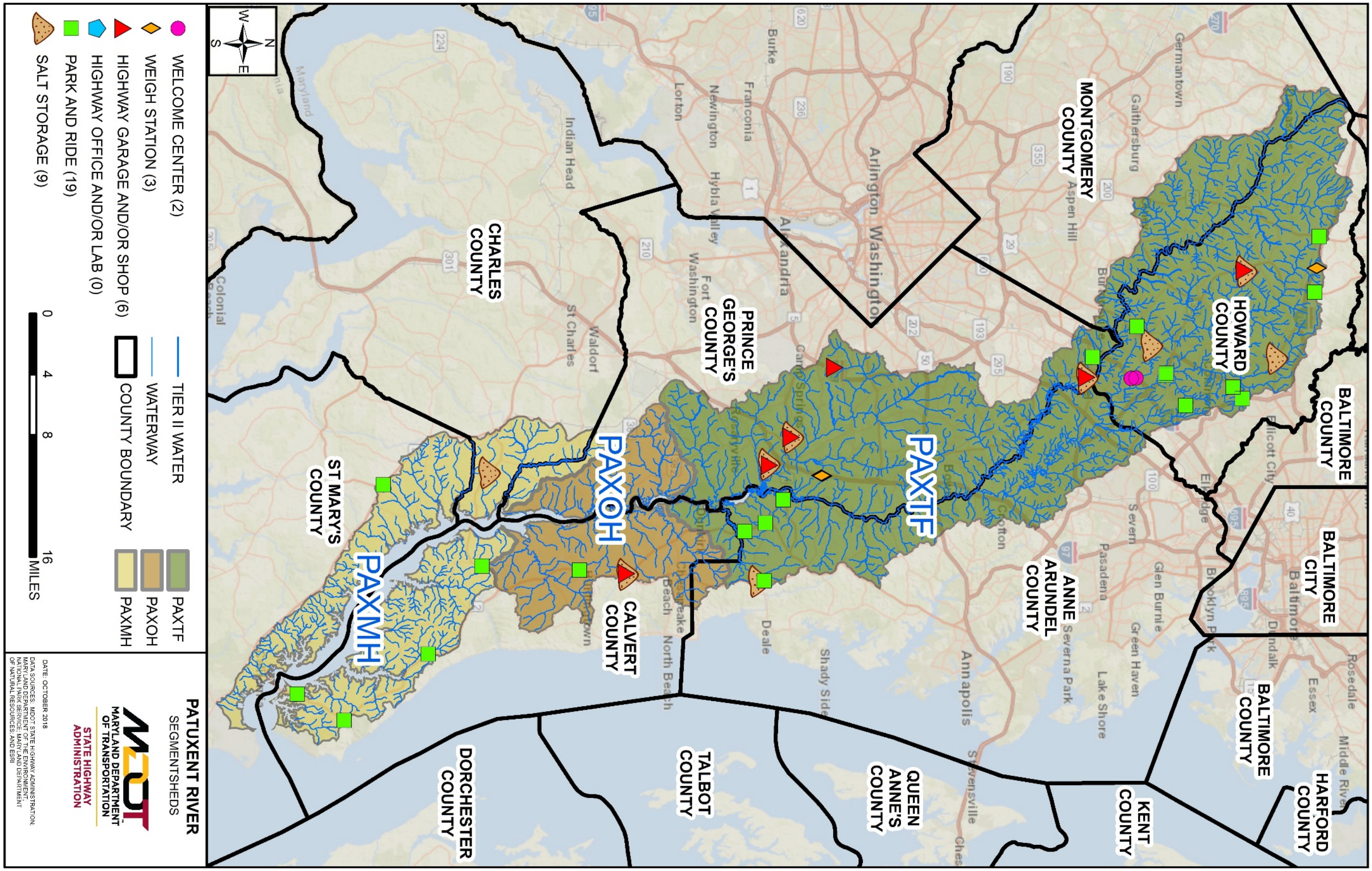


Figure 4-58: PAXMH, PAXOH, and PAXTF Segmentsheds

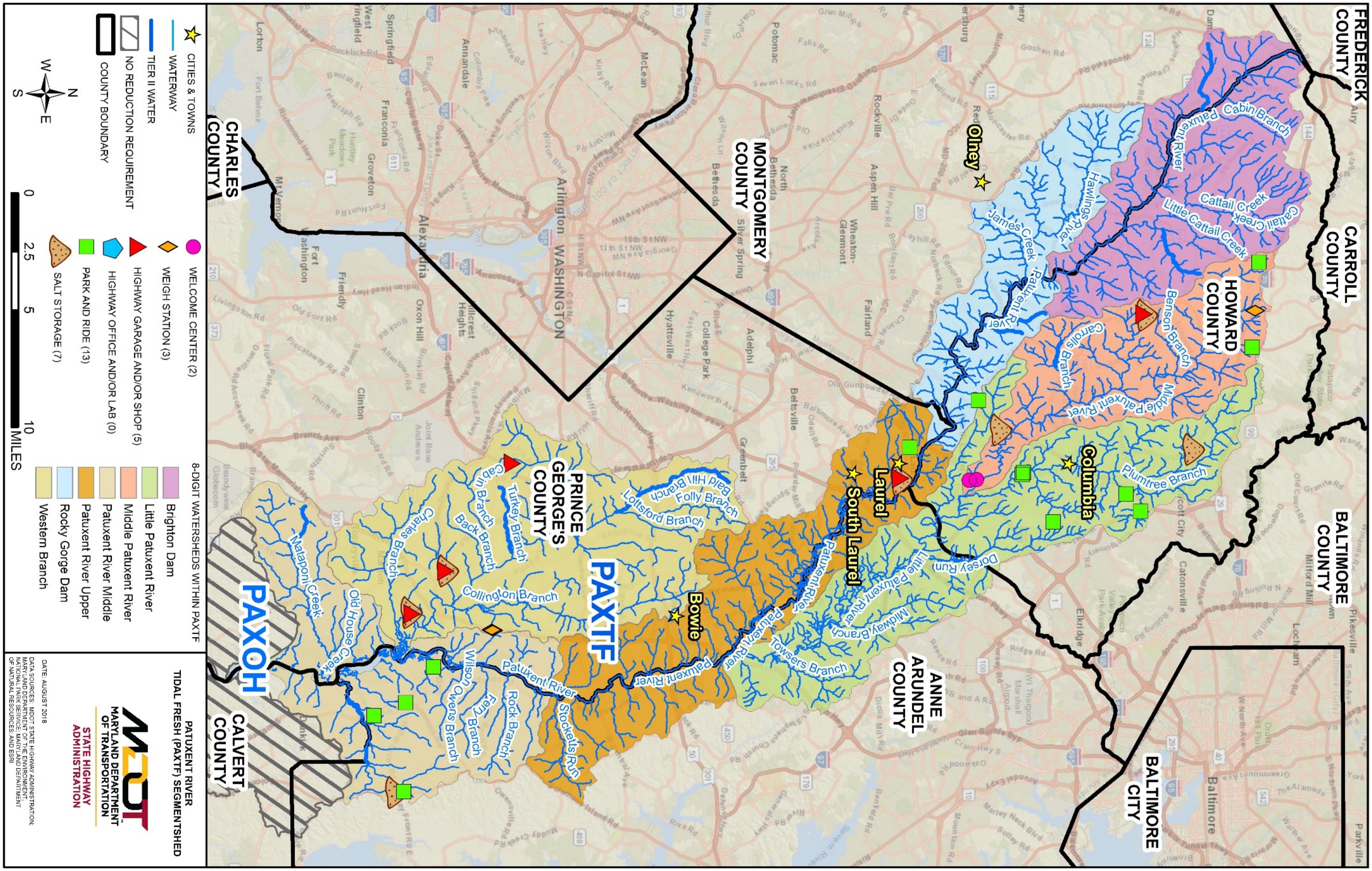


Figure 4-59: PAXTF Segmentshed

T.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Patuxent River Tidal Fresh segmentshed is shown in **Figure 4-60** which illustrates that 257 grid cells have been reviewed, encompassing portions of 76 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 1591 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 83 new structural SW controls constructed or under contract.
- 1010 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 498 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 778 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 224 sites constructed or under contract.
- 99 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 455 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 120 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Nine (9) sites constructed or under contract.
- 16 additional sites deemed potentially viable for stream restoration and pending further analysis may be candidates for future restoration opportunities.
- 95 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 343 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 70 new structural SW controls constructed or under contract.
- 22 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 251 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 656 outfalls potential for stabilization. Further analysis of these sites resulted in:

- 15 outfall sites constructed or under contract.
- 26 outfall sites deemed potentially viable for outfall stabilization efforts and pending further analysis, may be candidates for future restoration opportunities.
- 615 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 119 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of 14 existing structural SW controls constructed or under contract.
- 29 retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- 76 retrofit sites deemed not viable for retrofit and have been removed from consideration.

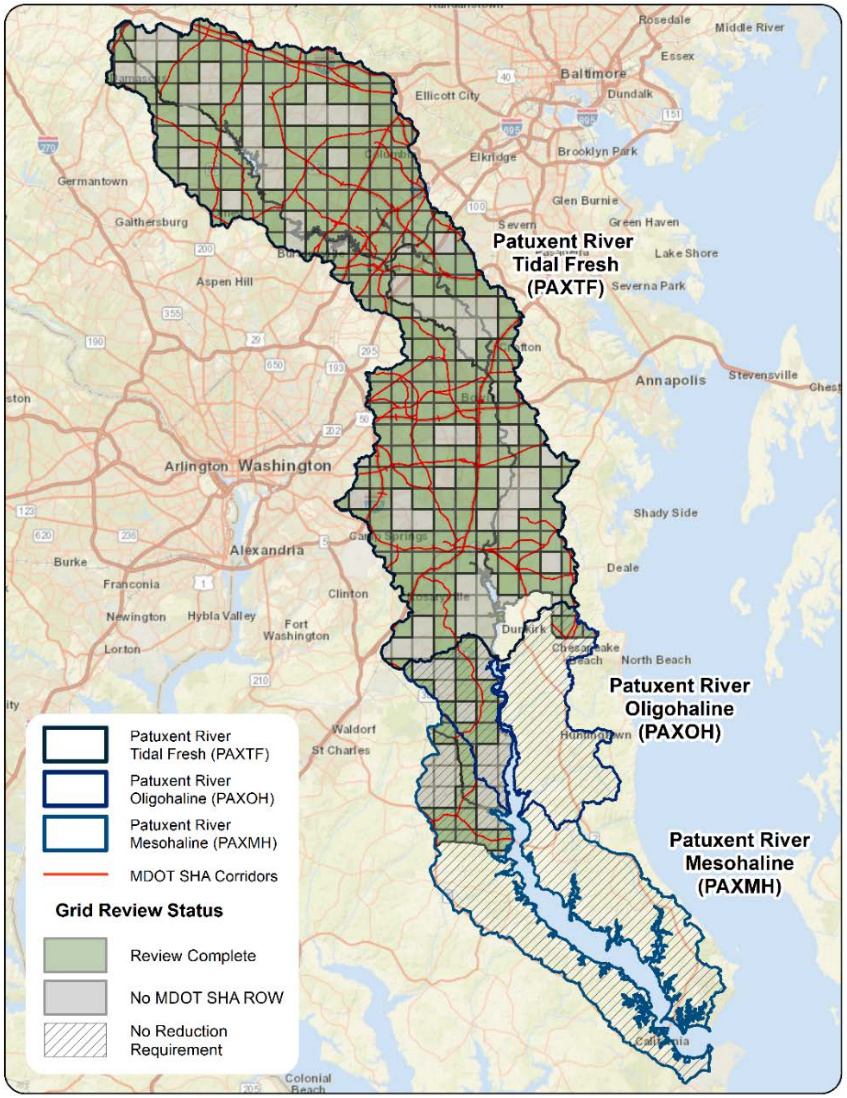


Figure 4-60: PAXMH, PAXOH, and PAXTF Segmentsheds Site Search Grids

T.4. Summary of County Assessment Review

As stated in **Section T.2.** above, MDOT SHA does not have a reduction requirement in the PAXMH and PAXOH segmentsheds; therefore, only the county watershed assessments that cover the PAXTF are summarized below. The following four Maryland counties contain 8-digit watersheds within the PAXTF: Montgomery, Howard, Anne Arundel, and Prince George's. (Note: While the PAXTF segmentshed does drain a very small portion of Frederick County, it is not a large enough area to be included in this section's county assessment summaries. In fact, the PCB TMDL states that "[n]o reduction was applied to the Frederick County portion of the NPDES regulated stormwater baseline load within the PAXTF tidal segment as it only accounts for a relatively small percentage of the total baseline load (0.01%) and is considered insignificant" (MDE, 2017a, p. 41).

Organized by county and their corresponding 8-digit watersheds, the assessments completed by the aforementioned four counties for the areas composing the PAXTF are summarized below. The summaries are best read while referring periodically back to **Figure 4-59**. This is because in addition to providing a close-up of the MDOT SHA facilities in the PAXTF, **Figure 4-59** was also labeled with the relevant cities and roads that serve as points of reference in the summaries.

Montgomery County Assessment

Brighton Dam and Rocky Gorge Dam (Montgomery County)

The 2012 *Patuxent Watershed Implementation Plan (including Pre-Assessment)* (Versar et al., 2012b)—hereinafter referred to as the "Montgomery County Plan"—serves as Montgomery County's assessment of the 8-digit Brighton Dam and Rocky Gorge Dam watershed portions within Montgomery County.

The Montgomery County portion of the Brighton Dam watershed (referred to in the Montgomery County Plan as the "Upper Patuxent River" subwatershed) is a 21-square-mile area located in the northern/northeastern region of the County. Land use within this portion of the watershed consists of rural lands (38 percent), forests (27 percent), and low density residential (23 percent). Streams within Montgomery County's portion of the Brighton Dam watershed are generally of high quality: the streams naturally support a healthy brown trout population with many of the streams serving as reference streams for the County's stream monitoring program (Versar et al., 2012b).

The Montgomery County portion of the Rocky Gorge Dam watershed (referred to in the Montgomery County Plan as the "Hawlings River" and the "Lower Patuxent River" subwatersheds) is a 39-square-mile area located in the northeastern/eastern region of the County. Land use within the Montgomery County portion of the Rocky Gorge Dam consists of medium (25 percent) and low (21 percent) density residential, forests (20 percent), and rural development (17 percent). Streams in the Montgomery County portion of the Rocky Gorge Dam watershed are subject to more impairment than the streams in the Montgomery County portion of the Brighton Dam watershed (Versar et al., 2012b).

The total impervious cover within Montgomery County's portions of Brighton Dam and Rocky Gorge Dam are 312 acres and 1,321 acres, respectively (Versar et al., 2012b). Major impervious elements include roads, parking lots, roofs, sidewalks, and paved courts. Of these various impervious cover types, roads and roofs make up the majority of the impervious surface (note: driveways were not included in the impervious cover calculations) (Versar et al., 2012b).

Currently, there are 173 structural stormwater BMPs in place within Montgomery County's Brighton Dam and Rocky Gorge Dam watersheds (Versar et al., 2012b). The great majority of these existing structural stormwater BMPs occur south of Reddy Branch surrounding the city of Olney (Versar et al., 2012b). The total drainage area treated is 1,298.8 acres, 336.5 of which are impervious acres (Versar et al., 2012b).

Applicable types of restoration practices being considered for future BMPs include new Environmental Site Design (ESD) retrofit practices (rainwater harvesting, upland reforestation, green roofs, etc.); ESD upgrades (retrofit ESD practices within existing publicly owned or privately owned stormwater infrastructure); voluntary ESD implementation (Low Impact Development [LID] practices installed as a result of County education and incentive programs [e.g., rainscape incentives offered in priority neighborhoods]); programmatic and operational practices (e.g., lawn care education); traditional retrofits (e.g., new ponds); credit for BMP maintenance upgrades; and riparian reforestation (Versar et al., 2012b).

Priority status for stormwater BMP retrofit projects are categorized as high, medium, or low priority. Low priority BMP projects include low scoring residential neighborhoods and golf courses. Medium priority projects include land-use types involving commercial/industrial, churches, private schools, apartments and condominiums (multi-family residential), townhouse units, and high and medium scoring residential neighborhood assessment areas. High priority projects are projects that modify existing BMPs that were permitted before 1986 (Versar et al., 2012b).

Current watershed restoration opportunities within the Montgomery County portion of the Brighton Dam watershed include an ESD (low priority) involving the Damascus Library. In the Montgomery County portion of the Rocky Gorge Dam watershed, there are several stream restoration opportunities (low priority), mostly along the Hawlings River and Reddy Branch. In addition, there is one ESD (high priority) opportunity at Longwood Community Center and two ESDs (low priority) opportunities at Ross Boddy Recreation Center near the city of Olney and at the Burtonsville Park and Ride. There are also several retrofit opportunities, including a retrofit (low priority) of the dry pond at the Sandy Spring Meadow community in Olney (Versar et al., 2012b).

Howard County Assessments

Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper (Howard County)

The 2017 *Patuxent River: Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper Watershed Assessment* (KCI, 2017b)—hereinafter referred to as the “2017 Howard County Assessment”—serves as Howard County’s assessment of the 8-digit Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watershed portions within Howard County. The Howard County portion of the Brighton Dam watershed is a 57.7-square-mile area located in northwestern Howard County. The Howard County portion of the Rocky Gorge Dam watershed is a 12.5-square-mile area located in the southwestern region of the County. Lastly, the Howard County portion of the Patuxent River Upper watershed is a small, 2.7-square-mile area located in the southernmost region of the County (KCI, 2017b).

In Howard County, land use within the Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds varies greatly. Primary land uses in Brighton Dam are split between agricultural, urban, and forest, while the Rocky Gorge Dam and Patuxent River Upper are primarily urban, followed by forest. The “urban” use in all three of these watersheds is predominantly residential. More specifically, land use within the Brighton Dam watershed is as follows: agricultural (37.5 percent), urban (34.5 percent), and forest (26.6 percent). Land use within the Rocky Gorge Dam watershed is urban (47.1 percent), agricultural (14.6 percent), and forest (34.1 percent); land use within the Patuxent River Upper watershed is urban (63.2 percent), agricultural (4.1 percent), and forest (27.7 percent) (KCI, 2017b).

All three watersheds are impaired with various pollutants, with completed TMDLs for *E. coli*, phosphorus, and sediment (KCI, 2017b).

The majority of soils within the Brighton Dam and Rocky Gorge Dam watersheds have moderate infiltration rates, while the Patuxent River

Upper watershed has a much larger proportion of soil groups with higher runoff potential and lower infiltration rates. Accordingly, in regard to the Patuxent River Upper watershed, the 2017 Howard County Assessment states: "[t]he low infiltration rates of these soils means that they are more susceptible to flooding and provide a poor porous medium for stormwater ponds and ESD opportunities, so opportunities should be considered carefully, using local-scale information" (KCI, 2017b, p. 16).

There are many existing BMPs (includes septic practices, tree planting, outfall stabilization, stream restoration, and stormwater structures) in each of watersheds. According to the 2017 Howard County Assessment, Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper have 800, 303, and 134 BMPs, respectively. The corresponding acres that these BMPs treat in Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper are 390.0 acres (0.6 square miles), 108.5 acres (0.2 square miles), and 86.1 acres (0.1 square miles), respectively (KCI, 2017b).

In order to further treat the three watersheds, the 2017 Howard County Assessment examined five types of potential retrofit and restoration opportunities: (1) BMP conversions, (2) new BMPs, (3) tree planting, (4) stream restoration, and (5) outfall stabilization (KCI, 2017b). **Table 4-79** presents the examples provided by Howard County under each category. Both field site selections and desktop analyses were used to identify areas for BMP retrofit or restoration within each watershed.

Of the 123 potential project site recommendations across the three watersheds, 35 project concept plans for the top-ranked projects have been developed. The approved concept plans include 6 BMP conversions, 8 new BMPs, 3 tree plantings, 14 stream restorations, and 4 outfall stabilizations projects.

The concept plans provide the location of the project, current site conditions, implementation information, potential impervious treatment or pollution reduction credits, and a cost estimate. (The complete set of concept plans is available in Appendix G of the 2017 Howard County Assessment [KCI, 2017b]).

Middle Patuxent River (Howard County)

The 2015 *Middle Patuxent River Watershed Assessment* (Versar, 2015b)—hereinafter referred to as the "2015 Howard County Middle Patuxent Assessment"—serves as Howard County's assessment of the 8-digit Middle Patuxent River watershed. Located entirely within Howard County, the Middle Patuxent River watershed is the only other 8-digit watershed besides the Western Branch (entirely in Prince George's County) in the PAXTF that does not cross over into another county or counties.

The Middle Patuxent River watershed is a 58-square-mile area located in central Howard County. Land use within the Middle River Patuxent watershed is as follows: agricultural (33.7 percent), residential (33.1 percent), and forest (26.7 percent) (Versar, 2015b).

Impervious surface cover was used to assess urban impacts to streams within the Middle Patuxent River watershed. According to Howard County's impervious cover data, 9.9 percent of the watershed is impacted by impervious surfaces (Versar, 2015b). A 9.9 percent impervious cover indicates that streams in the watershed are sensitive to becoming degraded. BMPs treat approximately 40 percent of the impervious surfaces in the Middle Patuxent River watershed (Versar, 2015b).

Soil conditions help determine water quantity and quality aspects of streams and rivers. Most soils in the Middle Patuxent River watershed fall into the U.S. Department of Agriculture Group B. Group B soils are loam and silt loam types with moderate infiltration and water transmission rates. Consequently, Group B soils provide good opportunities for stormwater management ponds as well as ESD. The southeastern portion of the watershed; however, features Group D soils.

Group D soils are poorly drained and need careful consideration regarding stormwater management (Versar, 2015b).

Biological monitoring conducted by the DNR Maryland Biological Stream Survey (MBSS) was used to assess stream health in the Middle Patuxent River watershed. The rating categories included Good, Fair, Poor, and Very Poor. The results indicated that 24 percent of the sites assessed were in Good condition, 46 percent were in Fair condition, 19 percent were Poor, and 12 percent were Very Poor. More sites in the Good condition were found in the upper portion of the Middle Patuxent River watershed, while the middle and the lower portion of the watershed had a relatively even distribution of stream conditions (Versar, 2015b). In addition, Howard County also evaluated the watershed's stream habitat condition by using the EPA's RBP. Monitoring results indicated that many of the streams within the Middle Patuxent River watershed are experiencing some level of habitat degradation (Versar, 2015b).

Table 4-79 shows examples of the following five categories of BMPs that Howard County considers to be major strategies towards addressing the County's Bay TMDL and NPDES MS4 permit requirements: (1) BMP conversions, (2) proposed new BMPs, (3) tree planting, (4) stream restoration, and (5) outfall stabilization (Versar, 2015b).

Howard County's overall (applicable across all project types) recommendations for restoration/preservation projects within the Middle Patuxent River watershed were based on the consideration of four pre-developed categories. The first consideration is "permit contribution," i.e., to what degree a project will help meet the County's NPDES MS4 requirements for pollution reduction and impervious surface treatment. The second consideration is "biological uplift," i.e., whether a project will provide additional biological uplift benefits such as the protection of wetlands. The third category—"programmatic benefit"—considers whether a project would have value beyond its primary purpose such as serving as a visible demonstration project or providing public education. The fourth and final category is "feasibility," i.e., the feasibility of project implementation. This includes whether the project site is privately or publicly owned, the accessibility of the site, and whether a repair is already required at the site (would minimize costs by upgrading the facility during the course of other required repairs) (Versar, 2015b).

Out of the 193 potential projects that the County identified and ranked, four-page concept plans were produced for each of the 39 top-ranked opportunities. (The complete set of concept plans is available in Appendix H of the 2015 Howard County Middle Patuxent Assessment [Versar, 2015b]). Overall, of the five recommended project types shown in **Table 4-79**, the 39 concept plans consisted of: 5 BMP conversions, 0 new BMPs, 13 tree plantings, 15 stream restoration projects, and 6 outfall stabilizations (Versar, 2015b).

Little Patuxent River (Howard County)

On behalf of the Howard County Department of Public Works, Versar completed the 2015 *Little Patuxent River Watershed Assessment* (Versar, 2015a)—hereinafter referred to as the "2015 Howard County Little Patuxent Assessment."

In 2014-2015, Howard County's Stormwater Management Division conducted an assessment of the Little Patuxent River watershed within Howard County in order to assess current conditions and recommend watershed restoration opportunities. As a result of the assessment, the project team recommended several opportunities including upgrades to existing stormwater BMPs, new BMPs, tree plantings, stream restoration, and stabilization of stormwater outfalls. Overall, this assessment yielded 760 potential projects and concept plans for 109 of the top-ranked opportunities identified (Versar, 2015a).

The portion of the Little Patuxent River watershed within Howard County drains 59 square miles (37,760 acres). The predominant land use is residential (41.0 percent). This is followed by commercial-industrial-institutional (18.6 percent), which occurs mostly in the southern half of the watershed. Forested areas (21.1 percent) occur mostly along the watershed's stream corridors and the Little Patuxent River mainstem. The watershed includes 9,043 acres of woods and 190 miles of streams (Versar, 2015c). More residential and commercial development is expected to take place in the future, especially around the planned community of Columbia (Versar, 2015a).

About 25.6 percent of the Little Patuxent River watershed within Howard County contains impervious cover; at this percentage, stream degradation is readily observed. As of 2015, there are 1,746 existing stormwater BMPs treating approximately 47 percent of this impervious area. The impervious cover includes roads, parking lots, driveways, major buildings, bridge decks, sidewalks, pathways, and swimming pools (Versar 2015a). Overall, the majority of the soils located in the watershed have high runoff potential; however, some upper parts (around Hammond Branch, for example) predominantly contain soils that have well to moderately well drained soils.

Stream conditions in Howard County's Little Patuxent River watershed were also assessed. While some sites were in Good condition in the upper parts of the watershed (including the upper reaches of Hammond Branch), most sites in the lower part of the watershed (including Dorsey Run) were in Poor to Very Poor condition (Versar, 2015a). In addition, stream habitat conditions were also evaluated. The results indicated that many streams in the Little Patuxent River watershed have been affected by habitat degradation (Versar, 2015a). This degradation, however, was more prevalent in the heavily developed urban areas. Consequently, conditions are generally better in the more rural parts of the County; however, stream degradation can still occur in the rural areas due to large lot development and nearby agricultural activities (Versar, 2015a).

For future treatment, the following five restoration opportunity types were considered: (1) BMP conversions, (2) proposed new BMPs, (3) tree planting, (4) stream restoration, and (5) outfall stabilization. Candidate project sites were identified that would benefit from these five restoration strategies (Versar, 2015a). **Table 4-79** presents the examples provided by Howard County under each category.

The County utilized and collected GIS data as the first step towards identifying candidate retrofit and restoration sites for further investigation in the field. Initially selected candidate sites were reviewed by Howard County staff to finalize the list of field sites to be visited. Ultimately, 530 sites and 50 stream miles were selected for field investigation, and another 72 sites previously assessed in other studies were scheduled for desktop assessments (Versar, 2015a).

Ranking criteria were developed according to the same four categories described in the previous summary of the 2015 Howard County Middle Patuxent Assessment: permit contribution, biological uplift, programmatic benefit, and feasibility (Versar, 2015a). In addition, a two-part, standardized method was developed for ranking and prioritizing the identified project opportunities. Each project was first ranked against all other projects of the same type. Then, all projects were pooled together and ranked against one another to enable ranking across project type and to determine which projects should be taken to the next design phase (Versar, 2015a).

Out of the 760 potential projects identified, ranking scores were used to select the 109 highest-ranked projects for concept plan development. (The complete set of concept plans is available in Appendix H of the 2015 Howard County Little Patuxent Assessment [Versar, 2015c]). Overall, of the aforementioned five restoration opportunity types, the 109 concept plans consisted of the following: 15 BMP conversions, 10 new BMPs, 19 tree plantings, 45 stream restorations, and 20 outfall stabilizations (Versar, 2015a).

Additional reductions could also be accomplished by activities such as street sweeping; erosion/sediment control; and public outreach efforts such as watershed trash cleanup campaigns, conservation landscaping, and pet waste education. Over the next several years, the County may add these types of activities as needed to meet TMDL goals (Versar, 2015a).

Table 4-79: Howard County Suggested BMPs within the Howard County Portions of the PAXTF
BMP Conversions
• Extended detention wet ponds/wetlands, shallow wetlands • Bioretention • Non-bioretention filtering practices • Infiltration practices • Swales • Addition of pre-treatment or post-treatment BMPs within existing dry or wet pond boundaries • New BMP retrofits outside of existing dry or wet pond boundaries but which would drain into an existing pond or capture and treat stormwater just outside of the existing pond (e.g., step pool conveyance)
New BMPs
• Extended detention wet ponds/wetlands, shallow wetlands • Bioretention • Non-bioretention filtering practices • Infiltration practices • Swales • Green roofs • Replacement of impervious cover with pervious pavement • Impervious cover removal • Rain barrels • Rain gardens • Rooftop disconnection
Tree Planting
• Reforestation of stream buffers • Reforestation of upland areas
Stream Restoration (restoring degraded stream channels for erosion control and enhanced nutrient processing)
Outfall Stabilization
• Rip Rap stabilization • Step Pool Conveyance (SPSC)/Regenerative Stormwater Conveyance (RSC) stabilization • Installing a drop structure or other stabilization of the outfall channel
Sources: KCI (2017b); Versar (2015a); and Versar (2015b)

Anne Arundel County Assessments

Little Patuxent River (Anne Arundel County)

In 2016, the Anne Arundel County Department of Public Works completed the *Little Patuxent Watershed Assessment Comprehensive Summary Report* (LimnoTech & Versar, 2016)—hereinafter referred to as the "2016 Report." For assessment purposes, the Little Patuxent River watershed was broken up into 21 subwatersheds. Each subwatershed was given a name to match the geographic area (stream or landmark) and assigned a number if there were multiple subwatersheds related to that geographic area (e.g., Dorsey Run 1, Dorsey Run 2, etc.) as well as a three-digit code beginning with "LP" for Lower Patuxent. Ten of the subwatersheds codes were given numbers: LP0 – LP9; the rest were given letters: LPA – LPK. For simplicity, the names, not codes, of the 21 subwatersheds are referenced in this summary.

There are a variety of jurisdictions in the watershed, including Fort Meade, the Patuxent Research Refuge, and the Maryland Sunrise Farm (formerly the U.S. Naval Academy Dairy Farm). In addition to the Little Patuxent River, major streams in Anne Arundel County's portion of the Little Patuxent River watershed include Dorsey Run, Rogue Harbor Branch, and Towsers Branch. Several major roads also traverse the watershed: MD 32, I-95, I-295 (Baltimore-Washington Parkway), MD 175 (Jessup Road), Piney Orchard Parkway, MD 3, MD 198, MD 50, MD 301 and MD 424. The watershed also contains the Crofton County (or Golf) Club in its southernmost portion.

The watershed has many sensitive environmental features such as wetlands and greenways. The majority of wetlands are located along the Little Patuxent River. With the exception of Fort Meade, greenways are located throughout the watershed. Forest (approximately 45.9 percent) makes up the biggest portion of land cover in the watershed. The largest land ownership types are "Natural Lands within County jurisdiction," the U.S. Department of Defense (Fort Meade), and the U.S. Fish and Wildlife Service (Patuxent Research Refuge). Of the property owned by the County, the private high density residential and County roads/facilities constitute the largest impervious areas. According to the 2016 Report, MDOT SHA owns about 387.9 acres in Anne Arundel County's portion of the Little Patuxent River watershed. Of the 387.9 acres, 159.5 acres are impervious (41 percent).

The fastest development in the watershed occurred in the Crofton Golf subwatershed from 1960 through 1979. In the 2000-2015 time period, the "Towsers Branch 3" subwatershed experienced the highest rate of new development (Towsers Branch is located in the most southern portion of the watershed near MD 3.)

Approximately 38 percent (majority) of the soils in the Little Patuxent watershed are classified as hydrologic soil Group C. Group C soils have a moderately high runoff potential when thoroughly wet and water transmission through the soil is somewhat restricted. The most common (47 percent) soil erodibility class present in the Little Patuxent River watershed is "potentially highly erodible land" (LimnoTech & Versar, 2016).

Based on the calculated Maryland Physical Habitat Index (MPHI) score, each stream reach was assigned a condition category of Severely Degraded, Degraded, Partially Degraded, or Minimally Degraded. Standard MPHI category breakpoints used by the DNR are as follows:

- 0 to 50.9 – Severely Degraded
- 51.0 to 65.9 – Degraded
- 66.0 to 80.9 – Partially Degraded
- 81.0 to 100 – Minimally Degraded

The 2016 Report states that the average stream-weighted MPHI score for the Little Patuxent River watershed is 79.3, which corresponds to the "Partially Degraded" condition. Riparian buffer impacts and erosion had the highest total cumulative impact score of all the inventoried features.

Riparian buffer impacts were mostly due to encroachment from residential lawns (LimnoTech & Versar, 2016).

The County has also selected several different types of restoration strategies. The County's selection criteria for restoration projects includes the cost effectiveness relative to the quantity of pollutant removed, maintenance needs, life expectancy, and public acceptance of the proposed project (LimnoTech & Versar, 2016).

The County's strategy is broken down into three primary categories:

- **Core Strategies** – Generally large capital improvement projects that represent the bulk of the load reductions and capital expenditures. Goals include obtaining compliance with WQSs and restoring stream stability, connectivity with floodplains, biological health.
- **Core Tier II Strategies** – Generally smaller scale capital projects or programmatic strategies collectively intended to close the County's gap on achieving its final 2025 required nutrient load reductions.
- **Potential Load Reductions Outside of the Core Strategy WIP Areas** – Credits that may be achieved from installation of stormwater management practices on private property as a result of potential future implementation of a County stormwater utility fee and associated credit program (LimnoTech & Versar, 2016).

The following represent the Core Strategies that will be employed in the Little Patuxent River watershed:

- Outfall Retrofits;
- Stormwater Pond Retrofits;
- Stream Restoration; and
- Programmed Projects (Programmed environmental restoration projects to be implemented by the County, including outfall retrofits, stream restorations, and BMP retrofits.)

The following represent the Core Tier II Strategies that will be employed in the Little Patuxent River watershed:

- Street Sweeping;
- Inlet Cleaning;
- Public Land Reforestation; and
- Stormwater to the MEP (This strategy includes retrofitting existing impervious surfaces to the MEP with stormwater management practices, including but not limited to green roofs, permeable pavement, bioretention, and downspout disconnection. The 2016 Report states that these retrofits will be limited to County-owned properties including the County's Board of Education and Recreation and Park facilities (LimnoTech & Versar, 2016).

For the third category strategy, "Potential Load Reductions Outside of the Core Strategy WIP Areas," the County assumes that these credits are limited to areas outside of existing areas covered by the Core Strategies and Core Tier II Strategies. Therefore, the following two broad types of restoration activities were considered in this category (LimnoTech & Versar, 2016):

- Private Commercial/Industrial Stormwater Management (credit accounts for stormwater management retrofits to private commercial and industrial properties)
- Private Residential Stormwater Management (credit accounts for retrofitting rooftops in high density residential areas with practices such as rain water harvesting or rain gardens)

Patuxent River Upper (Anne Arundel County)

On behalf of the Anne Arundel County Department of Public Works, LimnoTech completed the *Upper Patuxent River Watershed Overall Summary Recommendation Report* in September of 2008 (LimnoTech, 2008)—hereinafter referred to as the "Recommendation Report." The Recommendation Report explains that Anne Arundel County's portion of the Patuxent River Upper watershed is divided into 19 subwatersheds, named UP1 – UP9 and UPA – UPJ. The watershed was also split into northern and southern sections near where MD 3 intersects the watershed. The northern section contained UP1 – UP7; the southern section consisted of UP8, UP9, and UPA – UPJ.

According to the Recommendation Report, the entire portion of the Patuxent River Upper watershed within Anne Arundel County drains 22,500 acres, with impervious land cover comprising approximately 14 percent of the watershed as a whole. Land use, however, was assessed separately for the northern and southern sections of the watershed. In the northern section, the predominant land use was forest (76 percent), followed by residential (7 percent). Only 1 percent of the northern section is used for agriculture. In the southern section, the predominant land use was also forest (43 percent), followed by residential (22 percent). Agriculture was the third most common land use, making up 19 percent of the southern section.

The Recommendation Report used three methods to assess restoration and preservation potential within the watershed: a stream restoration assessment, a subwatershed restoration assessment, and a subwatershed preservation assessment. As part of these assessments, chemical and physical data were collected, and various GIS layers were updated.

The assessed stream reaches were placed into one of four categories: Good, Fair, Poor, and Very Poor. The stream reaches in the Patuxent River Upper watershed were predominantly Good to Fair on the rating scale. The full results of the stream restoration assessment are provided in the Recommendation Report (see “Table 2” on p. 7 of LimnoTech [2008]).

The subwatershed restoration assessment was intended to identify subwatersheds where conditions warranted restoration activities on a large scale, such as BMP retrofitting. Likewise, the subwatershed preservation assessment was intended to identify subwatersheds where conditions warranted consideration for preservation activities.

The subwatersheds were placed into one of four categories based on the results of the restoration and preservation assessments: Good, Fair, Poor, and Very Poor. For the subwatershed restoration assessment, subwatersheds UP2 (in northern section near the city of Laurel) and UPB (in southern section directly below MD 50/MD 301) were both rated Very Poor and were therefore the highest priority for restoration. For the subwatershed preservation assessment, subwatersheds UP1, UP6, and UP7 (UP1 and UP6 are in the northern section near the city of South Laurel; UP7 is the southernmost subwatershed in the northern section, extending down to where the northern section becomes the southern section near MD 3) were rated as Good and were therefore the best candidates for preservation. The full list of restoration and preservation rankings results can be found in the Recommendation Report (see “Table 4” and “Table 6” on p. 9 and p. 10, respectively, of LimnoTech [2008]).

Known impairments of the County’s portion of the Patuxent River Upper watershed include nutrients and sediments. Therefore, the Recommendation Report also conducted water quality modeling to better understand the potential for future water quality improvements. Existing and future development scenarios were modeled that included assumptions for impervious cover, stormwater management, and septic loading. For each scenario, BMP pollutant removal efficiencies and event mean concentration (EMC) values for the different land cover types were used to predict pollutant loading for a set of water quality parameters. These parameters included total nitrogen, total phosphorus, nitrates, fecal coliform, TSS, and metals. Loading determinations were made for the typical TMDL categories (urban, agricultural, and other) and were calculated separately with and without BMPs or ESD retrofits.

Two existing conditions scenarios were modeled: with fully maintained BMPs, and with failed urban BMPs. Eighteen different future condition scenarios were also modeled. Examples of conditions used in the future models included with or without various BMP implementation and maintenance, septic upgrades, implementation of the Sewer Master Plan, and varying levels of ESD retrofits, to name a few.

For some subwatersheds and water quality parameters, all current and future development scenarios met County loading goals. For other subwatersheds and water quality parameters, none of the scenarios met loading goals. The Recommendation Report generally concluded that ESD retrofits in County right-of-ways and select private lands provide the best opportunity for pollutant reduction.

Patuxent River Middle (Anne Arundel County)

In June 2018, KCI and Coastal Resources completed the *Herring Bay, Middle Patuxent, and Lower Patuxent Watershed Assessment Comprehensive Summary Report* (KCI & Coastal Resources, 2018) (hereinafter referred to as the “2018 Report”). The 2018 Report serves as Anne Arundel County’s assessment of the 8-digit Patuxent River Middle watershed portion within Anne Arundel County (referred to as the “Middle Patuxent” watershed in the 2018 Report).

For the 2018 Report, the Anne Arundel County portion of the Patuxent River Middle watershed, which is located in the southern portion of the County, was divided into 33 subwatersheds. Each subwatershed was given a name to match the surrounding geographic area (stream or landmark) and assigned a number if there were multiple subwatersheds related to that geographic area (e.g., Rock Branch 1, Rock Branch 2, etc.) as well as a three-digit code beginning with “MP” for Middle Patuxent. Ten of the subwatersheds were given numbers: MP0 – MP9; the rest were given letters: MPA, MPB, MPD – W, and MPZ. While not discussed in this summary, MPC, MPX, and MPY are three subwatersheds that are in the Patuxent River Lower watershed that were in grouped in with the Patuxent River Middle watershed for analysis and reporting in the 2018 Report. For simplicity, the names, not codes, of the 33 subwatersheds are used in this summary.

The Anne Arundel County portion of the Patuxent River Middle watershed is approximately 29,820 acres in area in the southern portion of the County. The watershed includes several named streams including Rock Branch, Wilson Owens Branch, Lyons Creek, Cabin Branch, Galloway Creek, and the middle branch of the Patuxent River.

In the Patuxent River Middle, the fastest development occurred in the Galloway Creek subwatershed between 1920 and 1999. Development is expected to continue to occur. The majority of future residential development will likely take place in and around the Wilson Owens Branch and Galloway Creek subwatersheds.

Impairments in the Patuxent River Middle watershed include nitrogen, phosphorus, TSS, and most recently, PCBs addressed by the PCB TMDL (MDE, 2017a).

The stormwater BMPs in the Patuxent River Middle watershed are typically owned by private land owners, the County, or other State agencies, such as the MDOT SHA. While the majority of BMPs in the watershed are privately owned, the MDOT SHA-owned BMPs account for about half of the managed drainage areas within the Patuxent River Middle watershed within Anne Arundel County (KCI & Coastal Resources, 2018). Examples of privately owned BMPs include small bioretention cells and ESD facilities such as rain gardens and downspout disconnection.

Four types of assessments were conducted for the Patuxent River Middle watershed in Anne Arundel County: stream restoration, subwatershed restoration, subwatershed preservation, and parcel scale. All four types of assessments utilized a prioritization rating scale of High, Medium High, Medium, or Low.

Results of the stream restoration showed that when compared with all of the major watersheds in Anne Arundel County, the Patuxent River Middle watershed has relatively few stream reaches rated High for restoration, with most of the reaches falling in the Medium and Low category. The "Lyons Creek 10" subwatershed had the most stream reaches in the High category with four reaches rated as High priority for restoration.

The subwatershed restoration assessment used a suite of indicator ratings that were weighed and combined to obtain a single restoration rating for each subwatershed. The indicators were grouped into one of seven categories: stream ecology, 303(d) list, septics, BMPs, H&H, water quality, and landscape. In the Patuxent River Middle watershed, only 4 subwatersheds out of the 33 subwatersheds received a rating of High for restoration priority: "Galloway Creek," "Wilson Owens Branch 2," "Lyons Creek 7," and "Lyons Creek 8."

The subwatershed preservation assessment also used a suite of indicator ratings that were weighed and combined to obtain a single preservation rating for each subwatershed. The indicators were grouped into one of five categories: stream ecology, future departure of water quality conditions, soils, landscape, and aquatic living resources. Ten subwatersheds out of the 33 subwatersheds (30 percent) were rated High priority for preservation: "Ferry Branch 1," "Galloway Creek," "Cabin Branch 1," "Two Run Branch 2," "Pindell Branch," "Lyons Creek 2," "Lyons Creek 9," "Cabin Branch 2," "Two Run Branch 1," and "Wilson Owens Branch 4." The 2018 Report further noted that two "Tier II High Quality Waters" stream segments exist in the "Cabin Branch 1" and the "Lyons Creek 10" subwatersheds.

As stated above, the "Cabin Branch 1" subwatershed received a preservation ranking of High. The nearby "Lyons Creek 10" subwatershed received a preservation ranking of Medium High. These two ratings coupled with the fact that several adjacent subwatersheds draining to the reaches in the "Cabin Branch 1" and "Lyons Creek 10" subwatersheds also rated High for preservation makes "…this an important area for implementing preservation measures" (KCI & Coastal Resources, 2018, p. 90).

Lastly, a parcel scale assessment was conducted. The 2018 Report noted that this additional assessment was completed due to the fact that the general land use conditions in the southern portions of Anne Arundel County differ from the rest of the County in that the southern areas are less developed and contain more agricultural and forest cover. Consequently, the amount of impervious surface area in the southern portions of the County is "considerably less" than in other parts of the County (KCI & Coastal Resources, 2018, p. 91). (Impervious surface accounts for only 4.8 percent of the total area in the Patuxent River Middle watershed.) Based on this information, the County has recognized that preservation is critical in the Patuxent River Middle watershed. Therefore, the County supplemented its subwatershed preservation assessment with three separate but related prioritization models that identified areas at the parcel level as good candidates for (1) preservation, (2) tree planting and/or riparian buffer restoration, and (3) impervious treatment (removal and conversion to pervious). At the parcel level, there were too many sites identified to provide a meaningful summary. Accordingly, the 2018 Report provides a visual summary of the identified good candidate sites for these actions in the form of several large maps (see Map 4.4 for the good candidate sites for preservation, Map 4.5 for the good candidate sites for reforestation, and Map 4.6 for the good candidate sites for impervious treatment in the 2018 Report).

Prince George's County Assessments

Rocky Gorge Dam and Patuxent River Upper (Prince George's County)

In 2015, Prince George's County Department of the Environment published the *Restoration Plan for the Upper Patuxent River and Rocky*

Gorge Reservoir Watersheds in Prince George's County (Tetra Tech, 2015c) (hereinafter referred to as the "2015 Restoration Plan").

There is a very small portion (approximately 530 acres or 0.83 square miles) of the Rocky Gorge Dam (referred to as the "Rocky Gorge Reservoir" watershed in the 2015 Restoration Plan) within Prince George's County. Prince George's portion of the Rocky Gorge Dam watershed is impaired with phosphorus associated with both upstream point and non-point sources. Almost all of the watershed contains hydrologic Group B soils. Land use in Prince George's portion of the Rocky Gorge Dam consists of mostly forest (more than 51 percent), followed by urban (less than 23 percent) and agricultural (more than 18 percent). Approximately 6.1 percent of the land in Prince George's part of the Rocky Gorge Dam watershed is impervious (Tetra Tech, 2015c).

Prince George's portion of the Patuxent River Upper watershed (referred to as the "Upper Patuxent River" watershed in the 2015 Restoration Plan) is approximately 31,881 acres (49.8 square miles) and includes several municipalities such as the cities of Laurel, South Laurel, and Bowie. It also includes a large area of the Patuxent Research Refuge owned and operated by the U.S. Fish and Wildlife Service. Streams in the portion of the watershed surrounding the city of Bowie are impaired with fecal coliform bacteria (Tetra Tech, 2015c). Sediment is listed as an impairment throughout the entire watershed (both the Rocky Gorge Dam and Patuxent River Upper). Almost half of the Patuxent River Upper watershed contains hydrologic Group B soils, while a combination of Group C and Group D soils make up the remainder of the watershed. Land use in Prince George's portion of the Patuxent River Upper watershed is mostly urban (about 51 percent, largely residential land); however, there is significant forested land (more than 38 percent) among the non-urban portions of the watershed. Approximately 18 percent of the land in Prince George's part of the Patuxent River Upper watershed is impervious (Tetra Tech, 2015c).

For the 2015 Restoration Plan, Prince George's portion of the Patuxent River Upper watershed was divided into 38 subwatersheds, named as PX-1 through PX-38. With the exception of PX-38, which is near the southern portion of the watershed, the subwatersheds start out with PX-37 near the northern most part of the watershed and progress in numerical order down the length of the watershed until PX-1 is reached at the southernmost tip.

An evaluation of each subwatershed in the Patuxent River Upper watershed was performed to aid in the selection of BMPs in the areas with the highest required pollutant load reductions. The County prioritized the subwatersheds by ranking the necessary total load reduction for each TMDL parameter and then averaging the individual ranks to obtain an overall rank for the subwatershed. According to the 2015 Restoration Plan, "Although not included in this restoration plan, PCBs are included in the subwatershed ranking" (Tetra Tech, 2015c, p. 63). Therefore, the TMDL parameters included in the ranking were total nitrogen (TN), total phosphorus (TP), TSS, BOD, fecal coliform bacteria, and PCBs. These six TMDL parameters are also noted as the "contaminants of most concern in the County" (Tetra Tech, 2015c, p. 107).

The highest ranked watersheds tended to be in areas with the largest amount of impervious cover. Subwatersheds PX-28, PX-30, and PX-34 were among the highly ranked watersheds. These subwatersheds encompass the cities of Laurel and South Laurel in the upper portion of the Patuxent River Upper watershed. Subwatersheds PX-12, PX-13, PX-14, and PX-17 were also highly ranked, with PX-13 emerging as the highest ranked subwatershed overall. These subwatersheds encompass the city of Glenn Dale and portions of the city of Bowie. The County noted that "[t]hese areas are dominated by commercial and residential areas with some minor institutional areas that could be used for BMP implementation in the future." (Tetra Tech, 2015c, p. 63) No ranking was completed for the Rocky Gorge Dam portion; however, its entire drainage area was included in the County's modeling calculations (Tetra Tech, 2015c).

Western Branch and WBRTF (Prince George's County)

The Western Branch, which includes the WBRTF segmentshed within its boundary, is located solely within Prince George's County. As of July 2018, a watershed restoration plan for the Western Branch is not available online at Prince George's Watershed Restoration Planning Site (http://pgcdoe.net/pgcountyfactsheet/Factsheet/Default). However, Prince George's County has prepared several Watershed Existing Condition Reports, including one from 2014 that covers the Western Branch and is summarized below. These reports were the initial step in the restoration plan development process for the watersheds in the County that have EPA-approved TMDLs. The reports characterize the watersheds, provide a review of existing reports and data, and present some additional data and spatial analyses.

In December 2014, Prince George's County Department of the Environment published the *Watershed Existing Condition Report for the Upper Patuxent River, Western Branch, and Rocky Gorge Reservoir Watershed* (Tetra Tech, 2014a)—hereinafter referred to as the "Watershed Existing Condition Report."

The Watershed Existing Condition Report stated that TSS issues in the Western Branch can be attributed to agricultural and urban land uses and stream bank erosion from increased stormwater sources. Located solely within Prince George's County, the Western Branch also has a problem with BOD, which can be an indicator of organic pollution. Lower DO in streams near discharges from WWTPs, agriculture feed lots, and septic systems is also a problem.

In the Western Branch, the land use is primarily forest and agriculture, which show areas of higher nutrient loads (Tetra Tech, 2014a). Stormwater ponds, which usually treat residential and non-urban areas, are the most implemented BMP in the Western Branch watershed. While this practice treats larger areas, they are less efficient than other practices at removing pollution.

Infiltration practices are the second most implemented stormwater control in the Western Branch; they treat smaller areas but remove pollution with greater efficiency. The oil and grit separators are known for treating more area but have lower removal efficiencies than infiltration practices. Existing BMPs in the Western Branch include bioretention, grass swales, infiltration, oil/grit separators, and ponds (Tetra Tech, 2014a).

There were two sites mentioned in the Watershed Existing Condition Report regarding benthic invertebrates and BIBI sampling within the Western Branch watershed; these sites are (Tetra Tech, 2014a):

- Southwest Branch – a total of 7 streams were sampled: 6 first order and 1 second order. One was rated Very Poor, three were rated Poor, and the remaining were rated as Fair.

- Collington Branch – a total of 12 streams were sampled. One was rated Very Poor, three were rated Poor, seven were rated as Fair, and one was rated as Good.

Prince George's County has also engaged in street sweeping, public outreach to promote environmental awareness, green initiatives, and community involvement in protecting natural resources. Past public outreaches conducted include distributing educational brochures on stormwater pollution, the "Can the Grease" program to decrease SSOs, and implementing recycling programs (Tetra Tech, 2014a).

Patuxent River Middle (Prince George's County)

As of July 2018, a watershed restoration plan is not available online at Prince George's Watershed Restoration Planning Site (http://pgcdoe.net/pgcountyfactsheet/Factsheet/Default) that covers the Patuxent River Middle watershed portion within Prince George's County. A Watershed Existing Condition Report covering the Patuxent River

Middle portion within Prince George's County is also currently not available on the site.

T.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet PCB reduction in the Patuxent Tidal Fresh segmentshed are shown in **Table 4-80**. Projected PCB reductions using these practices are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs implemented before the TMDL baseline. In this case, the baseline is 2010;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025,
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the PCB TMDL, MDOT SHA will meet 3.9 percent of the MDE 99.9 percent load reduction requirement through implementation of BMPs shown in **Table 4-80**. MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in Part III Section E.

Estimated costs to design, construct, and implement BMPs within the Patuxent Tidal Fresh segmentshed watershed total $33,205,000. These projected costs are based on an average cost per impervious acre treated derived from a cost history for each BMP type. Please see **Table 4-81** for a BMP strategy cost breakdown.

Figure 4-61 is a map of MDOT SHA's restoration practices in the PAXTF segmentshed, including those that are under design or construction. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-80: PAXTF PCB BMP Implementation

BMP	Unit	Baseline (Before 2010)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	3,669.5	185.8	228.4	TBD	4,083.7
Retrofit	drainage area acres		119.7		TBD	119.7
Impervious Surface Elimination	acres removed		0.5		TBD	0.5
Inlet Cleaning[1]	tons		20.7	42.9	TBD	63.6
Street Sweeping[1]	acres swept		177.8		TBD	177.8
Load Reductions	PCB g/yr.		0.14	0.20	5.09	
				Total Projected Reduction	**5.09**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-81: PAXTF Restoration BMP Cost

BMP	20202020	2025	Total
New Stormwater	$16,741,000	$10,720,000	$27,461,000
Retrofits	$5,091,000		$5,091,000
Impervious Surface Elimination	$146,000		$146,000
Inlet cleaning	$81,000	$245,000	$326,000
Street Sweeping	$181,000		$181,000
Total			$33,205,000

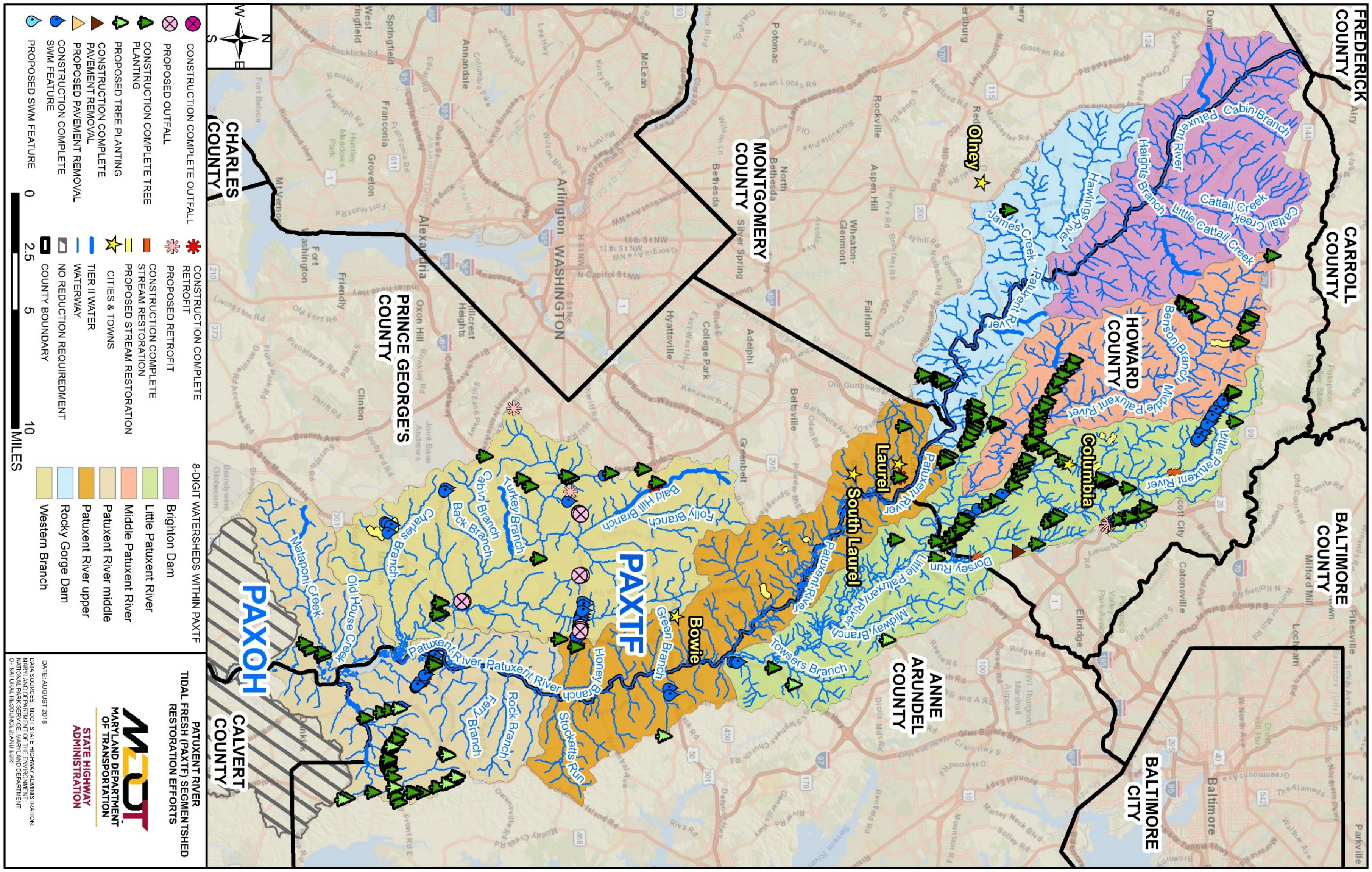


Figure 4-61: MDOT SHA Programmed Restoration Strategies within the PAXTF Segmentshed

U. PATUXENT RIVER UPPER WATERSHED

U.1. Watershed Description

The Patuxent River Upper watershed encompasses 88 square miles within west Anne Arundel and northeast Prince George's Counties, in addition to small areas in Montgomery and Howard Counties. The Patuxent River Upper begins in Howard County to the north and flows south ultimately draining to the Chesapeake Bay.

There are 556.5 centerline miles of MDOT SHA roadway located within the Patuxent River Upper watershed. The associated ROW encompasses 1,801.9 acres, of which 784.5 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) highway garage or shop, one (1) salt storage facility, and one (1) park and ride facility. See **Figure 4-62** for a map of the watershed.

U.2. MDOT SHA TMDLs within Patuxent River Upper Watershed

MDOT SHA is included in both bacteria (MDE, 2011h) and sediment (MDE, 2011i) TMDLs. Sediment is to be reduced by 11.4 percent in Anne Arundel, Prince George's and Howard Counties. Bacteria is to be reduced by 45.3 percent, as shown in **Table 3-3**.

U.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Patuxent River Upper watershed is shown in **Figure 4-63** which illustrates that 58 grid cells have been reviewed, encompassing portions of 19 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 289 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- Seven (7) new structural SW controls constructed or under contract.
- 180 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 102 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 59 locations as potential tree planting locations. Further analysis of these locations resulted in:

- Nine (9) sites constructed or under contract.
- Eight (8) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 42 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 31 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Two (2) sites constructed or under contract.
- One (1) additional site deemed potentially viable for stream restoration and pending further analysis may be a candidate for future restoration opportunities.
- 28 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 74 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Five (5) new structural SW controls constructed or under contract.
- Seven (7) additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 62 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 19 outfalls potential for stabilization. Further analysis of these sites resulted in:

- 19 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 18 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of two (2) existing structural SW controls constructed or under contract.
- Two (2) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- 14 retrofit sites deemed not viable for retrofit and have been removed from consideration.

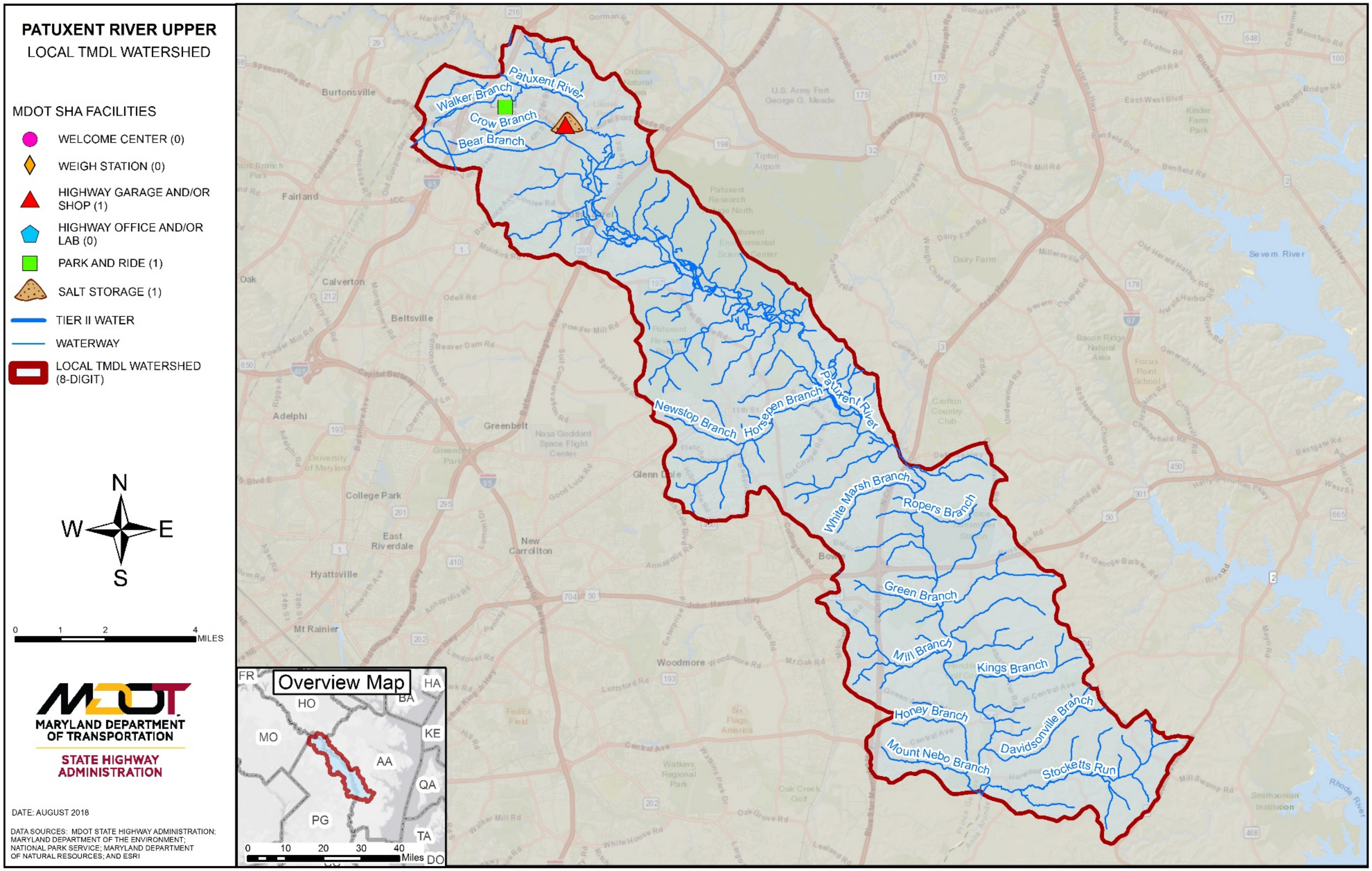


Figure 4-62: Patuxent River Upper Watershed

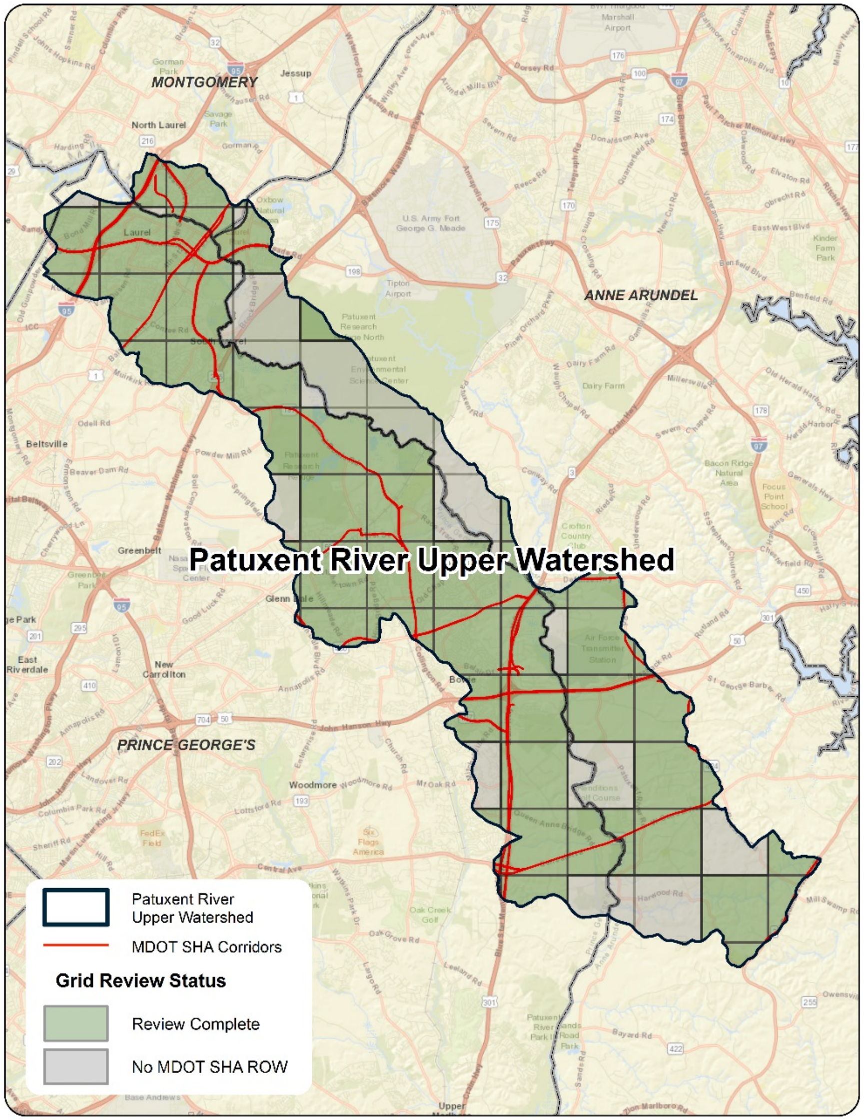


Figure 4-63: Patuxent River Upper Site Search Grids

U.4. Summary of County Assessment Review

Waters within the Patuxent River Upper watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- *Escherichia coli*;
- Mercury in Fish Tissue;
- Sulfates; and
- TSS.

Prince George's County Department of the Environment prepared the *Watershed Existing Condition Report for the Upper Patuxent River, Western Branch, and Rocky Gorge Reservoir Watersheds* in 2014 (Tetra Tech, 2014a) and the *Restoration Plan for the Upper Patuxent River and Rocky Gorge Reservoir Watersheds in Prince George's County* in 2015 (Tetra Tech, 2015c). The phosphorus in Rocky Gorge Reservoir, which is approximately 55 square miles in size, can be associated with non-point sources and urban runoff. In the Patuxent River Upper watershed, the problem with fecal coliform bacteria is attributed to wildlife and domestic animals, land surfaces, humans via septic and sewer systems, regulated stormwater, and SSO.

Total suspended solid issues in the watershed can be attributed to agricultural and urban land uses and stream bank erosion from increased stormwater sources. Western Branch has a problem with BOD, which can be an indicator of organic pollution. There is also a problem with lower DO (with streams near discharges from WWTPs and stormwater runoff, agriculture feed lots, septic systems and natural debris. Within the Patuxent River Upper watershed, Laurel and Bowie have the largest volumes of runoff, which are generated due to higher percent of impervious cover. In the lower portions of the Patuxent River Upper and Western Branch, the land use is primarily forest and agriculture, which shows areas of higher nutrient loads (Tetra Tech, 2014a).

An evaluation of each subwatershed in the Patuxent River Upper watershed was performed to aid in the selection of BMPs in the areas with the highest required pollutant loading reductions. The County prioritized the subwatersheds by ranking the necessary total load reduction for each TMDL parameter and then averaging the individual ranks to obtain an overall rank for the subwatershed. The highest ranked watersheds tended to be in areas with the largest amount of impervious cover. Subwatersheds PX-28, PX30, and PX-34 are among the highly ranked watersheds. These subwatersheds encompass the cities of Laurel and South Laurel in the upper portion of the Patuxent River Upper watershed. Subwatersheds PX-12, PX-13, PX-14, and PX-17 are also highly ranked, with PX-13 emerging as the highest ranked subwatershed as a whole. These subwatersheds encompass the city of Glenn Dale and portions of the city of Bowie. These areas are dominated by commercial and residential areas with some minor institutional areas that could be used for BMP implementation in the future (Tetra Tech, 2015c).

Stormwater ponds are the most implemented BMP, which usually treat residential and non-urban areas. While this practice treats larger areas, they are less efficient than other practices at removing pollution. Infiltration practices are the second most implemented stormwater control; they treat smaller areas but remove pollution with greater efficiency. The oil and grit separators are known for treating more area, but have lower removal efficiencies than infiltration practices. The Patuxent River Upper watershed currently has no bio-retention, infiltration, oil/grit separators, and ponds in use. The Western Branch has bio-retention, grass swales, infiltration, oil/grit separators and ponds (Tetra Tech, 2014a).

There were three sites mentioned in the watershed assessment report regarding benthic invertebrate and BIBI sampling within the Patuxent River Upper and Western Branch watersheds; these sites are (Tetra Tech, 2014a):

- Horsepen Branch – in 2013, four sites were sampled, three yielding a “poor” score, and one receiving a “fair” rating. The estimated number of biologically degraded stream miles increased from 33 percent to 75 percent.

- Southwest Branch – a total of 7 streams were sampled – 6 first order and one second order. One was rated “very poor,” three “poor,” and the remaining as “fair.” The number of biologically degraded stream miles decreased from 100 percent to 57 percent.

- Collington Branch - a total of 12 streams were sampled. One was rated “very poor,” three sites “poor,” seven as “fair,” and one as “good.” The stream miles classified as biologically impaired went from 58 percent to 33 percent.

As a whole, structural and nonstructural BMPs that have been implemented by Prince George’s County include permit compliance, TMDL WLAs, and flood mitigation. Prince George’s County has also engaged in street sweeping, public outreach to promote environmental awareness, green initiatives and community involvement in protecting natural resources. Past public outreaches conducted include educational brochures on stormwater pollution awareness, outreach in schools, and the “Can the Grease” program to decrease SSOs and recycling programs (Tetra Tech, 2014a).

U.5. MDOT SHA Pollutant Reduction Strategies

Patuxent River Upper is listed for both bacteria and sediment with each TMDL having a different baseline year; 2009 for bacteria and 2005 for sediment. Proposed practices to meet the bacteria and sediment reductions in the Patuxent River Upper watershed are shown in **Table 4-82 and 4-83**, respectively. Four time frames are included in the table below:

- BMPs built before the TMDL baseline. In this case, the bacteria baseline is 2009 and the sediment baseline is 2005;

- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the bacteria TMDL, MDOT SHA will meet .4 percent of the MDE 45.3 percent load reduction requirement through implementation of BMPs shown in **Table 4-82.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Patuxent River Upper watershed total $14,186,000. They are based on average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-84** for a summary of estimated BMP costs.

Figure 4-64 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design or construction. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-82: Patuxent River Upper Restoration Bacteria BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	190.3	1.3		TBD	191.6
Load Reductions	E. coli billion MPN/yr.		45.0	45	11,869	
Total Projected Reduction					**11,869**	

Table 4-83: Patuxent River Upper Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	493.9	46.1	37.2	N/A	577.2
Retrofit	drainage area acres		1.2		N/A	1.2
Impervious Surface Elimination	acres removed		0.1		N/A	0.1
Tree Planting	acres of tree planting		8.9	7.3	N/A	16.2
Stream Restoration	linear feet		2000.0	6,186.3	N/A	8186.3
Outfall Stabilization	linear feet		3.2	885.2	N/A	888.4
Inlet Cleaning[1]	dry tons		4.6		N/A	4.6
Street Sweeping[1]	acres swept		27.3		N/A	27.3
Load Reductions	TSS EOS lbs./yr.		100,163	366,589	0	
				Total Projected Reduction	**366,589**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-84: Patuxent River Upper Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$3,375,000	$3,009,000	$6,384,000
Retrofits	$28,000		$28,000
Impervious Surface Elimination	$23,000		$23,000
Tree Planting	$273,000	$222,000	$495,000
Stream Restoration	$1,336,000	$4,131,000	$5,467,000
Outfall Stabilization		$1,748,000	$1,748,000
Inlet cleaning	$17,000		$17,000
Street Sweeping	$24,000		$24,000
Total			$14,186,000

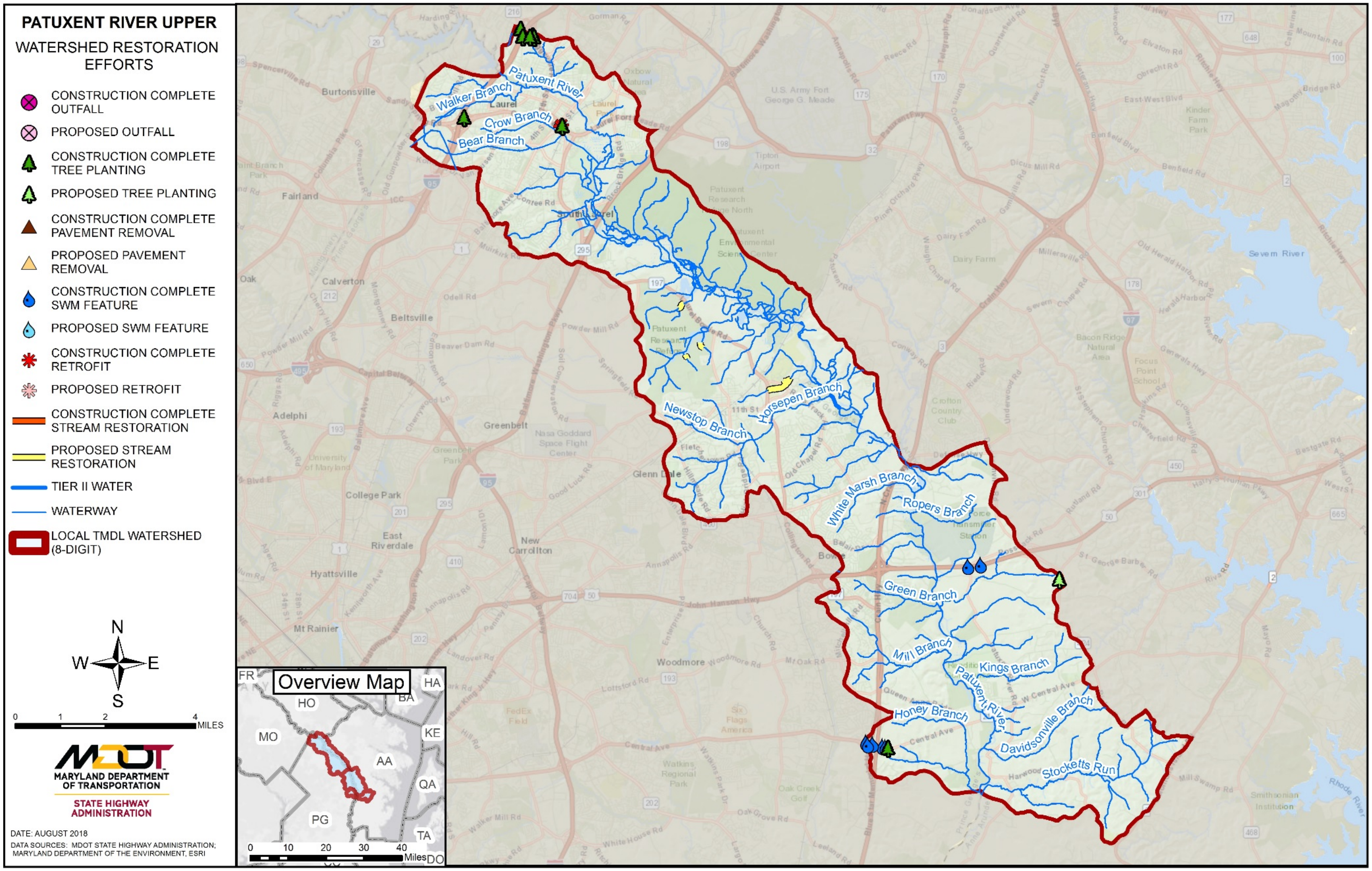


Figure 4-64: MDOT SHA Restoration Strategies within the Patuxent River Upper Watershed

V. POTOMAC RIVER MONTGOMERY COUNTY WATERSHED

V.1. Watershed Description

The Potomac River Montgomery County watershed includes the stretch of the mainstem Potomac River that flows 39 miles through Montgomery County, Maryland from the Frederick County border down to Washington, D.C. The watershed is predominantly located in Montgomery County (140.0 square miles), but small portions also extend into Frederick County (0.7 square miles) and Washington, D.C. (2.1 square miles). Tributary creeks and streams of the Potomac River Montgomery County watershed include Broad Run, Cabin Branch, Greenbrier Branch, Horsepen Branch, Little Falls Branch, Little Monocacy River, Muddy Branch, Piney Branch, Rock Run, Sandy Branch, and Watts Branch.

There are 760.6 centerline miles of MDOT SHA roadway located within the Potomac River Montgomery County watershed. The associated ROW encompasses 1,282.4 acres, of which 1,203.1 acres are impervious. There are no MDOT SHA facilities located within the Potomac River Montgomery County watershed. See **Figure 4-65** for a map of the watershed.

V.2. MDOT SHA TMDLs within Potomac River Montgomery County Watershed

MDOT SHA is included in the sediment TMDL (MDE, 2012e) and has a reduction requirement of 36.2 percent within Montgomery County, as shown in **Table 3-2**.

V.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Potomac River Montgomery County watershed is shown in **Figure 4-66** which illustrates that 51 grid cells have been reviewed, encompassing portions of 19 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 160 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- Six (6) new structural SW controls constructed or under contract.
- 76 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 78 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 58 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 23 sites constructed or under contract.

- 12 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 23 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 18 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- One (1) site constructed or under contract.
- One (1) additional site deemed potentially viable for stream restoration and pending further analysis may be a candidate for future restoration opportunities.
- 16 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 13 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- 13 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 21 outfalls potential for stabilization. Further analysis of these sites resulted in:

- Three (3) outfall sites deemed potentially viable for outfall stabilization efforts and pending further analysis, may be candidates for future restoration opportunities.
- 18 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

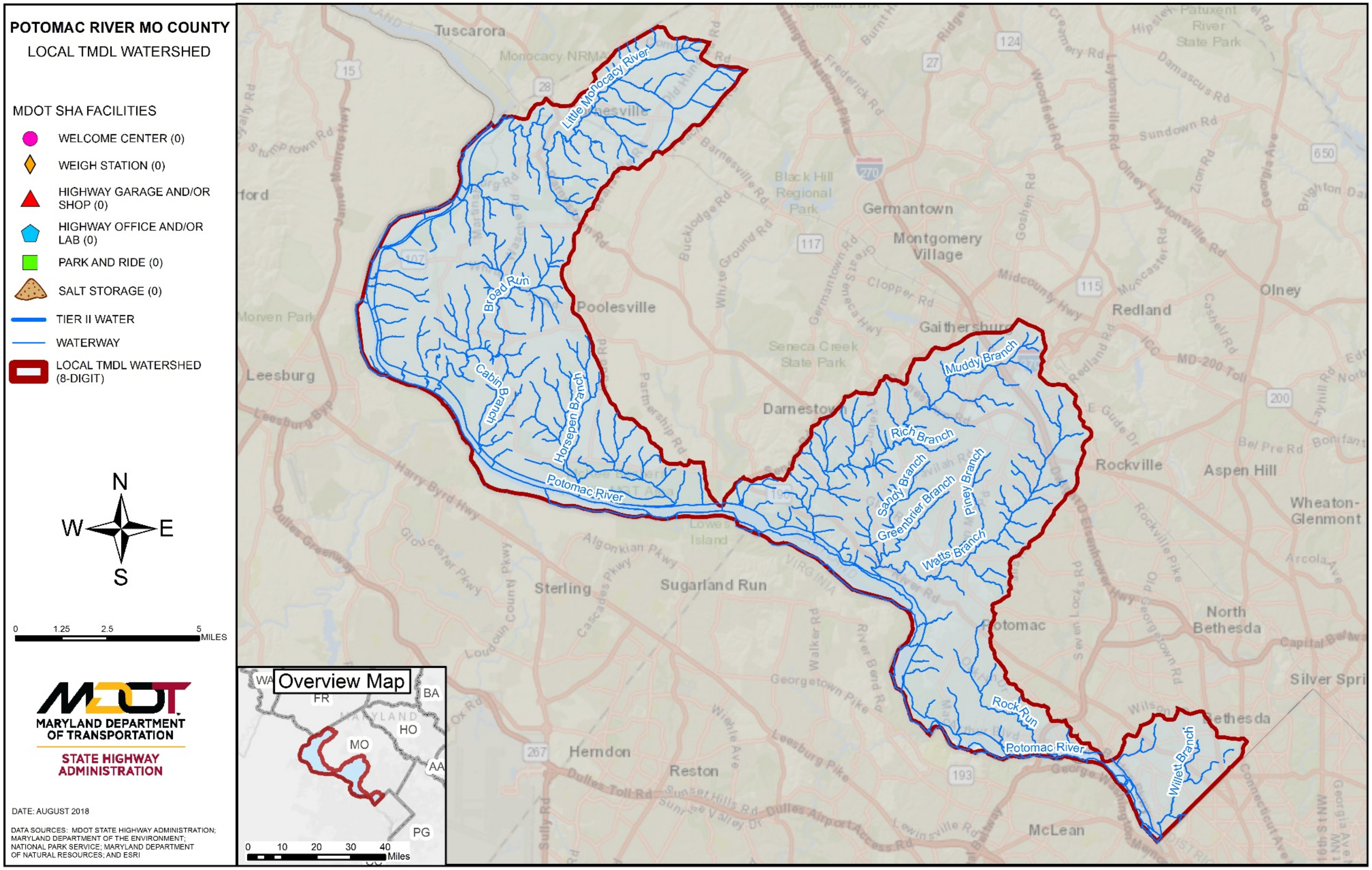


Figure 4-65: Potomac River Montgomery County Watershed

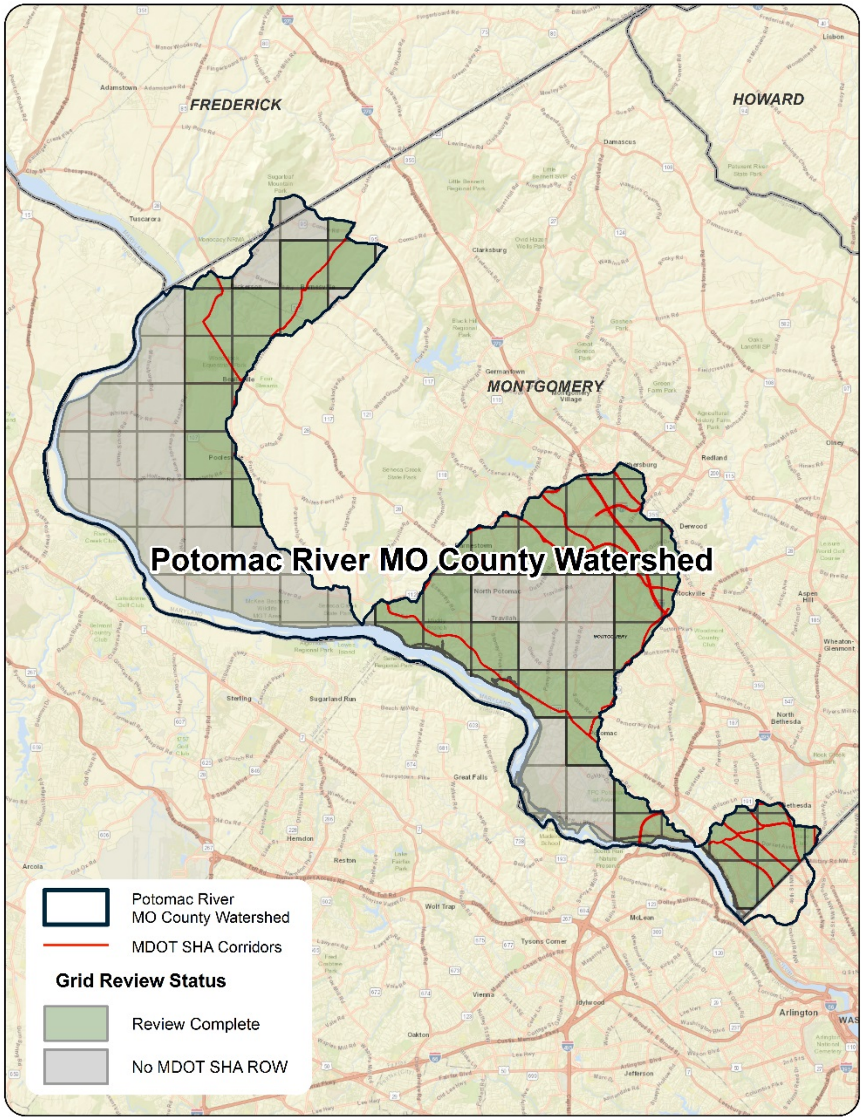


Figure 4-66: Potomac River Montgomery County Site Search Grids

V.4. Summary of County Assessment Review

Waters within the Potomac River Montgomery County watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- PCB in Fish Tissue;
- pH, High;
- Sulfates; and
- TSS.

In 2011 and 2012, Montgomery County Department of Environmental Protection (MO-DEP) published the *Muddy Branch and Watts Branch Subwatersheds Implementation Plan* (Horsley Witten Group, Inc. [HWG], 2012a), the *Upper Potomac Direct Watershed Pre-Assessment* Report (Versar et al., 2011a), and the *Lower Potomac Direct Watershed Pre-Assessment Report* (Versar et al., 2011b). MO-DEP also published the *Watts Branch Watershed Restoration Study* (AMT, Inc. and Biohabitats, 2003). In addition, the City of Gaithersburg published the *Muddy Branch Watershed Study* (URS, 2014b).

The Potomac River Montgomery County watershed comprises primarily urban land use, covering approximately 42 percent of the watershed (7 percent of which is impervious). Forested land comprises approximately 38 percent and agricultural land comprises approximately 20 percent. Within the Muddy Branch and the Watts Branch subwatersheds, the majority of the stream resource conditions were assessed as "fair" (75 percent) and 25 percent were assessed as "good" (HWG, 2014a). Within the Lower Potomac, the majority of stream resource conditions were assessed as "fair" or "poor," with only one site in the Rock Run subwatershed rated "good" (Versar et al., 2011b). Within the Upper Potomac, the majority of stream resource conditions were assessed as "good" or "fair" with only one site in the Broad Run watershed rated as "poor" (Versar et al., 2011a).

The *Upper* and *Lower Potomac Direct Pre-Assessment Reports* identified priorities for stormwater BMP retrofits. These include areas treated by pre-1986 permitted SWM facilities as high priority. Medium and lower priority sites did not include any MDOT SHA ROW, and focused on county-owned and privately-owned sites (Versar et al., 2011a and b).

The *Muddy Branch Watershed Study* identified four proposed stream restoration projects (URS, 2014b):

- M2 Stream Reach: Future Park City, experiencing widespread bank erosion, debris jams, sediment deposition and poor aquatic habitat. Proposed measures include grade control, rock toe protection, root wads, and a deflector.
- T3.1 Stream Reach: Quince Orchard Park, experiencing active lateral headcuts, poor aquatic habitat, and lateral channel migration. Proposed measures include grade control and rock toe protection.
- T4.1 Stream Reach: Brighton Village, experiencing widespread bank erosion, unstable banks, falling trees. Proposed measures include grade control and rock toe protection.
- T5.2a Stream Reach: I-370 Outfall, experiencing unstable banks and streambed, and poor aquatic habitat.

The Frederick County Office of Sustainability and Environmental Resources (OSER) “Publications and Resources” webpage does not currently (as of September 2018) include a watershed assessment for the very small portion of the Potomac River Montgomery County watershed in Frederick County (FR-OSER, 2018).

V.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment reductions in the Potomac River Montgomery County watershed are shown in **Table 4-85**. Projected sediment reduction using these practices are shown in **Table 3-2**. Four timeframes are included in the table:

- BMPs built before the TMDL baseline. In this case, the baseline is 2005;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the sediment TMDL, MDOT SHA will meet 48.5 percent of the MDE 36.2 percent load reduction requirement through implementation of BMPs shown in **Table 4-85.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within Potomac River Montgomery County watershed total $5,584,000. These projected costs are based on an average cost per impervious acre treated derived from a cost history for each BMP type. Please see **Table 4-86** for a BMP strategy cost breakdown.

Figure 4-67 shows a map of MDOT SHA’s restoration practices in the watershed and include those that are under design or constructed. Inlet cleaning and street sweeping is not reflected on this map.

Table 4-85: Potomac River Montgomery County Restoration Sediment BMP Implementation						
BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	624.9	16	15.1	TBD	656.0
Tree Planting	acres of tree planting		55.3		TBD	55.3
Stream Restoration	linear feet	201.0	1,855.2		TBD	2056.2
Outfall Stabilization	linear feet			400.0	TBD	400.0
Inlet Cleaning[1]	dry tons		18.2	59.1	TBD	77.3
Street Sweeping[1]			34.9		TBD	34.9
Load Reductions	TSS EOS lbs/yr.		48,320	155,573	320,708	
				Total Projected Reduction	320,708	

[1] Inlet cleaning and street sweeping are annual practices.

Table 4-86: Potomac River Montgomery County Restoration BMP Cost			
BMP	2020	2025	Total
New Stormwater	$463,000	$971,000	$1,434,000
Tree Planting	$1,611,000	$81,000	$1,692,000
Stream Restoration		$1,239,000	$1,239,000
Outfall Stabilization		$787,000	$787,000
Inlet cleaning	$77,000	$338,000	$415,000
Street Sweeping	$17,000		$17,000
Total			$5,584,000

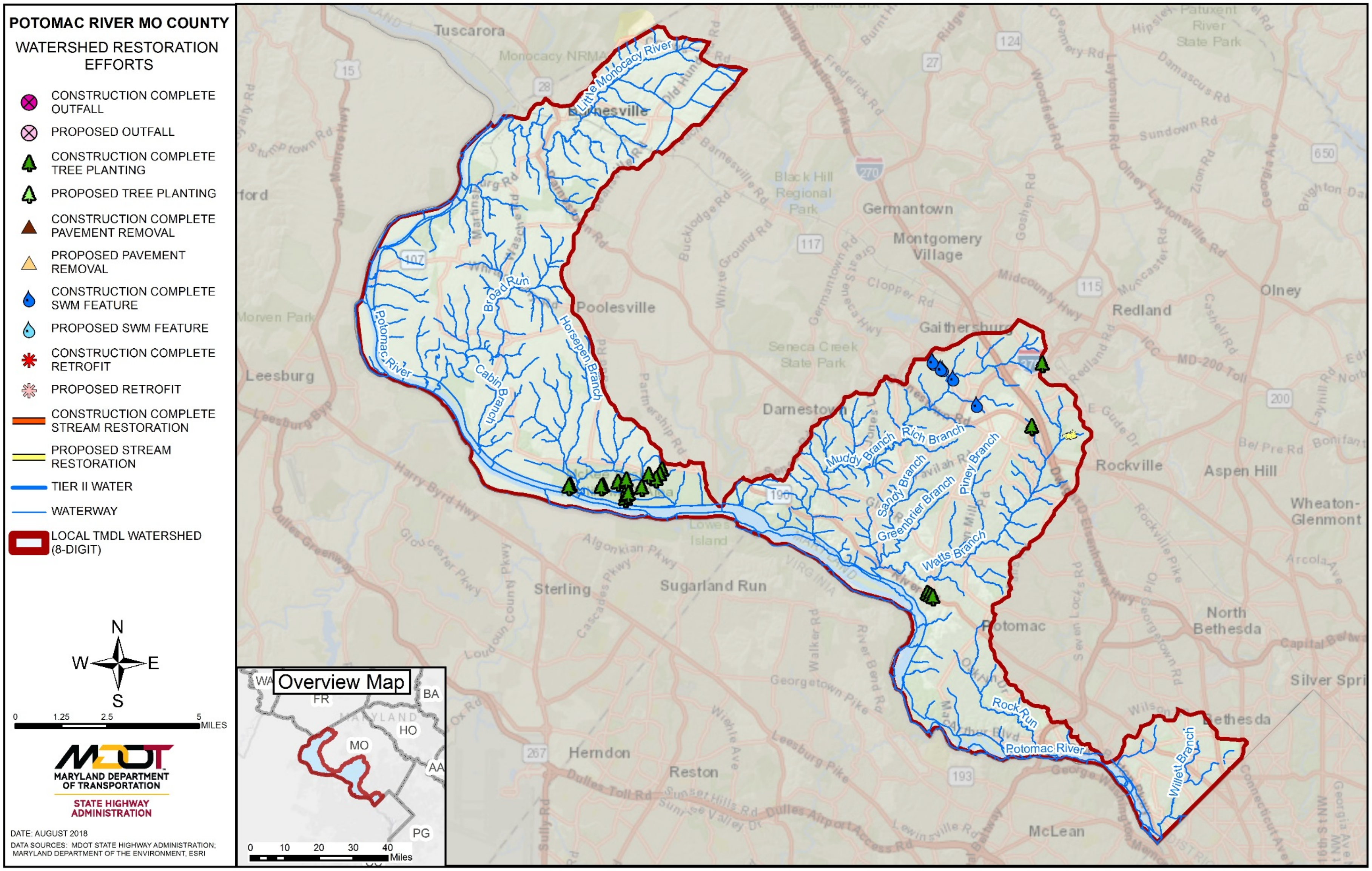


Figure 4-67: MDOT SHA Restoration Strategies within the Potomac River Montgomery County Watershed

W. POTOMAC RIVER UPPER TIDAL WATERSHED

W.1. Watershed Description

The Potomac River Upper Tidal watershed (Maryland 8-digit Basin Code: 02140201) encompasses approximately 56.6 square miles within Prince George's and Charles Counties, Maryland. The majority of the watershed is located in Prince George's County; a relatively small piece of the watershed is located in the northwestern tip of Charles County. Tributary creeks and streams of the Potomac River Upper Tidal watershed includes the mainstem Potomac River, Henson Creek, Carey Branch, and Hunters Mill Branch. The watershed drains directly into the Potomac River, which ultimately drains to the Chesapeake Bay.

The designated use of the Potomac River Upper Tidal watershed is Use Class II – Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting (Haywood & Buchanan, 2007).

Waters within the Potomac River Upper Tidal watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Nitrogen (Total);
- PCB in Fish Tissue; and
- Phosphorus (Total).

There are 68.1 centerline miles of MDOT SHA roadway located within the Potomac River Upper Tidal watershed. The associated ROW encompasses 1178.4 acres, of which 512.9 acres are impervious. There are no MDOT SHA facilities located within the Potomac River Upper Tidal watershed. See **Figure 4-68** for a map of the watershed.

W.2. MDOT SHA TMDLs within Potomac River Upper Tidal Watershed

MDOT SHA is included in the PCB TMDL (Haywood & Buchanan, 2007). PCBs for the Potomac River Upper Tidal are to be reduced by 92.1 percent, as shown in **Table 3-2**.

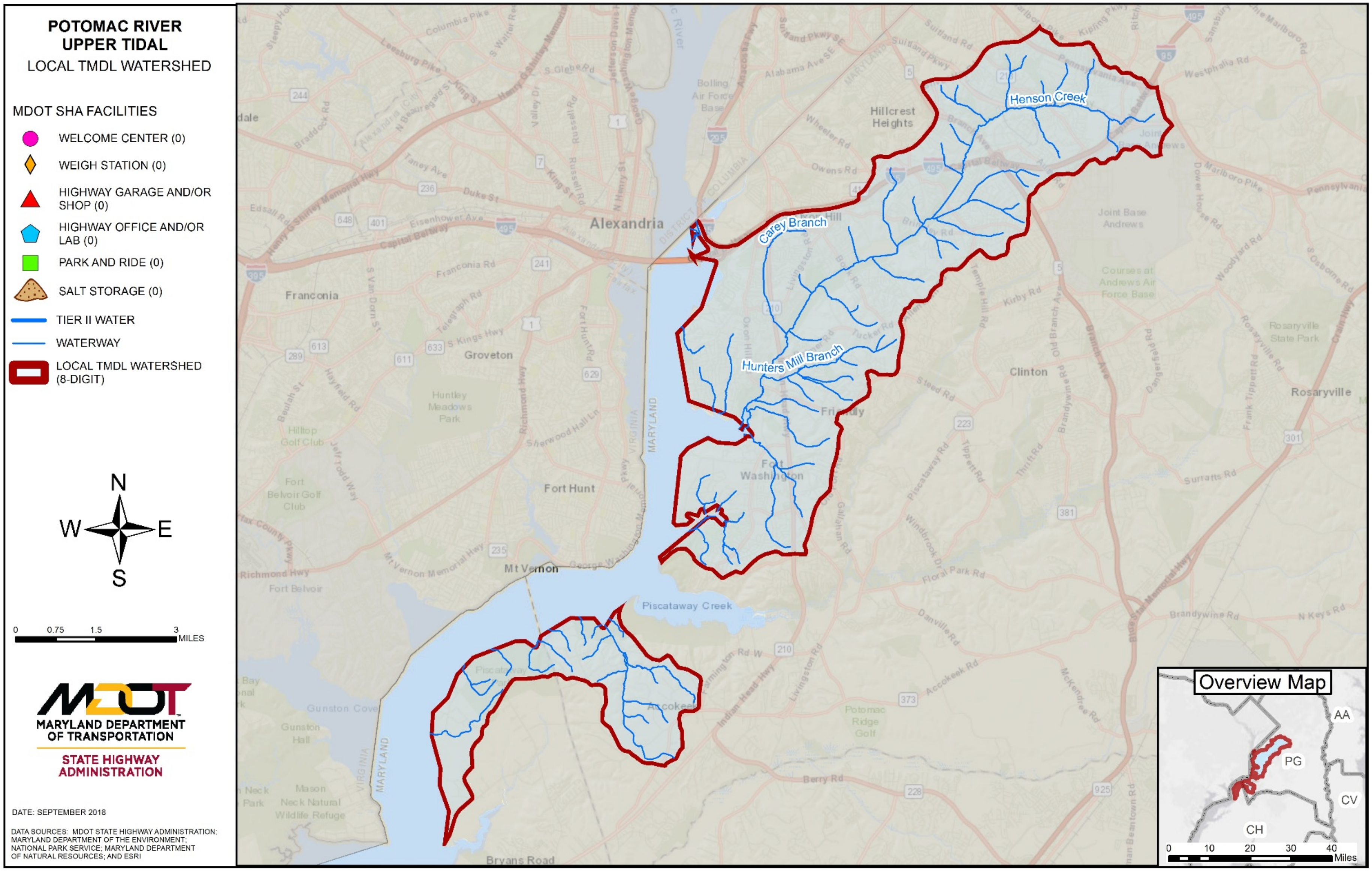


Figure 4-68: Potomac River Upper Tidal Watershed

W.3. Summary of County Assessment Review

As of September 2018, a restoration plan is not available on Prince George's Watershed Restoration Planning Site (http://pgcdoe.net/pgcountyfactsheet/Factsheet/Default) solely for the portion of the Potomac River Upper Tidal watershed in Prince George's County. In late 2014, however, Prince George's County published the *Watershed Existing Condition Report for the Potomac River Watershed*. (Tetra Tech, 2014b). This report is the initial step in the restoration plan development process for the watersheds in the County that have EPA-approved TMDLs. Key points from this report are summarized below.

Land use in the Prince George's County portion of the Potomac River Upper Tidal watershed is primarily urban (62%, of which 72% is residential) and forest (31%). A small percentage is used for agriculture (3%). Impervious area consists of roads (29%), buildings (27%), and parking lots (21%); the biological integrity values of the watershed ranges from poor to very poor in areas of impervious cover, to good in open areas with pervious cover (Tetra Tech, 2014b).

The County performed a BSID of the watershed in 2014 that identified many stressors on the watershed such as the application of road salts during winter, on-site septic systems, SW discharges, and the repeated additions of acidic material (i.e., atmospheric deposition) (Tetra Tech, 2014b).

According to Tetra Tech (2014b), PCBs in the Potomac River Upper Tidal watershed are generally from runoff and stormwater flow occurring at legacy-polluted sites and possibly from the illegal/improper dumping and/or disposal of PCB-containing products.

In addition, Prince George's County completed the *Restoration Plan for PCB-Impacted Waterbodies in Prince George's County*, which includes the County's portion of the Potomac River Upper Tidal watershed (Tetra Tech, 2015a). This plan reported that PCB concentrations in the watershed are linked to TSS and that current recreational fish consumption advisories suggest limiting the consumption of a number of fish species caught in the Potomac River due to PCBs.

PCBs sources within the Prince George's County of the watershed are hotspots from legacy contamination and are highly associated with soils and sediment. A reduction in sediment loads entering the watershed is expected to result in lower PCB concentrations over time. Programmatic Initiatives include public education regarding the handling and proper disposal of PCB light ballasts, PCB-containing equipment in industrial facilities, and PCBs in caulk and sealants used in renovation and repairs (Tetra Tech, 2015a).

The County will also use an adaptive management approach. Adaptive management is important in addressing PCBS because sources of contamination are generally unknown in number and size. The adaptive management approach involves identifying hot spots and conducting subsequent source tracking to hone in on the contributing PCB contamination sources. Adaptive management allows for adjustments of actions to increase effectiveness and for adopting new, more effective strategies. The County will also work with MDE to identify additional methods for PCB reductions (Tetra Tech, 2015a).

As previously stated, while most of the Potomac River Upper Tidal watershed is in Prince George's County, a small piece of the watershed is located in the northwestern tip of Charles County. Accordingly, in February 2018, Charles County published the *Upper, Middle, and Lower Potomac Watershed Assessment* (KCI, 2018). The following information pertains only to the document's discussion of the "Upper" section of the Potomac watersheds within Charles County, an area which corresponds to Charles County's portion of the Potomac River Upper Tidal watershed.

The Potomac River Upper Tidal watershed in Charles County is 5,615 acres, with forested lands making up much of the land use due to the presence of Piscataway National Park (KCI, 2018). Three types of assessments/surveys were used to identify the present conditions in the Charles County portion of the Potomac River Upper Tidal watershed: 1) an upland assessment (included a neighborhood source assessment [NSA] and a hotspot site investigation [HSI]), 2) a nutrient synoptic survey (included water quality sampling and stream discharge measurement), and 3) an SCA (KCI, 2018).

The upland assessment was used to identify sources of pollution located outside of waterways. An NSA was conducted at one neighborhood/subdivision site—identified as "PU-NSA-1"—in the Potomac River Upper Tidal watershed and an "opportunity index" was assigned based on the area's restoration potential. The opportunity index takes into consideration potential point source pollution locations as well as impervious surface percentages. The PU-NSA-1 site received a moderate restoration potential due to moderate pollution severity. Rain gardens, rain barrels, and conservation landscaping are recommended BMPs for the PU-NSA-1 site. An HSI was also conducted that identified locations within the watershed that have a higher probability of transporting stormwater with an above average pollutant concentration. Potential hotspot areas were identified via desktop GIS efforts as well as aerial imagery. Areas considered for HSI were urbanized areas associated with business, commercial, or industrial land use and identified as having inadequate stormwater management. No areas within the Potomac River Upper Tidal watershed were considered hotspots or potential hotspots as a result of the HSI (KCI, 2018).

The nutrient synoptic survey included water quality sampling conducted across the watershed in locations that would accurately portray the watershed as a whole. Methods such as upstream and downstream sampling were used to show how specific infrastructure impacted waterways in critical areas. Stream discharge measurements were also taken at each of the water quality monitoring locations. Quality and quantity profiling of streams allowed for specific BMP recommendations at specific locations. These recommendations typically involved outfall restoration. Results of the water quality sampling showed low nitrogen (<1.5 mg/L) and nitrate (<0.01kg/ha/day) loads. Total phosphorus loads occurring in the Potomac River Upper Tidal watershed were also low at all test locations. If water quality deterioration was to occur in the future, the recommended BMP solution would be specific to the type and source of the pollution (KCI, 2018).

Lastly, a SCA was conducted to assess critical stream sections for several possible impairments including erosion, channel alteration, and exposed outfall pipes. Both a desktop review and a field assessment were utilized for the SCA. Potential reforestation sites were searched for during the SCA assessment as well. As a result, one potential tree planting project site was identified in the Charles's County portion of the Potomac River Upper Tidal watershed. The site—identified as "PU_TP_1"—is 3.3 acres located on private property. If completed, the PU_TP_1 project is expected to result in a TSS load reduction of 268.5 pounds per year (KCI, 2018).

W.4. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Potomac River Upper watershed is shown in **Figure 4-69** which illustrates that 21 grid cells have been reviewed, encompassing portions of 13 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 74 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 63 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 11 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 57 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 21 sites constructed or under contract.
- 10 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 26 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified six (6) sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Two (2) additional sites deemed potentially viable for stream restoration and pending further analysis may be candidates for future restoration opportunities.
- Four (4) sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

No grass swale rehabilitation sites were identified within this watershed for potential restoration.

Outfall Stabilization

Preliminary evaluation identified 180 outfalls potential for stabilization. Further analysis of these sites resulted in:

- Three (3) outfall site constructed or under contract
- 17 outfall sites deemed potentially viable for outfall stabilization efforts and pending further analysis, may be candidates for future restoration opportunities.
- 160 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified one (1) existing structural SW controls as potential retrofits. Further analysis of this location resulted in:

- One (1) retrofit site deemed potentially viable for retrofit and pending further analysis may be a candidate for future restoration opportunities.

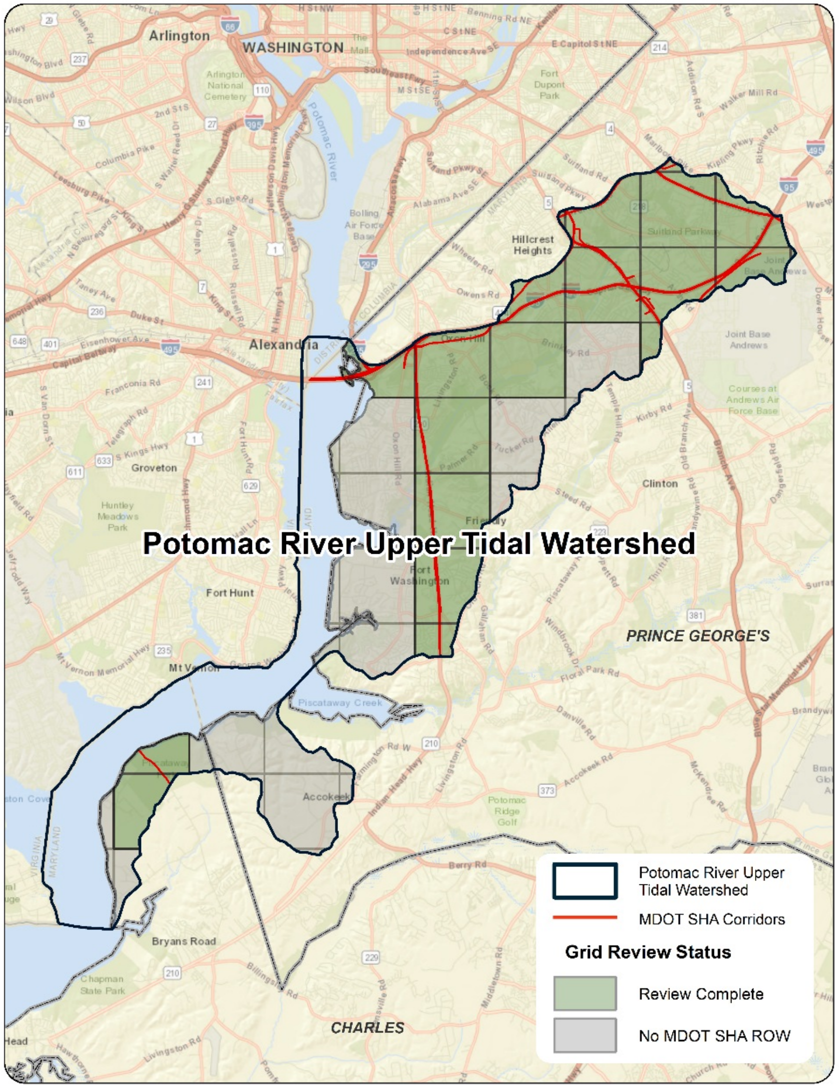


Figure 4-69: Potomac River Upper Tidal Site Search Grids

W.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet PCB reduction in the Potomac River Upper Tidal watershed are shown in **Table 4-87**. Projected PCB reductions using these practices are described in **Part III, Coordinated TMDL Implementation Plan** and are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs built before the TMDL baseline. In this case, the baseline is 2010;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the PCB TMDL, MDOT SHA will meet 5.4 percent of the MDE 92.1 percent load reduction requirement through implementation of BMPs shown in **Table 4-87.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Potomac River Upper Tidal Fresh watershed total $1,324,000. These projected costs are based on an average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-88** for a summary of estimated BMP costs.

Figure 4-70 is a map of MDOT SHA's restoration practices in the Potomac River Upper Tidal watershed, including those that are under design or construction. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-87: Potomac River Upper Tidal PCB BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	250.3	4.8	11.0	TBD	266.1
Inlet Cleaning[1]	dry tons		5.3	32.4	TBD	37.7
Street Sweeping[1]	acres swept		30.1		TBD	30.1
Load Reductions	PCB g/yr.		0.06	0.06	1.14	
				Total Projected Reduction	**1.14**	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-88: Potomac River Upper Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$234,000	$866,000	$1,100,000
Inlet cleaning	$24,000	$185,000	$209,000
Street Sweeping	$15,000		$15,000
Total			$1,324,000

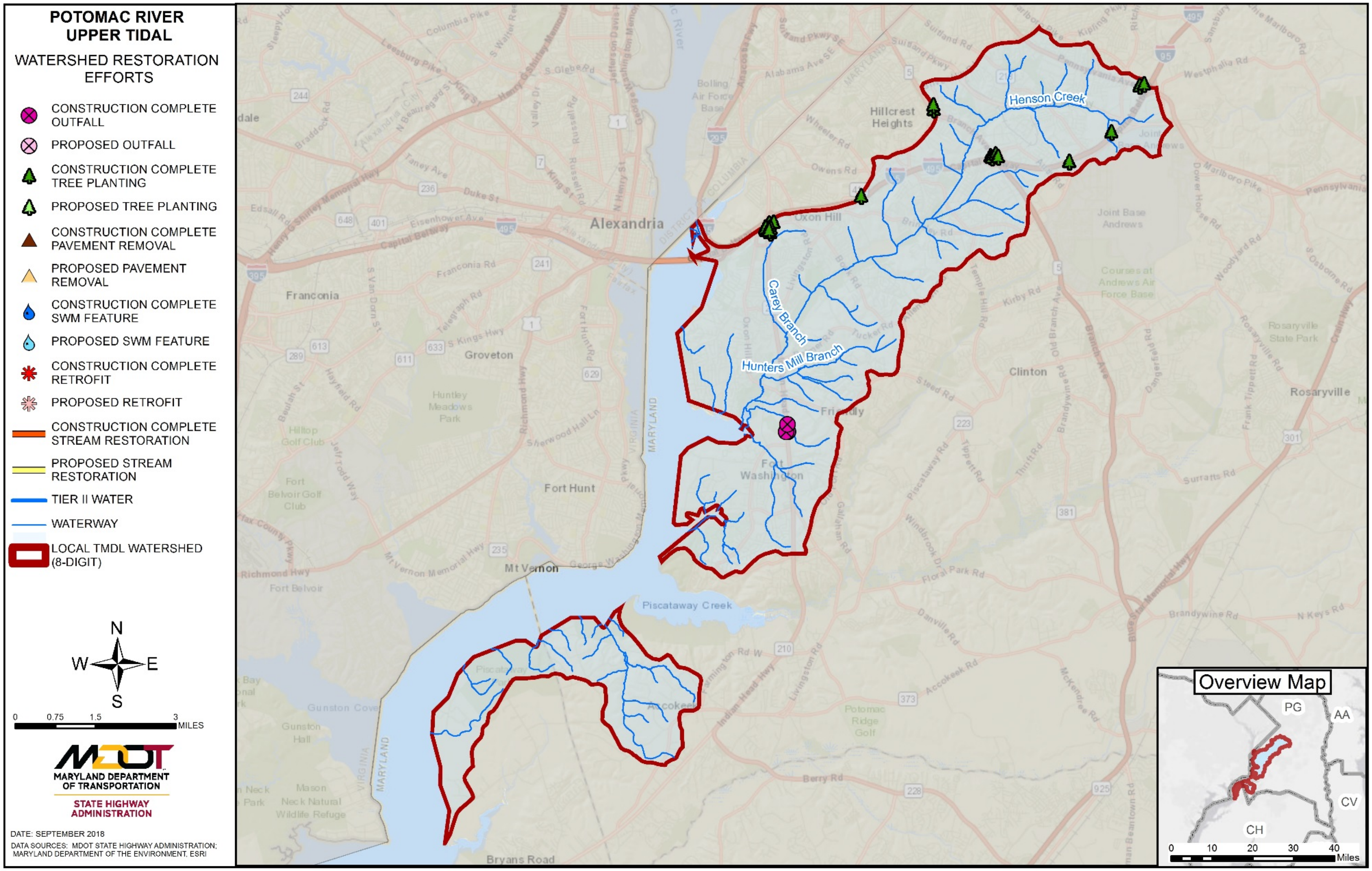


Figure 4-70: MDOT SHA Programmed Restoration Strategies within the Potomac River Upper Tidal Watershed

X. ROCK CREEK WATERSHED

X.1. Watershed Description

The Rock Creek watershed encompasses 61 square miles within Montgomery County, Maryland and Washington, D.C. Rock Creek headwaters are located in the Laytonsville area from which the river flows south to Washington, D.C, where it empties into the Potomac River. Tributary creeks and streams of the Rock Creek Watershed include Alexandra Aqueduct, Crabbs Creek, Mill Creek, and North Branch Rock Creek. The Rock Creek watershed in Maryland comprises primarily of residential land use, covering approximately 65 percent of the watershed. Municipal/institutional land comprises approximately ten percent, and roadway comprises approximately eight percent. Approximately six percent is identified as forest, open water, or bare ground.

There are 801.0 centerline miles of MDOT SHA roadway located within the Rock Creek watershed. The associated ROW encompasses 1,358.1 acres, of which 832.8 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) salt storage facility, and one (1) highway garage or shop. See **Figure 4-71** for a map of the watershed.

X.2. MDOT SHA TMDLs within Rock Creek Watershed

MDOT SHA is included in both phosphorus (MDE, 2013e) and sediment (MDE, 2011j) TMDLs. Phosphorus is to be reduced by 32 percent and sediment is to be reduced by 37.9 percent, as shown in **Table 3-2**.

X.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Rock Creek watershed is shown in **Figure 4-72** which illustrates that 45 grid cells have been reviewed, encompassing portions of 25 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 173 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 74 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 99 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 17 locations as potential tree planting locations. Further analysis of these locations resulted in:

- Five (5) sites constructed or under contract.
- One (1) additional site deemed potentially viable for tree planting and pending further analysis, may be a candidate for future restoration opportunities.

- 11 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 12 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Three (3) sites constructed or under contract.
- Nine (9) sites deemed not viable for stream restoration.

Grass Swale Rehabilitation

Preliminary evaluation identified nine (9) sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Four (4) new structural SW controls constructed or under contract.
- One (1) additional site deemed potentially viable for new structural SW control and pending further analysis, may be a candidate for future restoration opportunities.

- Four (4) sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 41 outfalls potential for stabilization. Further analysis of these sites resulted in:

- One (1) outfall site constructed or under contract.
- 40 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 12 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of three (3) existing structural SW controls constructed or under contract.
- Nine (9) retrofit sites deemed not viable for retrofit and have been removed from consideration.

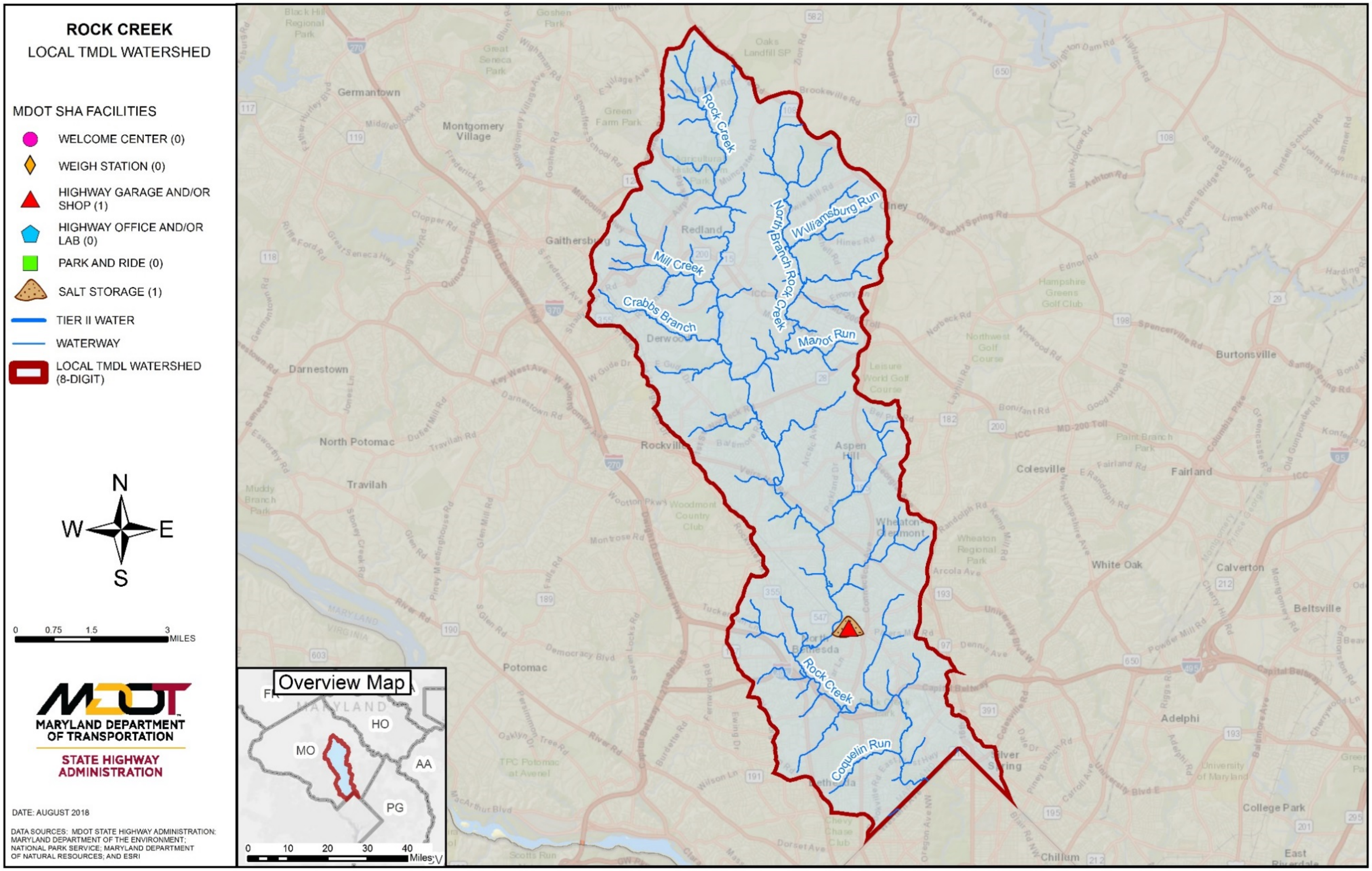


Figure 4-71: Rock Creek Watershed

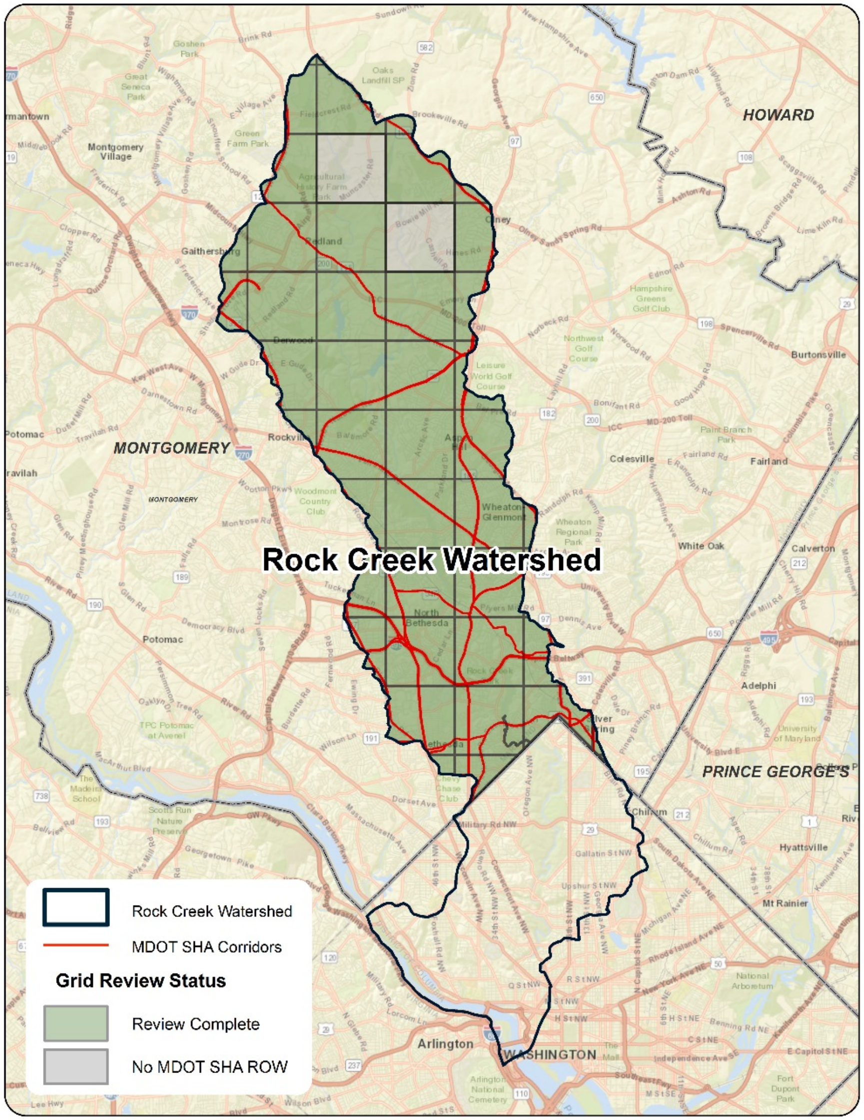


Figure 4-72: Rock Creek Site Search Grids

X.4. Summary of County Assessment Review

Waters within the Rock Creek watershed are subject to the following impairments as noted on MDE's 303(d) List:

- *Enterococcus*;
- Phosphorus (Total);
- Temperature, water; and
- TSS.

The *Rock Creek Implementation Plan* (Biohabitats et al., 2012c), prepared by the Montgomery County Department of Environmental Protection, was adopted in January 2012. This document provides a comprehensive plan for watershed restoration targeting bacteria reduction (with a TMDL), sediment and nutrient reduction (with a TMDL), runoff management and impervious cover treatment, and trash management. The majority of the stream resource conditions in Rock Creek were assessed as "fair" (53 percent), 18 percent were assessed as "good," and 22 percent as "poor." The remaining 2 percent were assessed as "excellent" (Biohabitats et al., 2012c).

Montgomery County's BMPs proposed within Rock Creek watershed are estimated to result in 52 percent load reductions for total nitrogen, 53 percent for total phosphorus, and 49 percent for TSS. An approximate 55 percent reduction of trash over baseline conditions is also anticipated (Biohabitats et al., 2012c). Preferred BMPs include ESD property retrofits, new structural SWM facilities, retrofitting underperforming SWM facilities, and stream restoration projects (Biohabitats et al., 2012c). Projects sites for ESD, pond retrofits, and new stormwater ponds have been identified and are focused on county-owned properties and priority neighborhood areas, which do not include MDOT SHA ROW.

X.5. MDOT SHA Pollutant Reduction Strategies

Rock Creek is listed for both phosphorus and sediment with each TMDL having a different baseline year, 2009 for phosphorus and 2005 for sediment. Proposed practices to meet the phosphorus and sediment reduction in the Rock Creek watershed are shown in **Table 4-89 and 4-90**. Projected phosphorus and sediment reductions using these practices are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs built before the phosphorus and sediment TMDL baseline. In this case, the phosphorus baseline is 2009 and the sediment baseline is 2005;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

MDOT SHA will accomplish the percent reduction presented in **Table 3-2**. Estimated costs to design, construct, and implement BMPs within the Rock Creek watershed total $14,663,000. These projected costs are based on an average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-91** for a BMP strategy cost breakdown.

Figure 4-73 is a map of the MDOT SHA restoration practices and includes those that are under design and construction. Inlet cleaning and street sweeping are not shown.

Table 4-89: Rock Creek Restoration Phosphorus BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	141.0	6.2	7.5	N/A	154.7
Retrofit	drainage area acres		29.4		N/A	29.4
Tree Planting	acres of tree planting		8.0	1.3	N/A	9.3
Stream Restoration	linear feet		13,764.0	398.0	N/A	14,162.0
Outfall Stabilization	linear feet			600.0		600.0
Inlet Cleaning[1]	dry tons		29.7			29.7
Street Sweeping[1]	acres swept		29.5			29.5
Load Reductions	TP EOS lbs./yr.		992	1,077	0	
				Total Projected Reduction	1,077	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-90: Rock Creek Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	118.2	6.2	7.5	N/A	131.9
Retrofit	drainage area acres		29.4		N/A	29.4
Tree Planting	acres of tree planting		8.0	1.3	N/A	9.3
Stream Restoration	linear feet		13,764.0	398.0	N/A	14,162.0
Outfall Stabilization	linear feet			600.0	N/A	600.0
Inlet Cleaning[1]	dry tons		29.7		N/A	29.7
Street Sweeping[1]	acres swept		29.5		N/A	29.5
Load Reductions	TP EOS lbs./yr.		661,381	721,308	0	
				Total Projected Reduction	721,308	

[1] Inlet cleaning and street sweeping are annual practices.

Table 4-91: Rock Creek Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$166,000	$2,238,000	$2,404,000
Retrofits	$1,187,000		$1,187,000
Tree Planting	$245,000	$40,000	$285,000
Stream Restoration	$9,191,000	$266,000	$9,457,000
Outfall Stabilization		$1,181,000	$1,181,000
Inlet cleaning	$136,000		$136,000
Street Sweeping	$13,000		$13,000
Total			$14,663,000

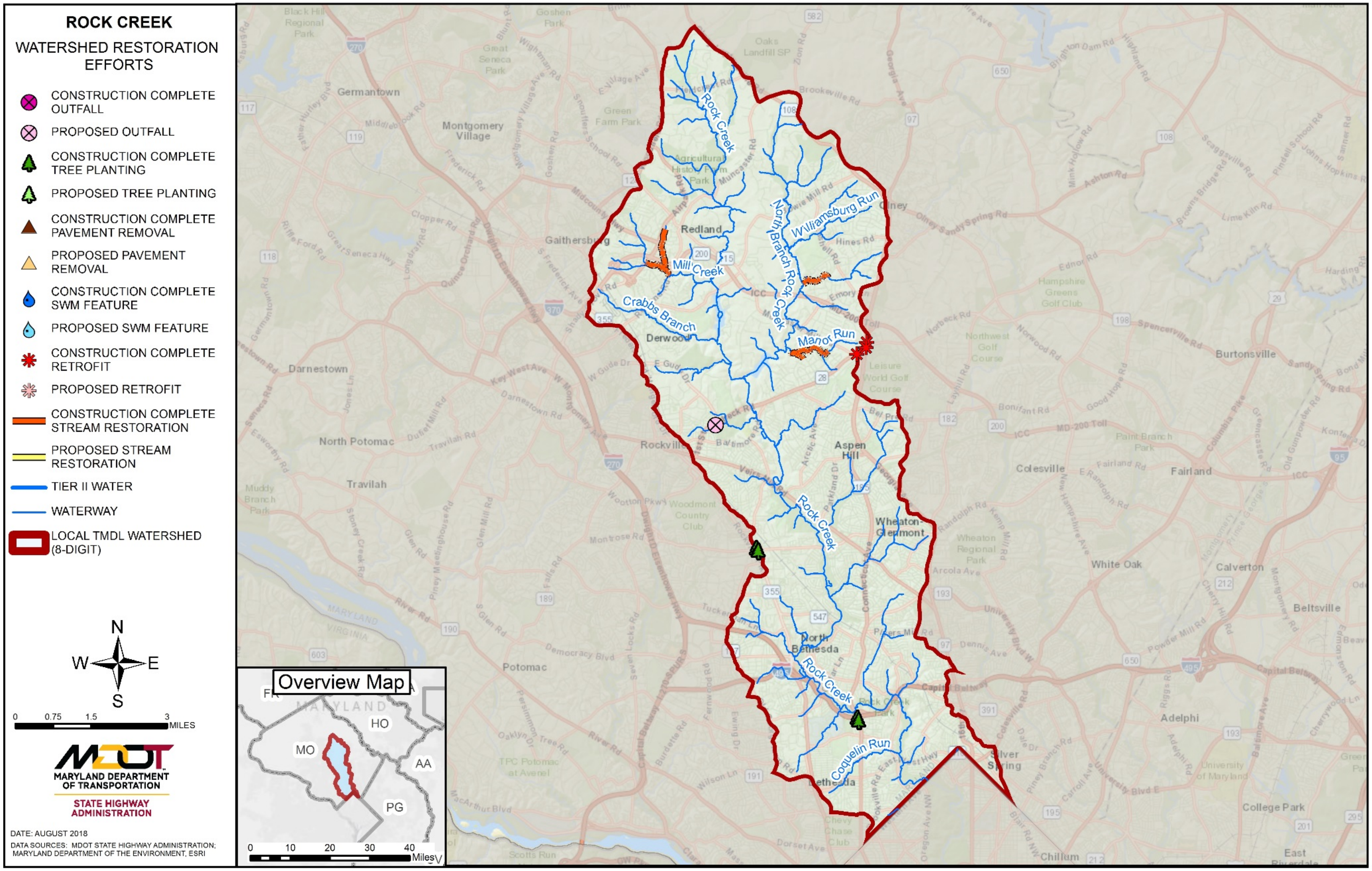


Figure 4-73: MDOT SHA Restoration Strategies within the Rock Creek Watershed

Y. SENECA CREEK WATERSHED

Y.1. Watershed Description

The Seneca Creek watershed encompasses 129 square miles located solely within Montgomery County. Seneca Creek begins in the northwestern portion of the County, near Damascus. Seneca Creek flows about 27 miles south, passing through the City of Gaithersburg, before joining the Potomac River. Tributary creeks and streams of the Seneca Creek watershed include Bucklodge Branch, Cabin Branch, Goshen Branch, Gunners Branch, Long Draught Branch, Magruder Branch, North Creek, Tenmile Creek, Whetstone Run, and Wildcat Branch.

There are 676.2 centerline miles of MDOT SHA roadway located within the Seneca Creek watershed. The associated ROW encompasses approximately 1,504.9 acres, of which 1,182.9 acres are impervious. MDOT SHA facilities located within the watershed consist of two (2) salt storage facilities, two (2) park and ride facilities, and one (1) highway garage or shop. See **Figure 4-74** for a map of the watershed.

Y.2. MDOT SHA TMDLs within Seneca Creek Watershed

MDOT SHA is included in the sediment (TSS) TMDL (MDE, 2011k) and has a reduction requirement of 44.9 percent, as shown in **Table 3-2**.

Y.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Seneca Creek watershed is shown in **Figure 4-75** which illustrates that 65 grid cells have been reviewed, encompassing portions of 14 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 445 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- Seven (7) new structural SW controls constructed or under contract.
- 195 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 243 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 144 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 30 sites constructed or under contract.
- 17 additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 97 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 18 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Two (2) sites constructed or under contract.
- Two (2) additional sites deemed potentially viable for stream restoration and pending further analysis may be candidates for future restoration opportunities.
- 14 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 23 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- One (1) additional site deemed potentially viable for new structural SW control and pending further analysis, may be a candidate for future restoration opportunities.
- 22 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

Preliminary evaluation identified 10 outfalls potential for stabilization. Further analysis of these sites resulted in:

- Three (3) outfall sites deemed potentially viable for outfall stabilization efforts and pending further analysis, may be candidates for future restoration opportunities.
- Seven (7) outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 25 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of two (2) existing structural SW controls constructed or under contract.
- Three (3) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- 20 retrofit sites deemed not viable for retrofit and have been removed from consideration.

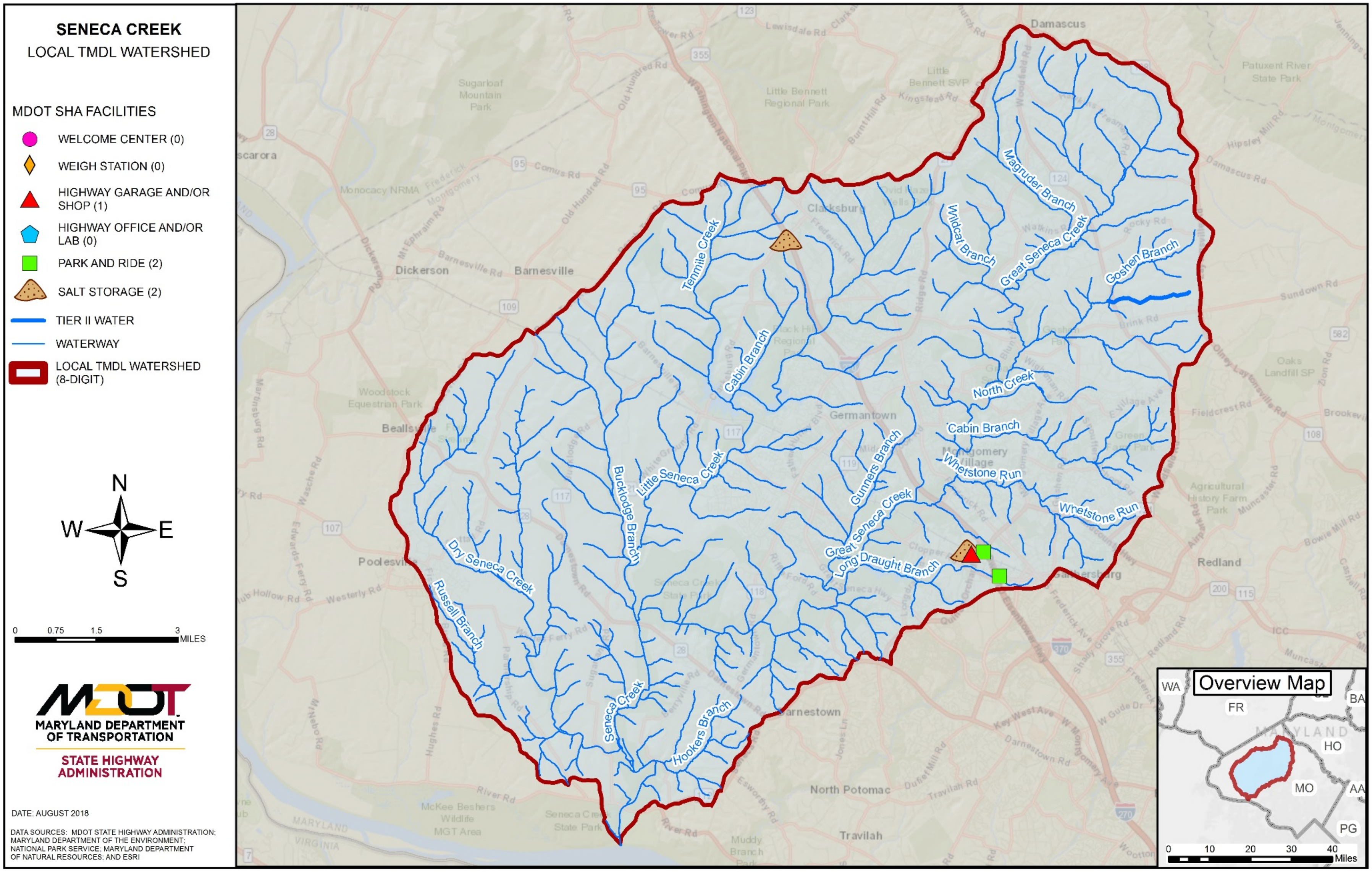


Figure 4-74: Seneca Creek Watershed

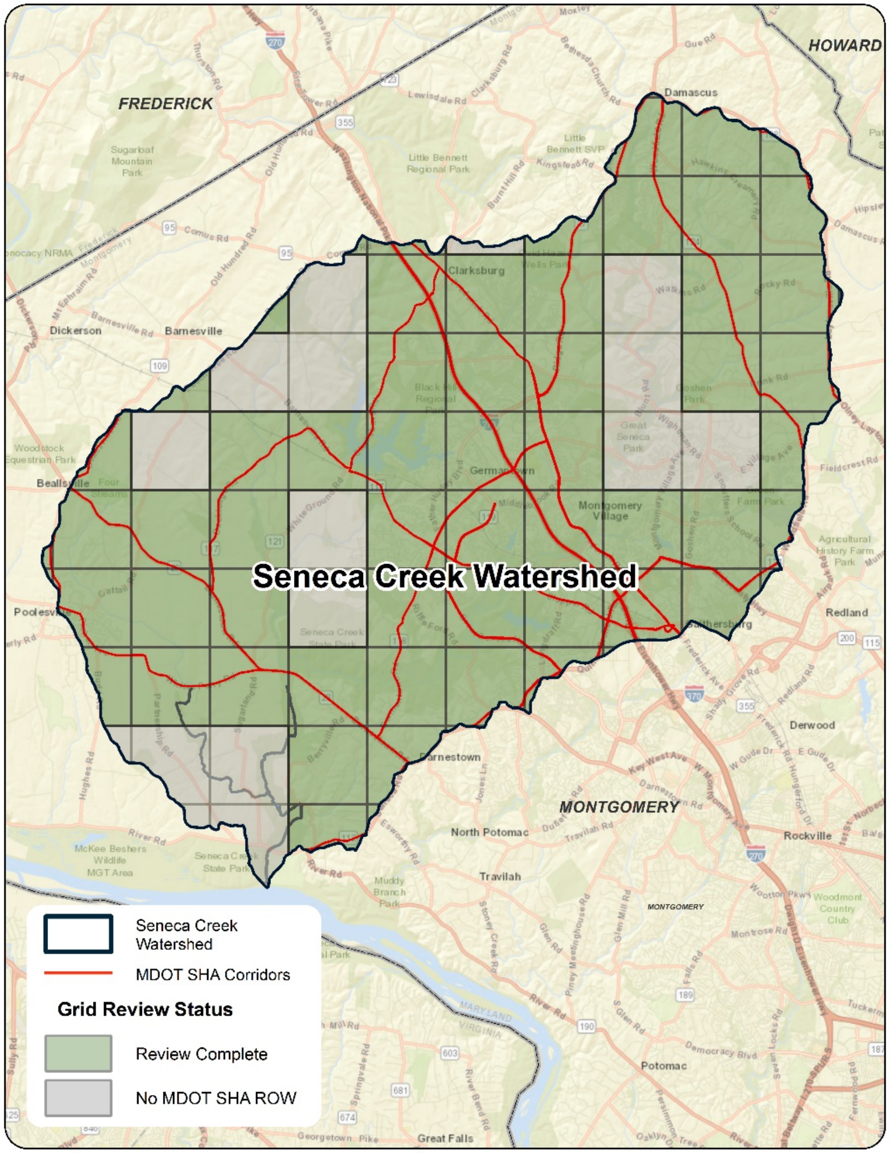


Figure 4-75: Seneca Creek Site Search Grids

Y.4. Summary of County Assessment Review

Waters within the Seneca Creek Watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- Phosphorus (Total);
- Sedimentation/siltation;
- Temperature, water; and
- TSS.

The Montgomery County Department of Environmental Protection (MO-DEP) has published the *Dry Seneca Creek & Little Seneca Creek Pre-Assessment Report* (Versar et al., 2011c) and the *Great Seneca Subwatershed Implementation Plan* (HWG et al., 2012b). MO-DEP also published the *Great Seneca Creek Watershed Study* in 1999 (MO-DEP, 1999). The City of Gaithersburg published the *Middle Great Seneca Watershed Study* in 2013 (URS, 2013) and the *Lower Great Seneca Creek Watershed Study* in 2014 (URS, 2014c).

The Seneca Creek watershed is mostly comprised of urban, forest, agriculture, and pasture land uses. Urban land covers approximately 38.5 percent of the watershed (7.5 percent of which is impervious), forested land is approximately 37.3 percent, agricultural is approximately 20.7 percent, and pasture is 3.5 percent (Versar et al., 2011c).

Within the Upper Great Seneca, the majority of the streams were rated as "good" (48 percent) or "fair" (41 percent), with 11 percent not assessed. The highest quality streams were found in the Upper and Lower Great Seneca watersheds, with poorer streams, primarily rated as "fair," found in the Middle Great Seneca watershed due to higher levels of development surrounding Gaithersburg. Stream conditions within the Dry Seneca Creek and Little Seneca Creek subwatersheds were rated as "excellent" to "poor," with most streams being rated as "good" (HWG, 2012b).

The *Dry Seneca Creek & Little Seneca Creek Pre-Assessment Report* (Versar et al., 2011c) identified priorities for stormwater BMP retrofits as the areas treated by pre-1986 permitted SWM facilities. Using ESD, SWM retrofits, and new SWM ponds are the preferred BMP types for these areas. Medium and lower priority sites did not include any MDOT SHA ROW, and focused on county-owned and privately-owned sites.
The *Middle Great Seneca Creek Watershed Study* identified five proposed stream restoration projects (URS, 2013):

- Stream Reach GST-1 on Whetstone Run, experiencing meandering, downcutting, over-widening, lack of vegetation and poor aquatic habitat. Proposed measures include grade control, bank protection, and channel realignment.
- Stream Reach GST-2a on Watkins Mill Run, experiencing erosion, limited riparian zone, and lack of vegetation. Proposed measures include grade control, and bank protection.
- Stream Reach GST-2b on Watkins Mill Run, experiencing channelization, steep banks, invasive species, and incision. Proposed measures include flow diversion and bed and bank stabilization.
- Stream Reach 2012-1a on the unnamed tributary, experiencing channelization, poor aquatic habitat, and bank erosion. Proposed measures include flow diversion and bed and bank stabilization.
- Stream Reach 2012-1b on the unnamed tributary, experiencing incision, trash, lack of vegetation, downcutting, and bank erosion. Proposed measures include step pool storm conveyance, grade control, and bank regrading.

The *Lower Great Seneca Creek Watershed Study* (URS, 2014c) identified two proposed stream restoration projects:

- Rabbit East #4 Stream Reach, experiencing steep banks, bank erosion, and incised channels. Proposed measures include grade control, bank protection, and channel realignment.
- Solitaire North Stream Reach, experiencing steep banks, bank erosion, and incised channels. Proposed measures comprise bed and bank stabilization.

Y.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment reduction in the Seneca Creek watershed are shown in **Table 4-92**. Projected sediment reduction using these practices are shown in **Table 3-2**. Four timeframes are included in the table:

- BMPs built before the TMDL baseline. In this case, the baseline is 2005;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the sediment TMDL, MDOT SHA will meet 71.6 percent of the MDE 44.9 percent load reduction requirement through implementation of BMPs shown in **Table 4-92**. MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E**.

Estimated costs to design, construct, and implement BMPs within the Seneca Creek watershed total $10,117,000. These projected costs are based on an average cost per impervious acre treated derived from a cost history for each BMP type. Please see **Table 4-93** for a BMP strategy cost breakdown.

Figure 4-76 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design and constructed. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-92: Seneca Creek Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2005)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	684.9	16.8	15.7	TBD	717.4
Retrofit	drainage area acres		32.5		TBD	32.5
Tree Planting	acres of tree planting		29.2	2.8	TBD	31.9
Stream Restoration	linear feet		6,623.0	837.9	TBD	7,460.9
Outfall Stabilization	linear feet			400.0	TBD	400.0
Inlet Cleaning[1]	dry tons		15.2	58.1	TBD	73.3
Street Sweeping[1]			20.6		TBD	20.6
Load Reductions	TSS EOS lbs/yr.		363,663	426,812	596,434	
				Total Projected Reduction	596,434	

[1] *Inlet cleaning and street sweeping are annual practices.*

Table 4-93: Seneca Creek Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$1032,000	$447,000	$1,479,000
Retrofits	$1,490,000		$1,490,000
Tree Planting	$892,000	$84,000	$976,00
Stream Restoration	$4,423,000	$560,000	$4,983,000
Outfall Stabilization		$787,000	$787,000
Inlet cleaning	$60,000	$332,000	$392,000
Street Sweeping	$10,000		$10,000
Total			$10,117,000

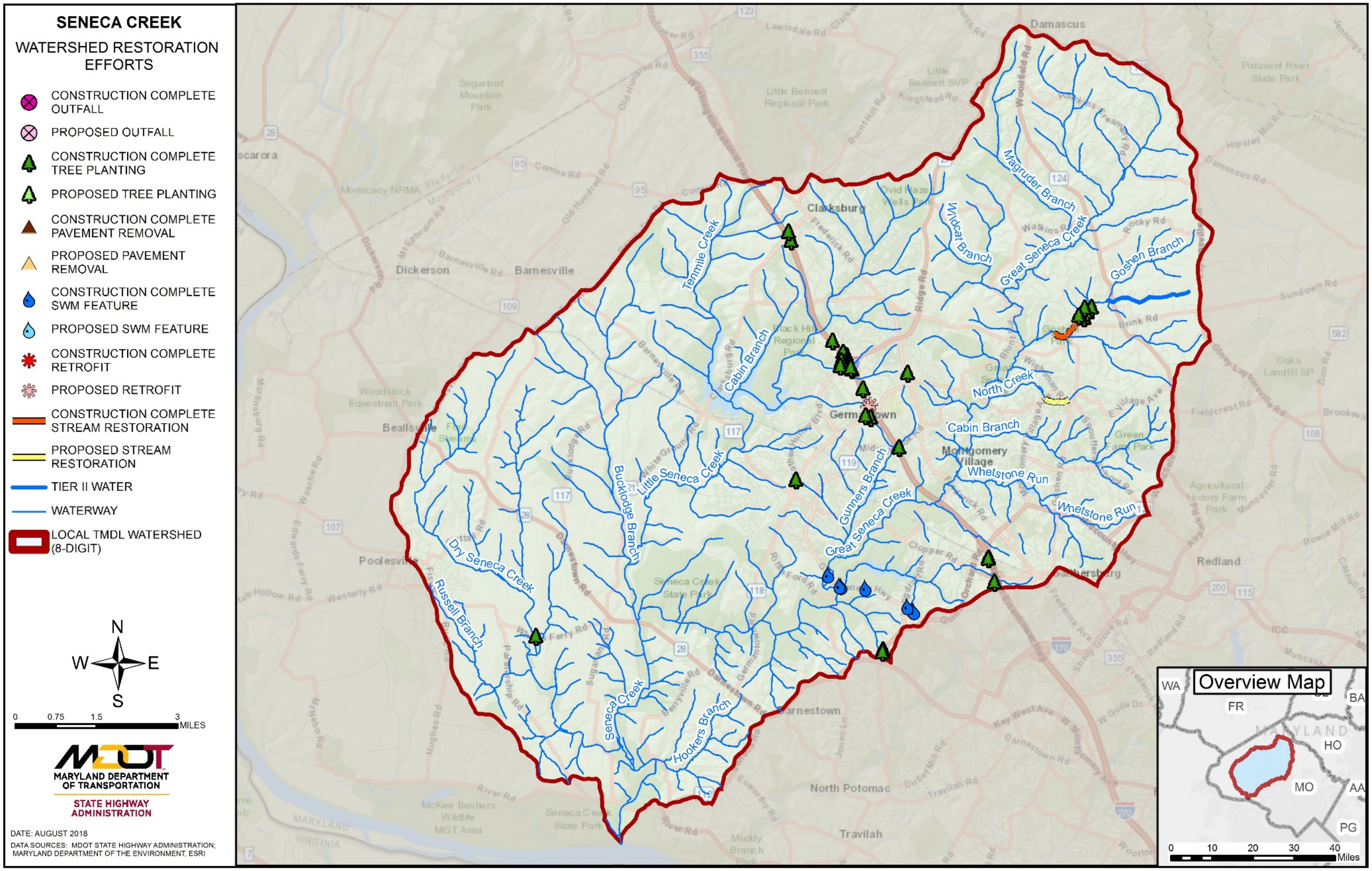


Figure 4-76: MDOT SHA Restoration Strategies within the Seneca Creek Watershed

Z. SOUTH RIVER WATERSHED

Z.1. Watershed Description

Located entirely within central Anne Arundel County, the South River watershed (Maryland 8-digit Basin Code: 02131003) drains to the South River, which discharges to the Chesapeake Bay. The South River watershed is approximately 56.6 square miles (36,200 acres), not including water/wetlands; approximately 300 acres of the watershed is covered by water. There are no "high quality," or Tier II, stream segments within the South River watershed. The entire South River watershed is within the Coastal plain geologic province of Maryland. The total population in the South River watershed is approximately 75,800 (MDE, 2017c).

The designated use of the non-tidal portion of the South River is Use Class I – Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life (MDE, 2017c).

Waters within the South River watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Chlorides;
- Fecal Coliform;
- Nitrogen (Total);
- PCB in Fish Tissue;
- Phosphorus (Total); and
- TSS.

There are 76 centerline miles of MDOT SHA roadway located within the South River watershed. The associated ROW encompasses 1,291 acres, of which 433 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) highway office or lab, two (2) park and rides, and one (1) salt storage facility.

See **Figure 4-77** for a map of MDOT SHA facilities within the South River watershed.

Z.2. MDOT SHA TMDLs within South River Watershed

MDOT SHA is included in the sediment TMDL (MDE, 2017c), with a reduction requirement of 28 percent, as shown in **Table 3-2**. This TMDL only applies to the non-tidal portion of the South River watershed. There are no other pollutants with TMDLs and MDOT SHA WLAs for the non-tidal portion of this watershed. There is a PCB TMDL for the mesohaline portion of the South River watershed.

Z.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan, Section C** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the South River watershed is shown in **Figure 4-78** which illustrates that 47 grid cells have been reviewed, encompassing portions of 14 state route corridors. Results of the visual inventory categorized by BMP type follow.

Structural SW Controls

Preliminary evaluation identified 164 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 19 new structural SW controls constructed or under contract.

- 118 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 27 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 47 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 27 sites constructed or under contract.
- 20 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 12 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Three (3) sites constructed or under contract.
- Nine (9) sites deemed not viable for stream restoration.

Grass Swale Rehabilitation

No grass swale rehabilitation sites were identified in this watershed for restoration.

Outfall Stabilization

Preliminary evaluation identified 91 outfalls along 2 State roadway corridors as potential for stabilization. Further analysis of these sites resulted in:

- 13 outfall sites deemed potentially viable for outfall stabilization efforts and pending further analysis, may be candidates for future restoration opportunities.
- 78 outfall sites deemed not viable for outfall stabilization and have been removed from consideration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified 20 existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of seven (7) existing structural SW controls constructed or under contract.
- Three (3) retrofit sites deemed potentially viable for retrofit and pending further analysis may be candidates for future restoration opportunities.
- 10 retrofit sites deemed not viable for retrofit and have been removed from consideration.

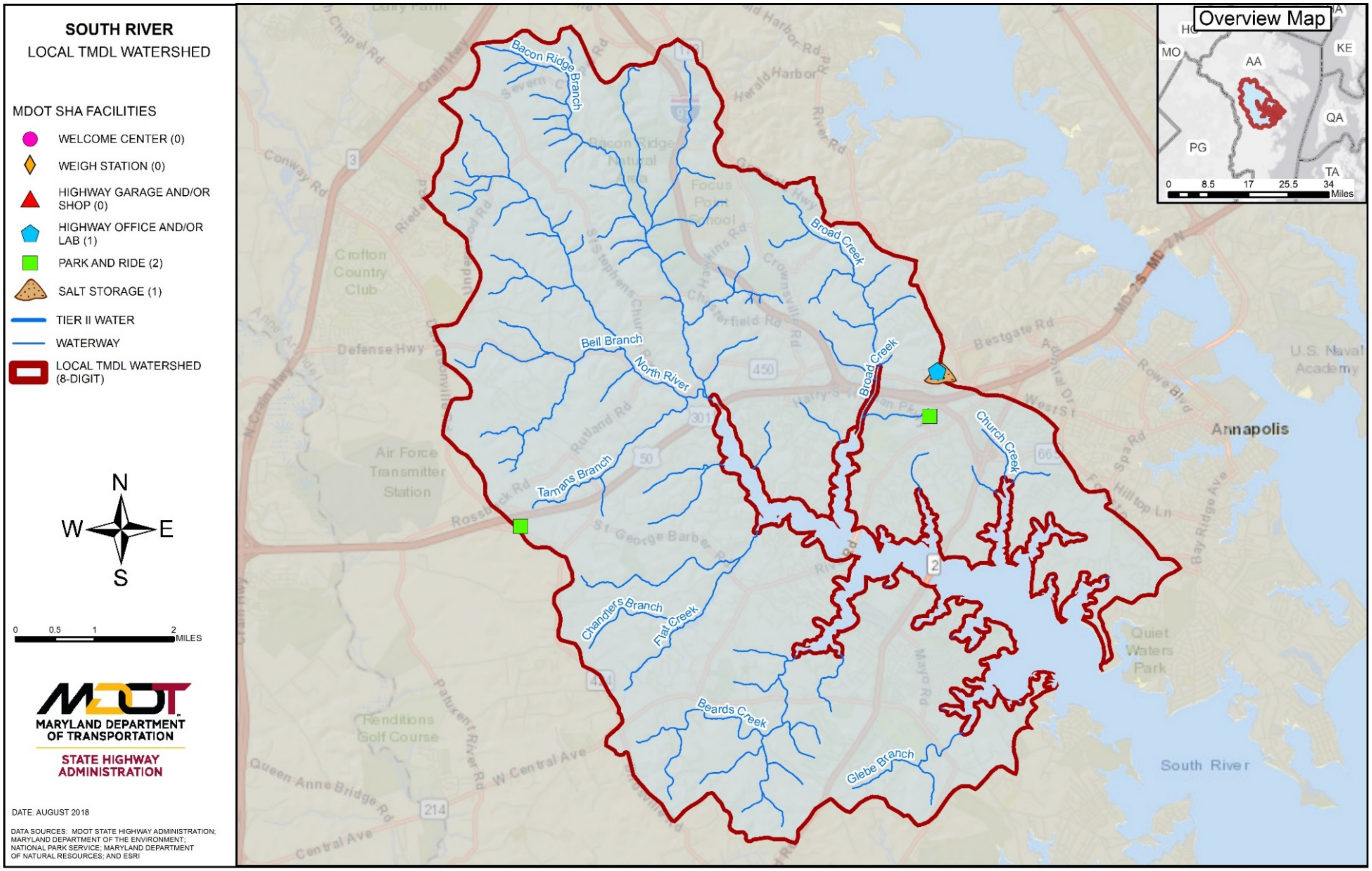


Figure 4-77: South River Watershed

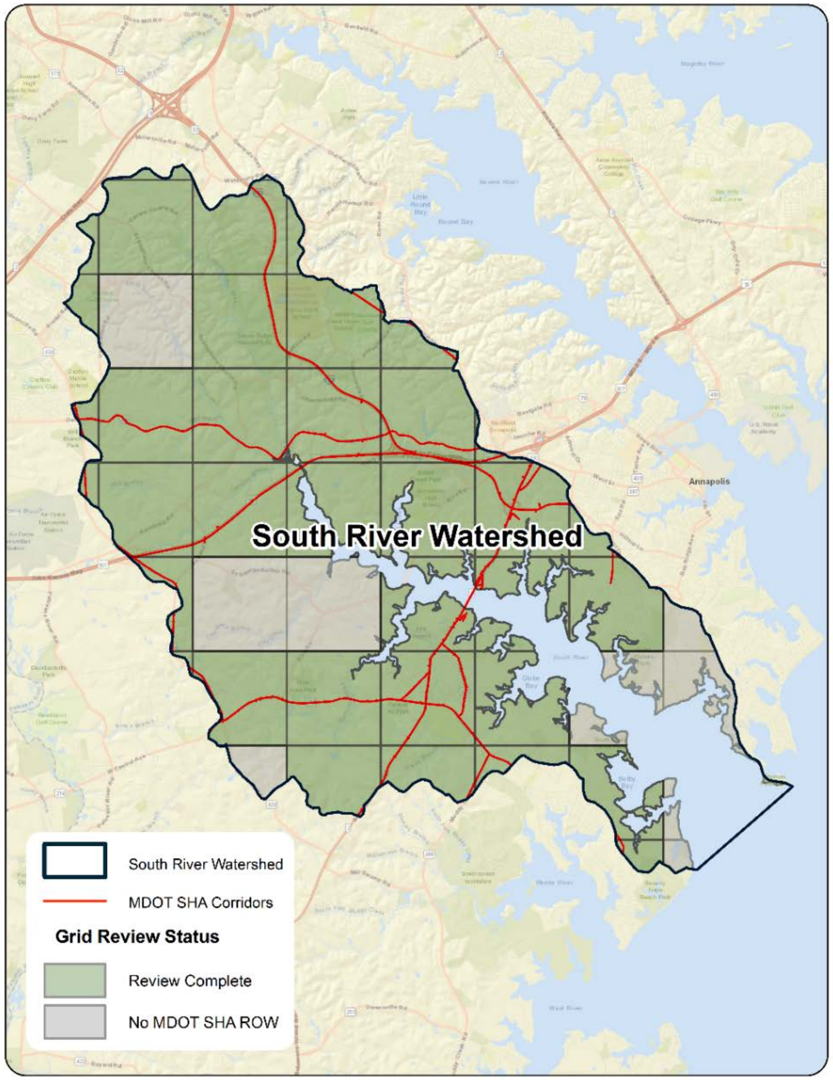


Figure 4-78: South River Site Search Grids

Z.4. Summary of County Assessment Review

On behalf of the Anne Arundel County Department of Public Works, CH2MHILL and KCI Technologies completed the *South River Watershed Study Summary Report* in November of 2008 (CH2MHILL and KCI, 2008) (hereinafter referred to as the "Watershed Study"). The Watershed Study elaborated on the findings from the 2006 Anne Arundel County-sponsored stream assessment of the South River watershed, which was completed as part of the County's Watershed Management Master Plan for the South River. Approximately 246 miles of streams were studied in the 2006 stream assessment; data collected from the assessment provided the County with information on the current conditions (or baseline condition) of the South River watershed (CH2MHILL and KCI, 2008).

In order to provide greater detail and specificity in the analysis and reporting, the South River watershed was divided into 59 subwatersheds in the Watershed Study. For ease of presentation, however, the 59 subwatersheds were grouped into three clusters: Headwaters, North Shore, and South Shore.

The Headwaters cluster of subwatersheds lies almost entirely above U.S. Route 301 (US 301) and includes 151.4 miles of streams with three major streams: North River, Bacon Ridge Branch, and Tarnans Branch. The Headwaters cluster area also includes the majority of the watershed surrounding Broad Creek to the north of US 301. The cluster is approximately 16,200 acres, of which 9 percent is impervious. Residential and transportation areas make up most of the impervious surface in the Headwaters cluster; approximately half of the impervious area is residential, and a quarter is transportation, which is due to the cluster being bisected by several major road corridors such as Interstate 97 and MD Route 450. The Headwaters cluster area is less populated than either the North Shore or South Shore clusters. While the Headwaters cluster has several residential and agricultural areas, "most notably in this cluster are the large tracts of contiguous forested land" (CH2MHILL and KCI, 2008, Appendix A, p.1).

The North Shore cluster of subwatersheds lies below US 301 to the north of South River and includes a portion of the city of Annapolis. Major streams include Broad Creek and Church Creek. The North Shore cluster is approximately 6,900 acres, of which 27 percent is impervious. It includes 21.3 miles of streams, with at least half of the subwatersheds containing streams that are completely influenced by tides. The North Shore cluster area is highly populated and is dominated by residential and commercial development. While this cluster also has a large percentage of forested land, it is much more fragmented than in the Headwaters cluster (CH2MHILL and KCI, 2008).

The South Shore cluster lies below US 301 to the south of South River. Major streams include Flat Creek and Beards Creek. The South Shore cluster is approximately 13,000 acres, of which 15 percent is impervious. It includes 69.8 miles of streams. Like the North Shore cluster, the South Shore cluster is also highly populated. The South Shore cluster includes a number of small parks and a small regional airport. There is a high residential concentration in the South Shore cluster subwatersheds that are directly adjacent to the South River. Several of the subwatersheds in this cluster are bisected by a significant utility corridor. The rest of the South Shore cluster area contains a significant amount of contiguous forested land (CH2MHILL and KCI, 2008).

Pollutant loading from the South River watershed was modeled for total nitrogen, total phosphorous, TSS, and fecal coliform. Specifically, for sediment (i.e., the pollutant of the subject TMDL [MDE, 2017c]), existing conditions showed that the areas with the highest TSS load from runoff (tons/yr) were in the North Shore cluster in the subwatersheds immediately surrounding Broad Creek and Church Creek as well as in the South Shore cluster in the subwatersheds immediately surrounding Glebe Creek (CH2MHILL and KCI, 2008).

Currently, Anne Arundel County is managing its stormwater runoff in the South River watershed through both urban stormwater management facilities and agricultural BMPs. In regard to the agricultural BMPs, the Watershed Study states that the significant acreage of agricultural land in the South River watershed prompted the County to carefully consider how to evaluate runoff quality and BMP effectiveness in these areas of the watershed. Therefore, the County collected and organized data on agricultural practices/BMPs (e.g., conservation tillage, cover crop, nutrient management; manure storage, etc.) in the watershed as an input to the County's watershed management process.

In addition to the stream assessment, information on land use, stormwater BMPs, and pollutant-loading models were compiled in a prioritization model that ranked and prioritized the watershed. This prioritization effort included prioritization within all three clusters for stream reach restoration; subwatershed restoration; and subwatershed preservation. The Watershed Study provides numerous color-coded maps that show the specific results (exact locations and ratings) of all prioritizations within each cluster. Broad-based conclusions can be drawn from these maps as well. For example, the preservation maps in particular show that the Headwaters cluster overwhelming contains the most subwatersheds ranked as high priority for preservation, which can be attributed to the fact that the Headwaters cluster has a limited amount of development along with large contiguous tracts of forest cover (CH2MHILL and KCI, 2008).

The modeling results for the South River watershed showed that the following four types of practices will provide the biggest impact towards reducing pollutant loadings from urban sources in the future: 1) implementation of enhanced stormwater retrofits, 2) expansion of stream buffers by 300 feet in unsewered areas, 3) preservation of greenways, and 4) implementation of regenerative conveyance BMPs (Watershed Study provides a figure that shows potential locations for regenerative conveyance). While the modeling results show the biggest impact if these BMP types are implemented fully across the watershed, the Watershed Study noted that other types of BMPs might be more appropriate for or have a bigger impact on the loading of an individual subwatershed. Other factors such as the results of cost benefit analyses will impact the County's final decision on which scenario to implement in an individual subwatershed (CH2MHILL and KCI, 2008).

Z.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment reduction in the South River watershed are shown in **Table 4-94**. Projected sediment reduction using these practices are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs built before the TMDL baseline. In this case, the baseline is 2009;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

MDOT SHA will accomplish the projected reduction to be achieved as a percent of the baseline load presented in **Table 3-2**.

Estimated costs to design, construct, and implement BMPs within the South River watershed total $31,062,000. These projected costs are based on an average cost per impervious acre treated derived from cost history for each BMP type. See **Table 4-95** for a summary of estimated BMP costs.

Table 4-94: South River Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs	Total BMPs		
			2020	2025	Future	Total
New Stormwater	drainage area acres	424.6	34.0	37.2	N/A	495.8
Retrofit	drainage area acres		95.1		N/A	95.1
Impervious Surface Elimination	acres removed		0.1		N/A	0.1
Tree Planting	acres of tree planting	0.6	7.0	10.4	N/A	18.0
Stream Restoration	linear feet		23,356.0	1,981.9	N/A	25,337.9
Outfall Stabilization	linear feet			400.0	N/A	400.0
Inlet Cleaning[1]	dry tons		2.9		N/A	2.9
Street Sweeping[1]	acres swept		48.8		N/A	48.8
Load Reductions	TSS EOS lbs/yr.		1,004,800	1,059,947	0	
				Total Projected Reduction	1,059,947	

[1] Inlet cleaning and street sweeping are annual practices.

Figure 4-79 is a map of MDOT SHA's restoration practices in the watershed and includes those that are under design and construction. Inlet cleaning and street sweeping are not reflected on this map.

Table 4-95: South River Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$4,124,000	$2,939,000	$7,063,000
Retrofits	$5,665,000		$5,665,000
Impervious Surface Elimination	$39,000		$39,000
Tree Planting	$213,000	$319,000	$532,000
Stream Restoration	$15,597,000	$1,324,000	$16,921,000
Outfall Stabilization		$787,000	$787,000
Inlet cleaning	$8,000		$8,000
Street Sweeping	$47,000		$47,000
Total			$31,062,000

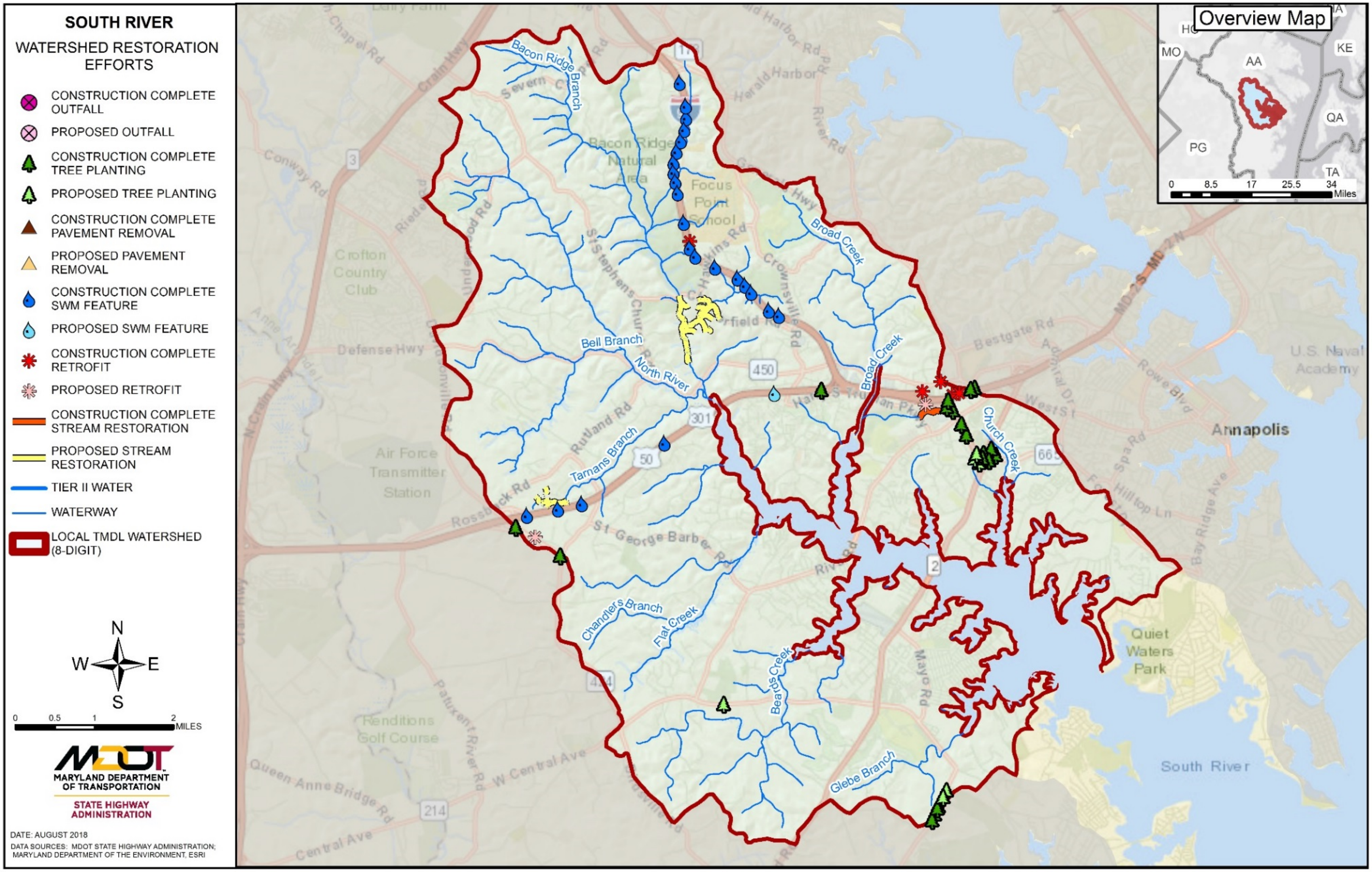


Figure 4-79: MDOT SHA Programmed Restoration Strategies within the South River Watershed

AA. SWAN CREEK WATERSHED

AA.1. Watershed Description

The Swan Creek watershed encompasses 26 square miles solely within Harford County, and is comprised of both non-tidal and tidal waters. The watershed drains into Swan Creek, which is located approximately four miles south of where the Susquehanna River drains into the Chesapeake Bay. The lower portion of Swan Creek is a small, shallow tidal embayment that drains into the Chesapeake Bay. While predominantly situated within Maryland's Piedmont geologic province, the lower portion of the Swan Creek watershed extends slightly into the Coastal Plain province. Major tributary creeks and streams of the Swan Creek watershed include Gasheys Creek, Swan Creek, and Carsins Run.

There are 29 centerline miles of MDOT SHA roadway located within the Swan Creek watershed. The associated ROW encompasses 252 acres, of which 142 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) park and ride facility. See **Figure 4-80** for a map of MDOT SHA facilities within the Swan Creek watershed.

AA.2. MDOT SHA TMDLs within Swan Creek Watershed

MDOT SHA is included in the sediment TMDL (MDE, 2016e) and has a reduction requirement of 13 percent within Harford County, as shown in **Table 3-2**. This TMDL only applies to the non-tidal portion of the Swan Creek watershed.

AA.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan, Section C** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Swan Creek watershed is shown in **Figure 4-81** which illustrates that 19 grid cells have been reviewed, encompassing portions of nine (9) state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 194 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 26 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 168 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 19 locations as potential tree planting locations. Further analysis of these locations resulted in:

- Nine (9) sites constructed or under contract.
- Three (3) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.

- Seven (7) sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified two (2) sites as potential stream restoration locations. Further analysis of these locations resulted in:

- Two (2) sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 21 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Five (5) new structural SW controls constructed or under contract.
- 16 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified five (5) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- One (1) retrofit site deemed potentially viable for retrofit and pending further analysis may be a candidate for future restoration opportunities.
- Four (4) retrofit sites deemed not viable for retrofit and have been removed from consideration.

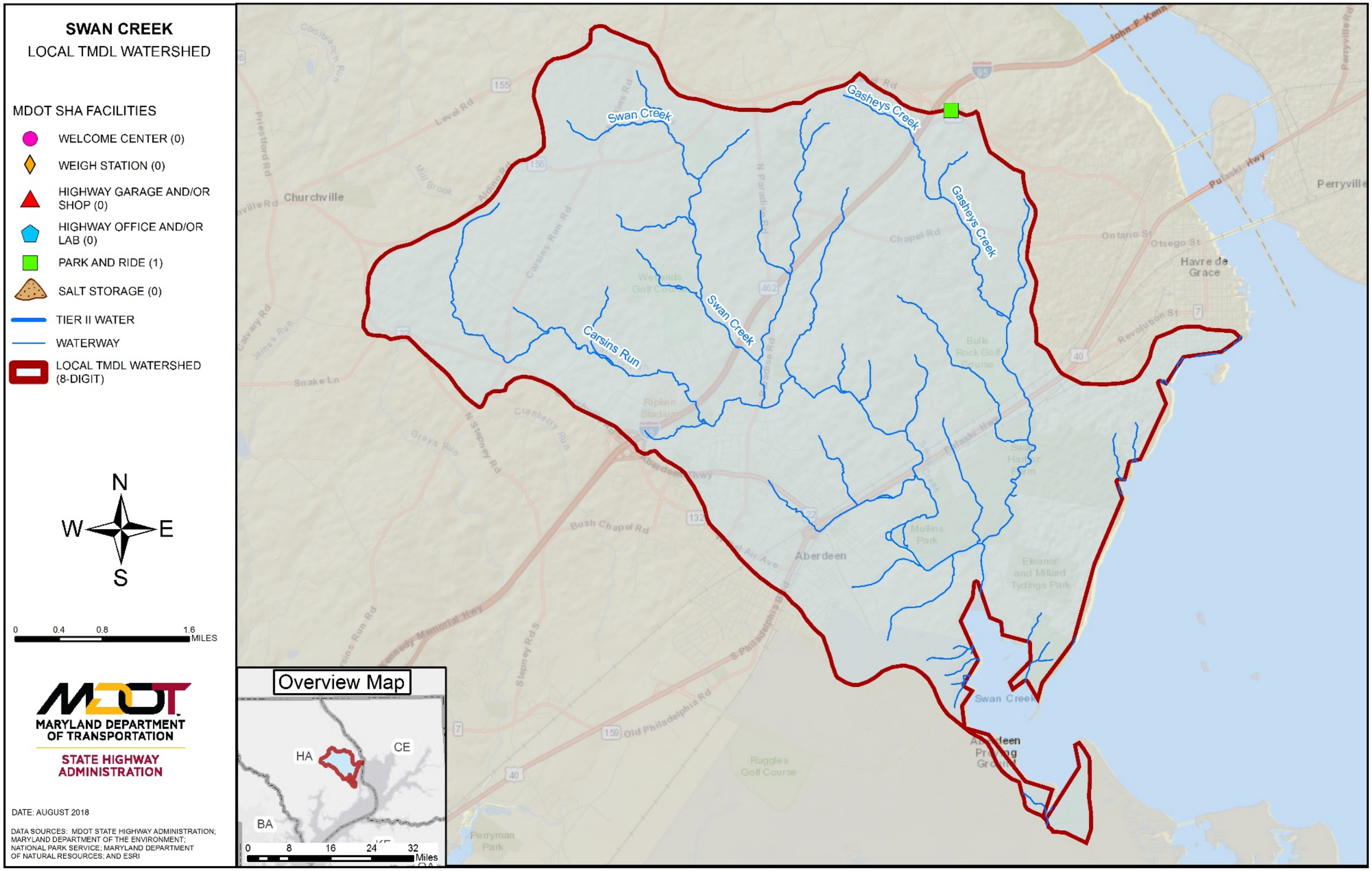


Figure 4-80: Swan Creek Watershed

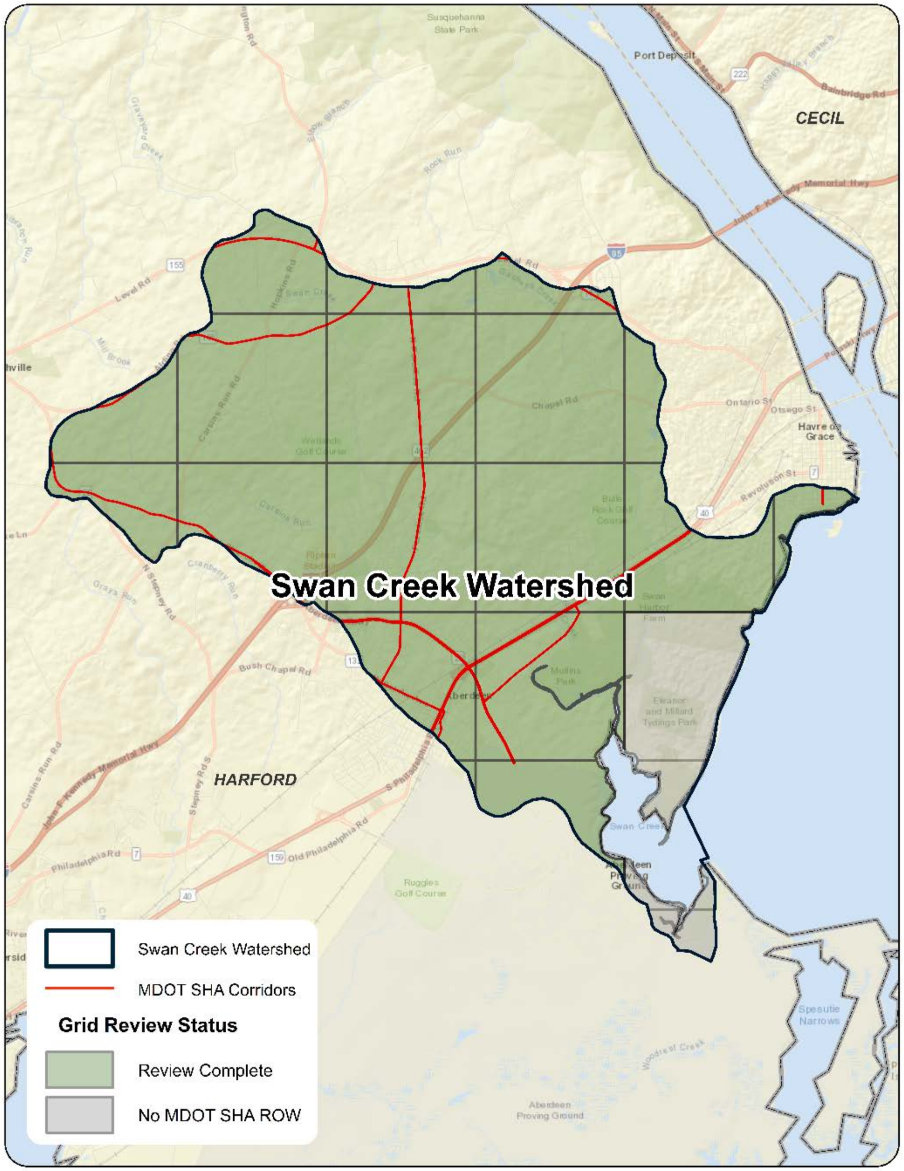


Figure 4-81: Swan Creek Site Search Grids

AA.4. Summary of County Assessment Review

The designated use of the non-tidal portion of Swan Creek (8-digit Basin Code: 02130706) is Use I – Water Contact Recreation and Protection of Aquatic Life (MDE, 2016e). Waters within the Swan Creek watershed are subject to the following impairments as noted on MDE's 303(d) List:

- Nitrogen (Total);
- Phosphorus (Total); and
- TSS.

Prepared by the DNR in partnership with Harford County, the 2002 *Bush River Watershed Characterization* (hereinafter referred to as the "Characterization Report") serves as Harford County's assessment of the Swan Creek watershed (DNR, 2002a). The Characterization Report was created to support Harford County's WRAS for its Bush River Project Area. While the Swan Creek watershed does not directly drain into the Bush River, it is included within the larger Bush River Basin (6-digit Basin Code: 021307) along with the Bynum Run, Atkisson Reservoir, Lower Winters Run, and Bush River watersheds. Accordingly, the Swan Creek watershed, although not specifically included within Harford County's Bush River WRAS initiative, was assessed in the Characterization Report to allow comparison of watersheds across the entire Bush River Basin (DNR, 2002a).

On the outset, the Characterization Report cites the 1998 *Maryland Clean Water Action Plan* (CWAPTW, 1998), which identified the Swan Creek watershed as a "Category 1 Priority" (highest State priority for restoration) based on indicators of water quality, landscape, and living resources that were developed for all watersheds in Maryland. The Characterization Report discussed problems within the Swan Creek watershed based on these three indicators.

First, with respect to water quality, the Swan Creek watershed was shown to be transporting large amounts of nitrogen and phosphorus to the Chesapeake Bay when compared to other Maryland watersheds that drain into the Bay. Water quality was also being affected by high soil erodibility and an insufficiency of riparian buffers around streams in the watershed. More specifically, the Swan Creek watershed was found to have an average soil erodibility factor (K) of 0.33, suggesting that control of soil erosion is particularly important; a K value greater than 0.275 was considered a likely factor for water quality problems. Approximately 28 percent of streams in the watershed lacked a riparian buffer.

The landscape indicator included the percent of impervious surface. Impervious surfaces were found to cover 14.2 percent of the Swan Creek watershed; this percentage indicated that average watershed conditions measured by impervious coverage in the Swan Creek watershed are worse than the statewide benchmark. The Characterization Report also indicated that a quarter of the Swan Creek watershed was listed as a "Priority Funding Area" under Maryland's Smart Growth program, where State funding for infrastructure may be available to support development and redevelopment. Further development in the Swan Creek watershed is expected to increase impervious surface coverage.

The living resources indicator focused on the importance of habitat for sensitive species and fish movement within the Swan Creek watershed. The Characterization Report indicated that 44 acres of Wetlands of Special State Concern (WSSC) were located in the Swan Creek watershed. WSSC are wetlands identified as having sensitive species habitat in or near the wetland. Both the Swan and Gasheys Creek streams as well the Chesapeake Bay shore area are within the vicinity of the 44 acres. Likewise, the Oakington Road and Swan Harbor Farm Park communities are also within the vicinity of the Swan Creek watershed's 44 acres of WSSC. Gasheys Creek is of particular importance as it was declared critical habitat for the federally endangered Maryland darter (*Etheostoma sellare*) in 1984. The Characterization Report also discusses how blockages in the watershed's streams can interfere with or prevent some fish species from moving upstream to otherwise viable habitat. The structural components of lakes, farm ponds, or drainage ditches can cause blockages (DNR, 2002a).

The DNR Fish Passage Program identified fish blockages at seven sampling stations in the Swan Creek watershed (See **Table 4-96**). Mitigation or removal of blockages to fish movement is recommended as many fish species need the ability to move between stream segments to maintain healthy, resilient populations (DNR, 2002a).

Overall, Harford County and DNR suggested several BMPs for the Bush River Basin in the Characterization Report; however, no recommendations specific to the Swan Creek watershed were made except for the aforementioned fish blockage removal opportunities listed in **Table 4-96**. General recommendations included incorporating "Green Infrastructure" (areas of natural vegetation and habitat that have statewide or regional importance as defined by criteria developed by DNR) and the habitat needs of sensitive forest interior dwelling species into local land use planning and management; encouraging the use of agricultural BMPs and conservation programs; and conducting stream buffer and wetland restorations (DNR, 2002a).

Table 4-96: County Identified Fish Blockages / Removal Opportunities in the Swan Creek Watershed

Station	Stream	Name/Location
CW010	Gasheys Creek	0.2 mile below Chapel Road
CW011	Gasheys Creek	Chapel Road
CW030	Swan Creek	0.1 mile above Rt. 40
CW031	Swan Creek	100 ft. above Oak Street
CW032	Swan Creek	130 yards above Oak St
CW063	Unnamed Tributary to Gasheys Creek	0.33 mile below Chapel Rd
CW064	Unnamed Tributary to Gasheys Creek	Chapel Road

Source: DNR (2002a)

AA.5. MDOT SHA Pollutant Reduction Strategies

Proposed practices to meet sediment reduction in the South River watershed are shown in **Table 4-97**. Projected sediment reduction using these practices are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs built before the TMDL baseline. In this case, the baseline is 2009;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

MDOT SHA will accomplish the projected reduction to be achieved as a percent of the baseline load presented in **Table 3-2**.

Estimated costs to design, construct, and implement BMPs within the Swan Creek watershed total $1,693,000. These projected costs are based on an average cost per impervious acre treated derived from a cost history for each BMP type. See **Table 4-98** for a summary of estimated BMP costs .

Figure 4-82 shows a map of MDOT SHA's restoration practices in the watershed and includes those that are under design and construction. Inlet cleaning is not reflected on this map.

Table 4-97: Swan Creek Restoration Sediment BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	29.9	0.8	5.5	N/A	6.3
Tree Planting	acres of tree planting		9.0	1.0	N/A	10.0
Stream Restoration	linear feet			295.2	N/A	295.2
Outfall Stabilization	linear feet			369.0	N/A	369.0
Inlet Cleaning[1]	dry tons		11.9			11.9
Load Reductions	TSS EOS lbs./yr.		5,400	36,118	0	
				Total Projected Reduction	36,118	

[1] *Inlet cleaning is an annual practice.*

Table 4-98: Swan Creek Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$180,000	$219,000	$399,000
Tree Planting	$276,000	$30,000	$306,000
Stream Restoration		$197, 000	$197,000
Outfall Stabilization		$726,000	$726,000
Inlet cleaning	$65,000		$64,000
Total			$1,693,000

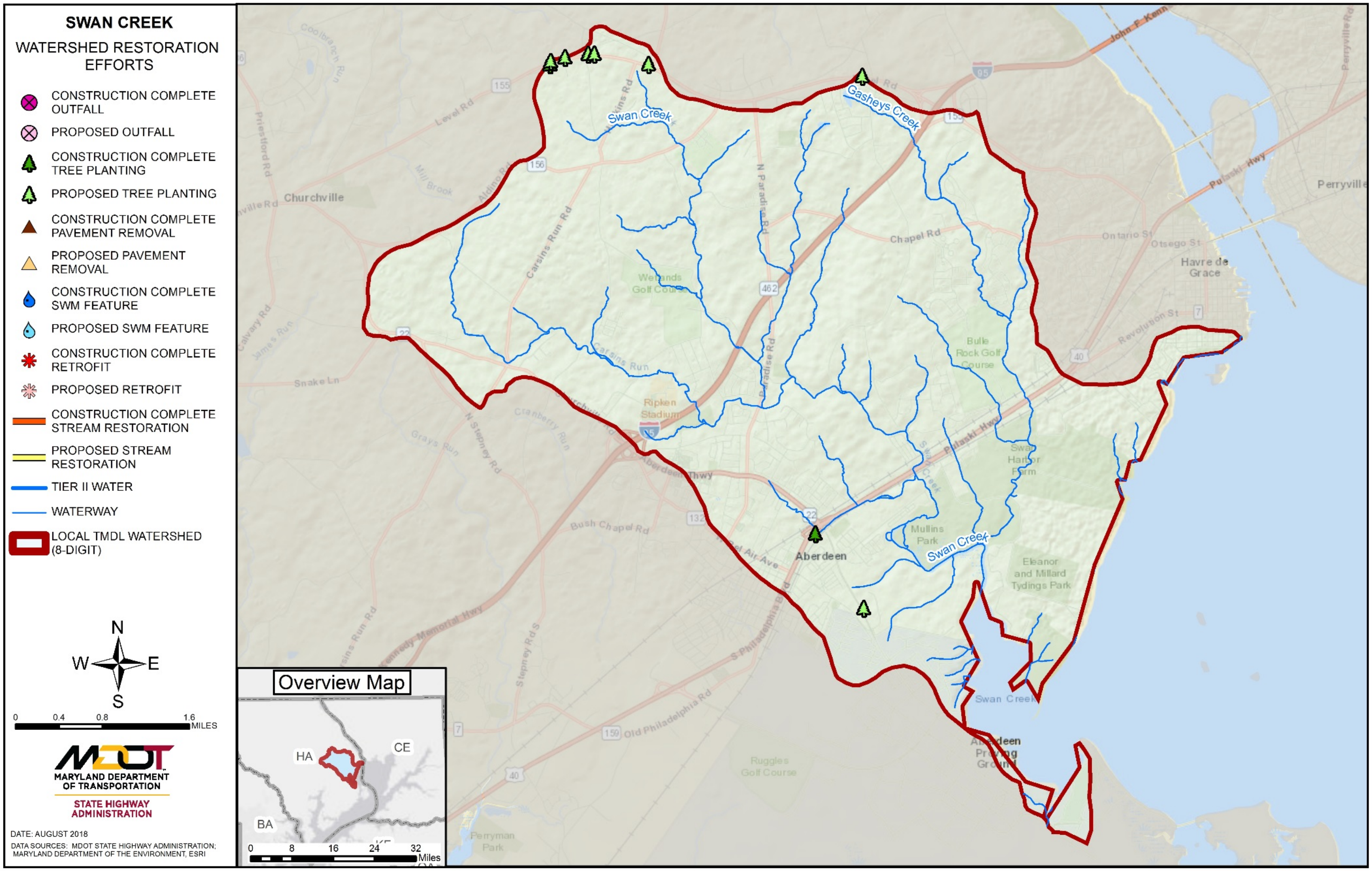


Figure 4-82: MDOT SHA Restoration Strategies within the Swan Creek Watershed

AB. UPPER MONOCACY RIVER WATERSHED

AB.1. Watershed Description

The Upper Monocacy River originates in Pennsylvania and flows through Maryland ultimately into the Potomac River. The watershed encompasses approximately 274 square miles within the state of Pennsylvania and approximately 724 square miles in both Frederick and Carroll Counties, Maryland. In Frederick County, it is divided into six subwatersheds: Fishing Creek, Glade Creek, Hunting Creek, Owens Creek, Toms Creek, and Tuscarora Creek.

There are 665.1 centerline miles of MDOT SHA roadway located within the Upper Monocacy River watershed. The associated ROW encompasses 1,219.9 acres, of which 630.5 acres are impervious. MDOT SHA facilities located within the watershed consist of one (1) highway garage or shop, one (1) welcome center, and two (2) salt storage facilities. See **Figure 4-83** for a map of the watershed.

AB.2. MDOT SHA TMDLs within Upper Monocacy River Watershed

TMDLs requiring reduction by MDOT SHA include phosphorus (MDE, 2013f) and sediment (MDE, 2009g). Phosphorus is to be reduced by 3.0 percent and sediment is to be reduced by 49 percent as shown in **Table 3-2**.

AB.3. MDOT SHA Visual Inventory of ROW

The MS4 Permit requires MDOT SHA to perform visual assessments. **Part III, Coordinated TMDL Implementation Plan,** describes the MDOT SHA visual assessment process. For each BMP type, implementation teams have performed preliminary evaluations for each grid and/or major state route corridor within the watershed as part of desktop and field evaluations. The grid-system used for the Upper Monocacy River watershed is shown in **Figure 4-84** which illustrates that 84 grid cells have been reviewed, encompassing portions of 13 state route corridors. Results of the visual inventory categorized by BMP type follow:

Structural SW Controls

Preliminary evaluation identified 966 locations as potential new structural SW control locations. Further analysis of these locations resulted in:

- 36 new structural SW controls constructed or under contract.
- 675 additional sites deemed potentially viable for new structural SW controls and pending further analysis, may be candidates for future restoration opportunities.
- 255 sites deemed not viable for structural SW controls and have been removed from consideration.

Tree Planting

Preliminary evaluation identified 208 locations as potential tree planting locations. Further analysis of these locations resulted in:

- 84 sites constructed or under contract.

- Seven (7) additional sites deemed potentially viable tree planting and pending further analysis, may be candidates for future restoration opportunities.
- 117 sites deemed not viable for tree planting and have been removed from consideration.

Stream Restoration

Preliminary evaluation identified 10 sites as potential stream restoration locations. Further analysis of these locations resulted in:

- 10 sites deemed not viable for stream restoration and have been removed from consideration.

Grass Swale Rehabilitation

Preliminary evaluation identified 40 sites as potential grass swale rehabilitation. Further analysis of these locations resulted in:

- Seven (7) new structural SW controls constructed or under contract.
- 33 sites deemed not viable for structural SW controls and have been removed from consideration.

Outfall Stabilization

No outfall stabilization sites were identified within this watershed for potential restoration.

Retrofit of Existing Structural SW Controls

Preliminary evaluation identified six (6) existing structural SW controls as potential retrofits. Further analysis of these locations resulted in:

- Retrofit of one (1) existing structural SW controls constructed or under contract.
- Five (5) retrofit sites deemed not viable for retrofit and have been removed from consideration.

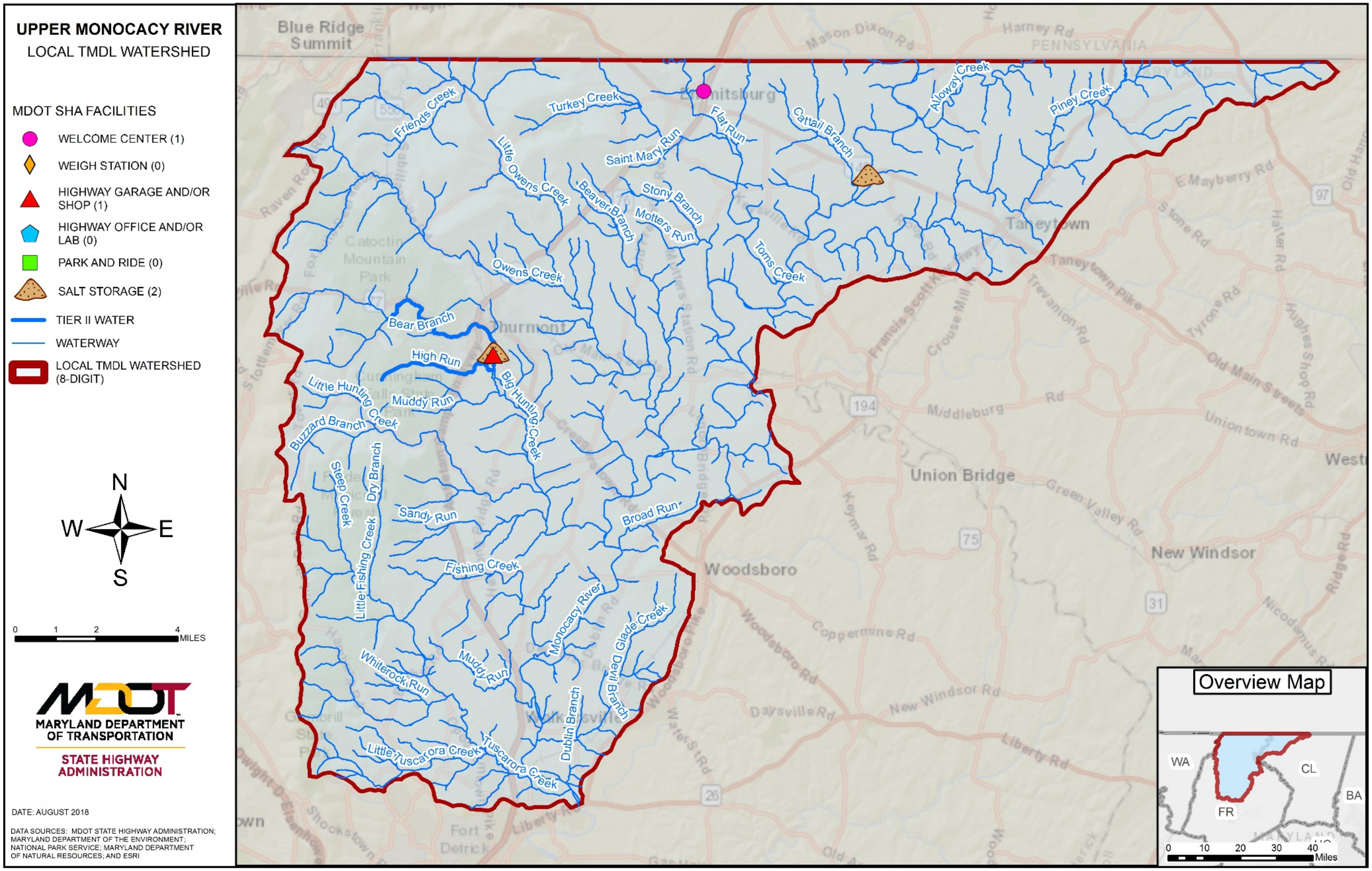


Figure 4-83: Upper Monocacy River Watershed

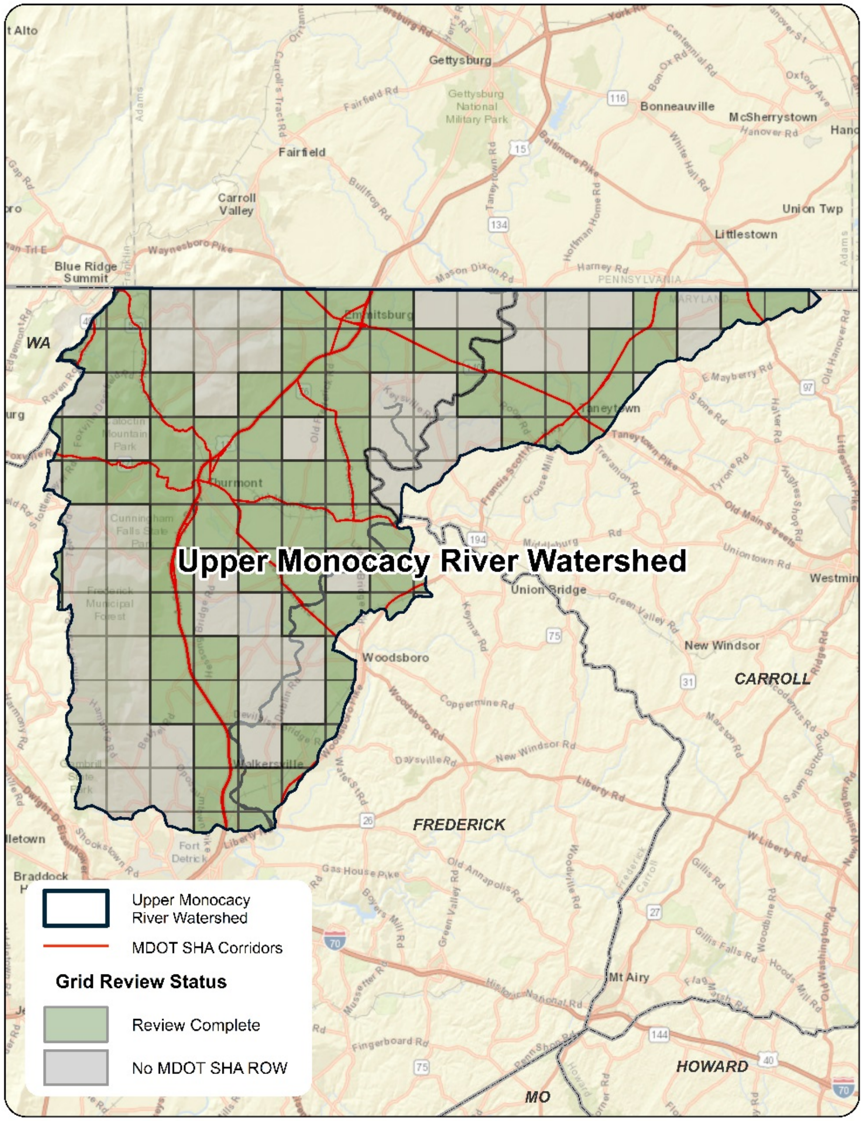


Figure 4-84: Upper Monocacy River Site Search Grids

AB.4. Summary of County Assessment Review

Waters within the Upper Monocacy River watershed are subject to the following impairments as noted on MDE's 303(d) List:

- *Escherichia coli*;
- Phosphorus (Total);
- Temperature, water; and
- TSS.

The Upper Monocacy River watershed is ranked in the *Maryland Clean Water Action Plan* (CWAPTW, 1998) as a "Category 1 Priority," a watershed not meeting clean water and other natural resource goals and therefore needing restoration, and a "Selected Category 3," a pristine or sensitive watershed most in need of protection. The Frederick County Division of Public Works completed a *Watershed Restoration Action Strategy* (WRAS) for the Upper Monocacy River watershed within Frederick County in 2005 (FR-DPW, 2005). According to the WRAS, impervious land cover comprises 3.7 percent of the watershed, and 25 percent of the soils are considered highly erodible.

For the purposes of planning, Frederick County has selected the following generalized restoration strategies to aid in meeting restoration goals within the Upper Monocacy River watershed:

- Restore riparian corridors;
- Improve impaired streams;
- Identify and preserve pristine areas;
- Protect and expand existing green infrastructure and riparian corridors; and
- Protect water quality and habitat through appropriate zoning.

The DNR conducted a SCA in Frederick County and identified 226 sites with varying degrees of severity in terms of channel alteration, erosion (120,153 linear feet), exposed pipes, fish passage barriers, inadequate buffers, and pipe outfalls. Sites were prioritized based on the greatest need and potential for restoration. The sites with the most severe problems are listed below in **Table 4-99.**

Detailed information on site locations and less severe sites can be found in the 2004 *Upper Monocacy River Stream Corridor Assessment Survey* (DNR, 2004). According to this survey, the following potential stream restoration sites were identified within the Upper Monocacy River watershed with a severity rating of two (severe) or one (very severe).

Table 4-99: Upper Monocacy River Stream Corridor Assessment Survey Restoration Site Recommendations

Subwatershed	Reach ID	Length (ft.)	Impact(s)
Glade Creek	2719205	107	Downcutting
Glade Creek	2819202	69	Downcutting
Glade Creek	2821402	10247	Downcutting
Hunting Creek	1914103	409	Widening
Owens Creek/Beaver Branch	1621201	1980	Downcutting
Toms Creek	2208201	570	Downcutting
Tuscarora Creek	0510302	12464	Widening
Fishing Creek	1510104	--	Total fish blockage (dam)
Fishing Creek	1510106	--	Total fish blockage (dam)
Fishing Creek	1512312	--	Total fish blockage (channelized)
Hunting Creek	1813301	--	Total fish blockage (channelized)
Hunting Creek	1813302	--	Total fish blockage
Owens Creek/Beaver Branch	2419103	--	Total fish blockage (road crossing)
Toms Creek	1924301	--	Total fish blockage (channelized)
Toms Creek	2307303	--	Total fish blockage (road crossing)
Source: DNR (2004)			

The Frederick County Office of Sustainability and Environmental Resources also conducted SCAs from 2008 – 2011 (Round 1) and again from 2013 – 2016 (Round 2) that include the Fishing Creek, Glade Creek, Hunting Creek, Owens Creek, Toms Creek, and Tuscarora Creek subwatersheds of the Upper Monocacy River watershed (Versar, 2012; Versar, 2017a). Information on water quality, erosion, physical habitat, and BIBI scores for several sites within the Upper Monocacy River watershed can be found in the SCA reports; however, detailed location information is not provided.

Lastly, in 2017, Frederick County completed and published the *Upper Monocacy River Watershed Assessment Frederick County, Maryland* (EA, 2017). This document expanded upon and continued the efforts described in the previously issued 2005 WRAS (FR-DPW, 2005). The EA (2017) document provides water quality conditions and a listing of completed restoration projects as well as new project opportunities in order of priority within the Upper Monocacy River watershed's six subwatersheds: Toms Creek, Owens Creek, Hunting Creek, Fishing Creek, Tuscarora Creek, and Glade Creek.

For the portion of the Upper Monocacy River watershed in Carroll County, the Carroll County Bureau of Resource Management released the *Upper Monocacy River Watershed Characterization Plan* in the spring of 2016 (CL-BRM, 2016e). According to this plan, the current impairments within Carroll County's portion of the Upper Monocacy River watershed are bacteria, phosphorus, and sediment (CL-BRM, 2016e). The Upper Monocacy River watershed in Carroll County is mostly rural with mixed urban uses accounting for less than three percent of the total land use; agriculture is the dominant land use (approximately 69 percent) (CL-BRM, 2016e). Within the watershed, the Piney Creek (0255) subwatershed has the highest percentage (7.55 percent) of total impervious area for the entire watershed (Piney Creek [0255] subwatershed drains a large portion of the city of Taneytown) (CL-BRM, 2016e).

AB.5. MDOT SHA Pollutant Reduction Strategies

Upper Monocacy is listed for both phosphorus and sediment with each TMDL having a different baseline year; 2009 for phosphorus and 2000 for sediment. Proposed practices to meet the phosphorus and sediment reduction in the Upper Monocacy River watershed are shown in **Table 4-100 and 4-101**. Projected phosphorus and sediment reductions using these practices are shown in **Table 3-2**. Four timeframes are included in the table below:

- BMPs built before the phosphorus and sediment TMDL baseline. In this case, the phosphorus baseline is 2009 and the sediment baseline is 2000;
- BMPs implemented after the baseline through fiscal year 2020; and
- BMPs implemented after fiscal year 2020 through fiscal year 2025; and
- Future BMPs to be implemented after fiscal year 2025.

Although MDOT SHA will accomplish the projected reduction, our current modeling only looks forward to 2025, which may not achieve 100 percent of the required reduction. For example, under the sediment TMDL, MDOT SHA will meet 83.8 percent of the MDE 49 percent load reduction requirement through implementation of BMPs shown in **Table 4-101.** MDOT SHA will work to increase expected reductions for all pollutant TMDLs through strategies identified in **Part III Section E.**

Estimated costs to design, construct, and implement BMPs within the Upper Monocacy River watershed total $21,126,000. These projected costs are based on an average cost per impervious acre treated derived from cost history for each BMP type. See **Table 4-102** for a BMP strategy cost breakdown.

Figure 4-85 shows a map of MDOT SHA's restoration practices in the watershed and include those that are under design and construction. Inlet cleaning is not reflected on this map.

Table 4-100: Upper Monocacy River Restoration Phosphorus BMP Implementation

BMP	Unit	Baseline (Before 2009)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	193.6	70.4	86.9	N/A	350.9
Retrofit	drainage area acres		15.6		N/A	15.6
Impervious Surface Elimination	acres removed		0.7		N/A	0.7
Tree Planting	acres of tree planting	0.2	55.8	40.4	N/A	96.4
Stream Restoration	linear feet			4,633.6	N/A	4,633.6
Outfall Stabilization	linear feet			800.0	N/A	800.00
Inlet Cleaning[1]	tons		0.2	18.6	N/A	18.8
Load Reductions	TP EOS lbs./yr.		131	613	0	
				Total Projected Reduction	**613**	

[1] *Inlet cleaning is an annual practice.*

Table 4-101: Upper Monocacy River Restoration Sediment BMP Implementation

BMP[1]	Unit	Baseline (Before 2000)	Restoration BMPs			Total BMPs
			2020	2025	Future	
New Stormwater	drainage area acres	179.8	70.4	86.9	TBD	337.1
Retrofit	drainage area acres		15.6		TBD	15.6
Impervious Surface Elimination	acres removed		0.7		TBD	0.7
Tree Planting	acres of tree planting		56.0	40.4	TBD	96.4
Stream Restoration	linear feet			4,633.6	TBD	4,633.6
Outfall Stabilization	linear feet			800.0	TBD	800.00
Inlet Cleaning[1]	tons		0.2	18.6	TBD	18.8
Load Reductions	TSS lbs./yr.		65,776	346,081	412,831	
				Total Projected Reduction	**412,831**	

[1] *Inlet cleaning is an annual practice.*

Table 4-102: Upper Monocacy River Restoration BMP Cost

BMP	2020	2025	Total
New Stormwater	$6,845,000	$5,718,000	$12,563,000
Retrofits	$647,000		$647,000
Tree Planting	$192,000		$192,000
Stream Restoration	$1,714,000	$1,235,000	$2,949,000
Outfall Stabilization		$3,094,000	$3,094,000
Inlet cleaning		$1,574,040	$1,574,000
Street Sweeping	$1,000	$106,000	$107,000
Total			$21,126,000

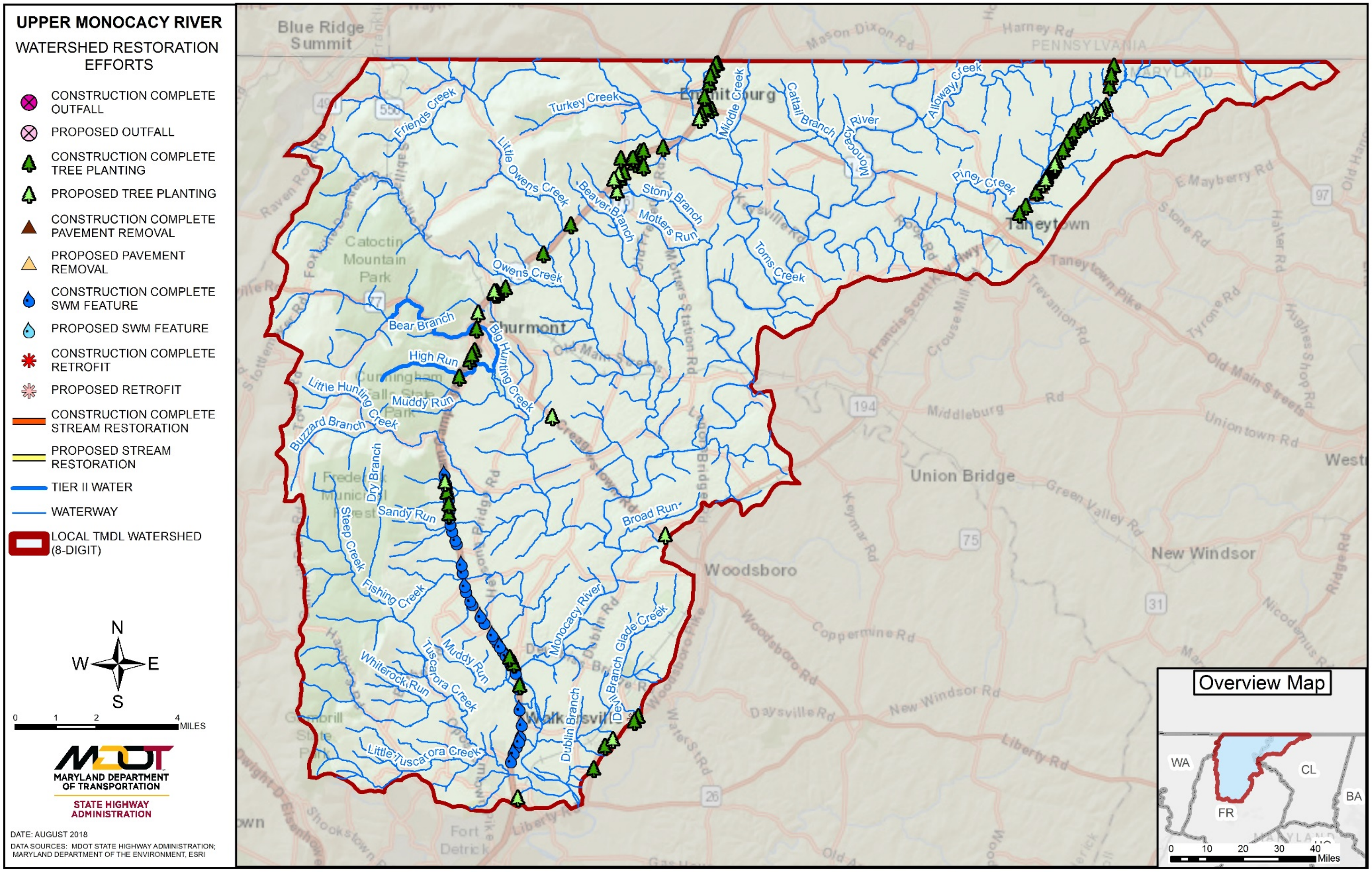


Figure 4-85: MDOT SHA Restoration Strategies within the Upper Monocacy River Watershed