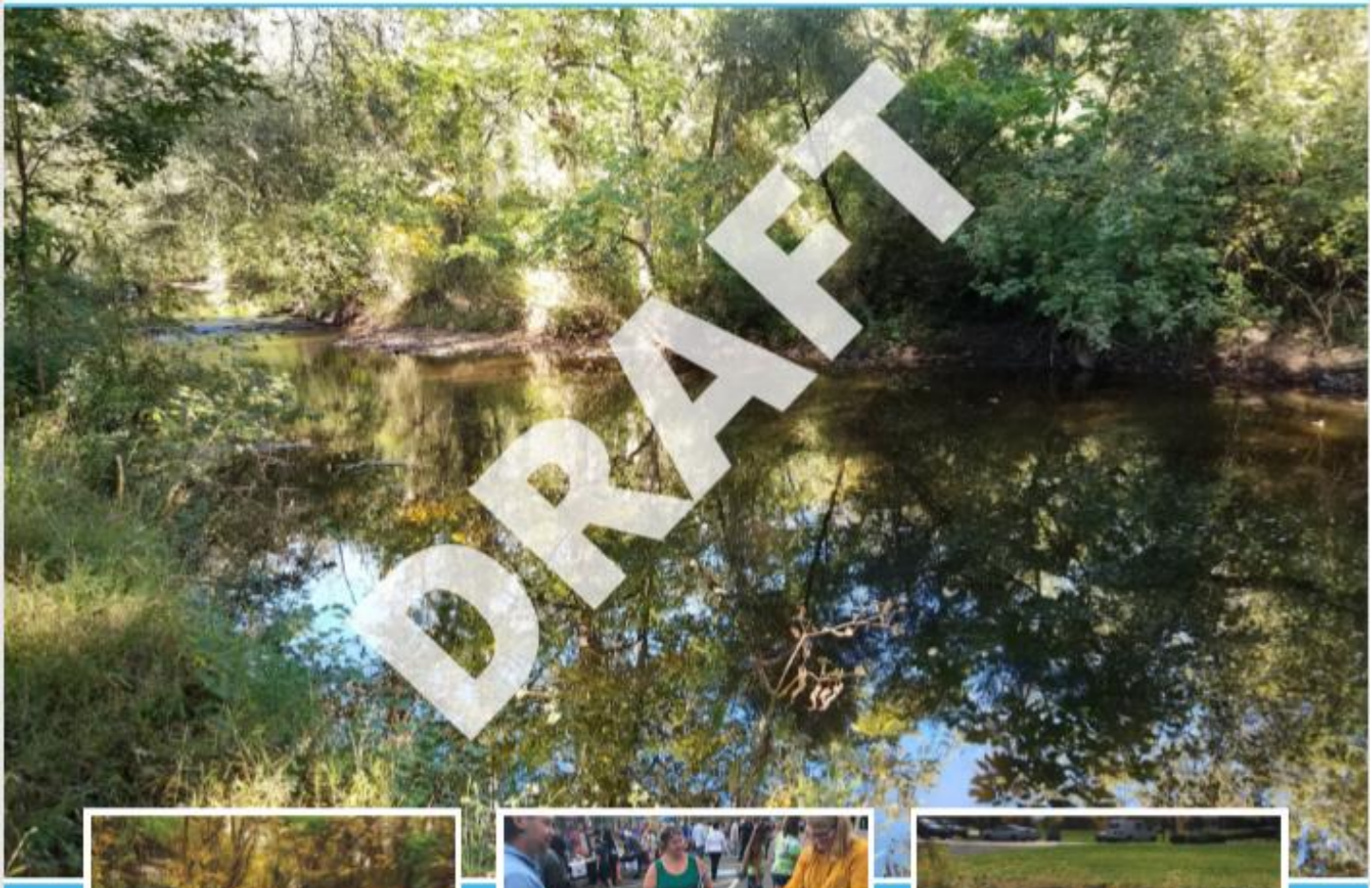
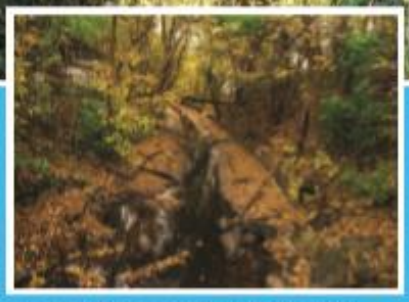
Joint Pollutant Reduction Plan

Paxton Creek Watershed TMDL, Chesapeake Bay PRP,
Wildwood Lake PRP, and UNT Spring Creek PRP





Photos (above) credit: PCWEA, CRW

Capital Region Water
Lower Paxton Township
Susquehanna Township

Draft for Public Comment

September 15, 2017
Revised November 7, 2019

Joint Pollutant Reduction Plan

Paxton Creek Watershed TMDL Plan
Chesapeake Bay PRP
Wildwood Lake PRP
UNT Spring Creek PRP

CAPITAL REGION WATER
LOWER PAXTON TOWNSHIP
SUSQUEHANNA TOWNSHIP

DAUPHIN COUNTY, PENNSYLVANIA

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EXECUTIVE SUMMARY

Capital Region Water (City of Harrisburg), Lower Paxton Township, and Susquehanna Township, Dauphin County, Pennsylvania herein referred to as the "Municipal Entities", by virtue of an intergovernmental cooperation agreement, have prepared this Chesapeake Bay Pollutant Reduction Plan (CBPRP), Total Maximum Daily Load (TMDL) Plan, and Pollutant Reduction Plan (PRP) to address Paxton Creek, Wildwood Lake and an unnamed tributary (UNT) to Spring Creek, referred herein as the "Joint Plan," to meet the pollutant load reductions requirements for the 2018 MS4 permit renewal process. The Joint Plan was developed to address the watershed pollutant load reduction requirements mandated by the United States Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (PADEP). Comments on the 2017 Joint plan were received from PADEP in a letter dated April 9, 2019. A subsequent meeting to review the comments occurred on June 10, 2019 with representatives of the Municipal Entities and PADEP staff. This plan revision updates the plan in terms of pollutant base loading process, project identification, and anticipated implementation based upon the comments, discussion, and progress made since the draft plan was submitted to PADEP. Being that the surface waters of the major streams in the region (Paxton Creek, Spring Creek, and Beaver Creek) all drain to the Susquehanna River, and ultimately to the Chesapeake Bay, goals for water quality compliance can be accomplished through implementation of one (1) comprehensive Joint Plan focusing efforts on the Paxton Creek Watershed, which contains the most regulated stream. Further, this Joint Plan addresses the Appendix E requirement for an unnamed tributary (UNT) to Spring Creek, the Appendix E requirement for Wildwood Lake – which is located within the Paxton Creek Watershed, and Capital Region Water's combined sewer system that discharges to Paxton Creek and the Susquehanna River.

The Municipal Entities previously developed a collaborative TMDL Strategy, submitted to PADEP in December 2015. The research, field work, analysis, and project selection approach from that Strategy are the basis of this Joint Plan, with updates where regulatory objectives have changed and based on further field work and analysis. The TMDL Strategy should be referenced during the review of this Joint Plan for past research completed that provided the framework for this Joint Plan. True to the sentiment in the TMDL Strategy, the three (3) entities' intention regarding this Joint Plan is to continue to collaborate through implementing a unified, cost-effective plan that meets the regulatory objectives facing each municipal entity.

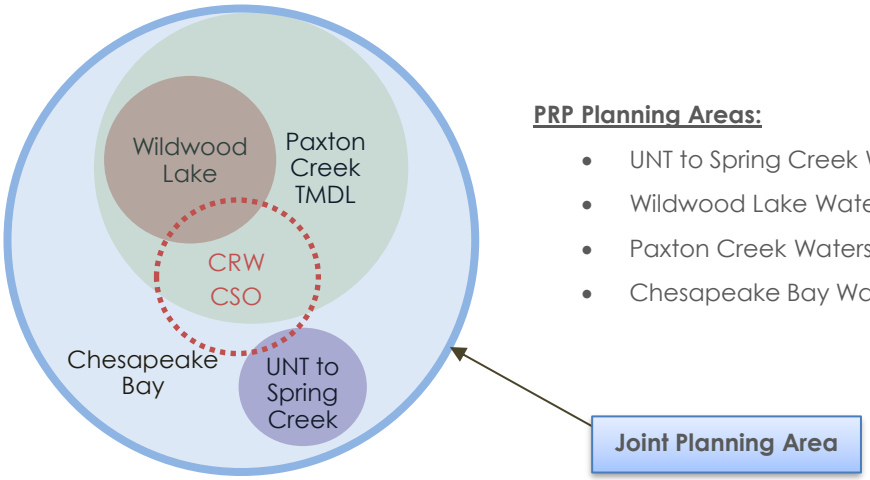
The impaired waters and pollutants of concern for each participating Municipal Entity were determined by referencing the PADEP's Pollutant Aggregation Suggestions for MS4 Requirements Table (Municipal) (last revised 9/8/2017). GIS software was used to map stream impairments and determine the planning area associated with each impaired waterway. Model My Watershed modeling software was used to calculate the baseline pollutant loading in pounds per year for the entire Paxton Creek Watershed, as well as the baseline pollutant load for the larger Joint Planning Area, which encompasses the Chesapeake Bay Pollutant Reduction Plan planning areas of each jurisdiction.

Through successful implementation of the Joint Plan, the following objectives will be achieved:

- Short-term sediment load reduction of 10% for the Paxton Creek TMDL
- Long-term 35% sediment load reduction necessary to meet the prescribed WLAs for Paxton Creek TMDL
- Appendix-D CBPRP, 10% sediment load reduction for the Municipal Entities' combined Chesapeake Bay Planning Areas (Joint Planning Area)
- Appendix-E Siltation, 10% sediment load reduction for Wildwood Lake
- Appendix-E Siltation, 10% sediment load reduction for the UNT to Spring Creek

These goals will be achieved within five (5) years of PADEP's issuance of each Municipal Entities' Individual MS4 Permit (Exhibit A).

Exhibit A. Joint Planning Area Watershed Connectivity Exhibit



PRP Planning Areas:

- UNT to Spring Creek Watershed (Appendix-E PRP)
- Wildwood Lake Watershed (Appendix-E PRP)
- Paxton Creek Watershed (TMDL)
- Chesapeake Bay Watershed (Appendix-D CBPRP)

The permit-required pollutant load reductions are based upon corresponding stream impairments. For waters with only siltation (TSS) impairments, or when the PADEP's "Presumptive Approach" is being utilized, a 10% reduction of sediment pollutant load is required. The Paxton Creek Watershed is subject to a mandatory 35% sediment load reduction, necessary to meet the Wasteload Allocations listed in the Errata to the 2008 Paxton Creek TMDL Report. The required long-term 35% sediment load reduction for the Paxton Creek Watershed and the 10% sediment load reduction for the Joint Planning Area will be achieved concurrently through implementation of the Joint Plan during the upcoming five (5) permit term. Table A presents a summary of the Municipal Entities' short-term pollutant load reduction requirements for the upcoming five (5) year permit term. The existing pollutant loads take into account several baseline load reductions for installed BMPs and existing hydrological conditions within the Planning Area.

As a Joint Plan, this document will address both the PRP requirements, pollutant reductions required for individual impaired waters, as well as the Chesapeake Bay and TMDL impairments. The individual impaired water planning areas and the Paxton Creek TMDL planning area are included within the larger Joint Planning Area, therefore any pollutant load reductions achieved within the Joint Planning and Paxton Creek TMDL planning areas will also be counted towards achieving the individual Appendix-E PRP sediment load reduction goals for the Wildwood Lake and the UNT to Spring Creek. Implementation of the Joint Plan over the first five years of the upcoming permit term will result in each of the Municipal Entities achieving the required sediment load reductions (Table A) for all of their respective impaired streams requiring Pollutant Reduction Plans, per PADEP's Municipal Requirements Table. The results of a watershed analysis using Model My Watershed modeling software confirms the feasibility of achieving all required sediment load reductions through implementation of the Joint Plan.

The inherent complexity of implementing numerous, large-scale projects in a five-year timeframe with limited annual cash flow and limited land control, necessitates a significant number of alternate projects be identified and included in this plan in order to provide flexibility during implementation. Early action projects are identified with an "EAP" notation. As projects are completed and reported on in each MS4's Annual Reports, plan implementation progress will be quantified. The plan goal will be accomplished once the implemented projects meet the joint planning area load reduction goal. For those planned projects that are not completed during the individual permit term because the goal has been met, the MS4s reserve the possibility of implementing the projects in the future should there be a new regulatory water quality improvement goal.

Table A. Short-Term (5-yr) Pollutant Load Reduction Requirements by PRP Planning Area

Planning Area	Impairment	Existing Sediment Load (lb/yr)	Required Sediment Load Reduction	Sediment Reduction Required (lb/yr)
Paxton Creek TMDL	Sediment / Siltation	3,630,159	10%	363,016
Joint Planning Area	Sediment / Nutrients	16,943,984	10%	1,694,398
Wildwood Lake	Sediment / Siltation	2,825,290	10%	282,529
UNT to Spring Creek	Sediment / Siltation	45,137	10%	4,514

Further analysis of the Model My Watershed modeling effort revealed that the majority of the sediment load was a result of streambank erosion. As such, the BMP implementation strategy developed to meet the pollutant load reduction goals relies largely on stream restoration projects (Table B), rather than land-based BMPs. The proposed stream restoration projects will rely, where practical, on vegetative stabilization and floodplain reconnection rather than hard armoring of eroding streambanks. Each project will incorporate riparian buffer restoration and naturalization of the adjacent floodway as appropriate. Stream restoration locations were chosen in part based on geographic location, targeting the Paxton Creek Watershed, because severe erosion areas were observed in the field and secondary benefits related to work in those areas increased the project priority. Because the Paxton Creek Watershed accounts for a large portion of the Joint Planning Area and the entire Wildwood Lake Watershed, implementing stream restoration projects in the Paxton Creek Watershed provides sediment load reductions for each of the overlapping Planning Areas.

Table B. Proposed BMPs and Associated Sediment Reductions

Map Reference	BMP Name	Benefiting Watershed(s)	Latitutde	Longitude	Length (ft)	Reduction (lbs)
BMP-01	Fox Hunt - Stream Restoration	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.335491°	-76.879814°	750	86,250
BMP-02	Stonebridge Apartments	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.301103°	-76.823866°	1,450	166,750
BMP-03	Wildwood Lake, Black Run	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.307771°	-76.882665°	1,075	123,625
BMP-04	Veteran's Park South	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.293398°	-76.859017°	1,000	115,000
BMP-05	Veteran's Park North	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.294232°	-76.860350°	1,150	132,250
BMP-06	CWP – Shutt Mill Rd/Walker Mill Road	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.316231°	-76.870776°	4,400	505,171
BMP-07	Susquehanna Union Green	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.325675°	-76.855535°	2,600	505,700
BMP-08	Bradley Drive	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.319371°	-76.860073°	950	109,250
BMP-09	Black Run - North	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.316022°	-76.870342°	3,368	387,320
BMP-10	Black Run - South	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.311085°	-76.871213°	2,000	230,000
BMP-11	Pines Apartment Complex	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.289522°	-76.840440°	1,450	166,750
BMP-12	Capital Area Greenbelt	UNT to Spring Creek, CBPRP	40.272602°	-76.841858°	1,800	207,000
BMP-13	Walker Mill Road Stream and Retrofit	Paxton Creek TMDL, Wildwood Lake, CBPRP	40.305650°	-76.866050°	600	79,400
BMP-14	CRW UNT to Spring Creek GSI Projects	UNT to Spring Creek, CBPRP	40.269089°	-76.844171°	N/A	23,024
BMP-15	CRW Street Sweeping (25 times per year)	Paxton Creek, UNT to Spring Creek, CBPRP	N/A	N/A	N/A	29,864
BMP-16	Combined Sewer System Rehabilitation & Optimization	N/A	N/A	N/A	N/A	355,000
					Total Proposed Sediment Reduction:	**3,222,354**

The implementation of the proposed BMPs listed in Table B will provide the necessary sediment load reductions for each Municipal Entity to accomplish their respective pollutant load reduction requirements for the upcoming five (5) year MS4 permit term (Table C).

Table C. Proposed Early Action Project BMPs' Sediment Reductions by PRP Planning Area

Planning Area	Impairment	Required Sediment Load Reduction (lb/yr)	Proposed Sediment Load Reduction (lb/yr)	Required Reduction Goal Achieved? (Yes/No)
Paxton Creek TMDL	Sediment / Siltation	363,016	2,132,159	Yes
Joint Planning Area	Sediment / Nutrients*	1,694,398	3,222,534	Yes
Wildwood Lake	Sediment / Siltation	282,529	2,102,295	Yes
UNT to Spring Creek	Sediment / Siltation	4,514	230,024	Yes

*Presumptive approach used to meet nutrient reduction requirements

The BMP strategy proposed herein will be implemented by the Municipal Entities as outlined in the Intergovernmental Cooperation Agreements ("Agreements") between each of the three (3) participating municipal entities. Funds will be sourced through a variety of mechanisms, including any collected stormwater fees, municipal funds, available grants, partnerships, and public donation of materials and manpower.

Public participation was integrated into the development process through providing the public with a draft copy of the 2017 Joint Plan, which was made available for a thirty (30) day public review and comment period. The Joint Plan was also presented during a public meeting held on August 15, 2017 at the Lower Paxton Municipal Building, at which time the public was provided an opportunity to ask questions and make comments. Additionally, the plan was made available for viewing on the participant's respective websites, and a notice was placed in *The Patriot News* and *Paxton Herald* stating the intent of the proposed Joint Plan. The public comment review period was renewed for the 2019 revision, including a public meeting held on November 19, 2019 and advertisement in *The Patriot News* and *Paxton Herald*.

INTRODUCTION

Capital Region Water (City of Harrisburg), Lower Paxton Township, and Susquehanna Township, Dauphin County, Pennsylvania herein referred to as the "Municipal Entities", by virtue of an intergovernmental cooperation agreement, have prepared this Chesapeake Bay Pollutant Reduction Plan (CBPRP), Total Maximum Daily Load (TMDL) Plan, and Pollutant Reduction Plan (PRP) to address Paxton Creek, Wildwood Lake and an unnamed tributary (UNT) to Spring Creek, referred herein as the "Joint Plan," to meet the pollutant load reductions requirements for the 2018 MS4 permit renewal process. The Joint Plan was developed to address the watershed pollutant load reduction requirements mandated by the United States Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (PADEP). Comments on the 2017 Joint plan were received from PADEP by a letter dated April 9, 2019. A subsequent meeting to review the comments occurred on June 10, 2019 with representatives of the Municipal Entities and PADEP staff. This plan revision updates the plan in terms of pollutant base loading process, project identification, and anticipated implementation based upon the comments, discussion, and progress made since the draft plan was submitted to PADEP.

This Joint Plan demonstrates how to meet all of the Municipal Entities' sediment load reductions required through the implementation of a Chesapeake Bay Pollutant Reduction Plan; a TMDL Plan benefiting the Paxton Creek Watershed; and the various Appendix E Pollutant Reduction Plans listed in PADEP's MS4 Requirements Table[1] for Municipal MS4s. Capital Region Water's requirements are identified as the City of Harrisburg's requirements on the MS4 Requirements Table, as Capital Region Water is the system operator.

Each of the Municipal Entities own, operate, and maintain Small Municipal Separate Storm Sewer Systems (MS4s). MS4s in each community discharge stormwater to Paxton Creek, which is subject to a TMDL for sediment. As such, each Municipal Entity is required to prepare and submit to PADEP a TMDL Plan addressing how they intend to meet the sediment load reductions and Wasteload Allocations (WLAs) prescribed in EPA's Paxton Creek Watershed TMDL Report[2]. Additionally, as owners and operators of MS4s that discharge stormwater to the Chesapeake Bay Watershed, each community is required to prepare and submit a Chesapeake Bay Pollutant Reduction Plan, describing how the MS4 will reduce the sediment load of stormwater discharging to the Bay's watershed by 10% during the next five (5) year permit term. PADEP also mandates any MS4 discharging stormwater to a stream impaired for sediment and/or nutrients complete an Appendix E – Pollutant Reduction Plan, addressing how the MS4 intends to reduce the sediment pollutant loading of stormwater discharging to the impaired stream by 10% in the next five (5) year permit term.

Being that the surface waters of the major regional streams (Paxton Creek, Spring Creek, and Beaver Creek) all drain to the Susquehanna River, and ultimately to the Chesapeake Bay, goals for water quality compliance can be accomplished through implementation of one (1) comprehensive Joint Plan focusing efforts on the Paxton Creek Watershed, which is the most regulated waterbody. Further, this Joint Plan addresses the Appendix E requirement for an unnamed tributary (UNT) to Spring Creek, the Appendix E

[1] PADEP, Municipal Requirements Table (Municipal), Rev. 9/8/2017

[2] US EPA, Nutrient and Sediment Total Maximum Daily Load in Paxton Creek Watershed, Pennsylvania, June 30, 2008

requirement for Wildwood Lake, which is located within the Paxton Creek Watershed, and Capital Region Water's combined sewer system (CSS) that discharges to Paxton Creek and the Susquehanna River.

Capital Region Water operates a combined sewer system within the City of Harrisburg, including approximately 1,720 acres draining to Paxton Creek and another 661 acres draining directly to the Susquehanna River. The 2008 Paxton Creek TMDL Report incorrectly categorized CRW's combined sewer system as part of the City of Harrisburg MS4. In addition, CRW's existing combined sewer system, by way of treatment in the currently captures and treats about 53% of the average annual runoff generated within the combined sewer service area, providing land-based sediment load reductions as well as decreases in the frequency and magnitude of runoff discharged to Paxton Creek, partially mitigating streambank erosion. The 2008 Paxton Creek TMDL Report does not account for any of this load reduction and consequently overestimates sediment loads attributed to the City of Harrisburg and its MS4. Section D.3 of this Joint Pollution Reduction Plan partitions this load and takes credit for load reductions achieved by the existing combined sewer system.

CRW is currently under a partial Consent Decree with EPA and PADEP, resulting in a requirement to prepare and implement a long-term control plan (LTCP) to reduce combined sewer overflows (CSOs). CRW's CSO LTCP was submitted for review in 2018. The goals of the CSO LTCP are the same as the Paxton Creek TMDL and Chesapeake Bay PRP – reduce flows, establish a less erosive flow regime, and remove land-based sediment loads with the operation of structural BMPs. CRW will implement short- and long-term control measures that further reduce the frequency, magnitude, and sediment load attributable to CSOs discharged to the Paxton Creek and the Susquehanna River. This Joint Pollution Reduction Plan includes an initial estimate of the short-term load reduction anticipated to be achieved through implementation of early-action projects under the LTCP. Land-based pollutant load reductions attributable to the existing operation and short-term enhancements to CRW's combined sewer system were determined directly from hydrologic/hydraulic modeling performed in support of the LTCP. Streambank erosion loads and load reductions attributable to CRW's combined sewer system are determined by extrapolating sediment loads defined for high-density development using the Generalized Watershed Loading Function (GWLF-E) watershed model. This sediment load reduction will be analyzed further as the LTCP is implemented.

The Municipal Entities previously developed a collaborative TMDL Strategy, submitted to PADEP in December 2015. The research, field work, analysis, and project selection approach from that Strategy are the basis of this Joint Plan, with updates where regulatory objectives have changed, refinement related to the LTCP development, and based on field work and analysis completed in 2017. The TMDL Strategy developed in 2015 should be referenced during the review of this Joint Plan for past research completed that provided the framework for this Joint Plan. True to the sentiment in the TMDL Strategy, the three (3) entities' intention regarding this Joint Plan is to continue to collaborate through implementing a unified, cost-effective plan that meets the regulatory objectives facing each municipal entity.

SECTION A: PUBLIC PARTICIPATION

A complete copy of the 2017 Joint Plan was made available for public to review from August 2, 2017 to September 1, 2017. The availability of the document was publicized in *The Patriot News* and *The Paxton Herald* on August 1, 2017 and August 2, 2017, respectively. The published public notices contained a brief description of the Joint Plan, the dates and locations at which the Joint Plan was available for review by the public, and the length of time provided for the receipt of comments.

A copy of the 2017 public notices are included in Appendix A. Public comments were accepted for thirty (30) days following the publication date of the public notice. Several public comments were received. Copies of all public comments and the responses related to each comment are included in Appendix A.

A public meeting was held on August 15, 2017 at the Lower Paxton Township Municipal Building to present the information contained in this Joint Plan to the public. Comments and questions regarding the Joint Plan were received during the public presentation. A copy of the 2017 plan presentation meeting minutes are included in Appendix A.

For the 2019 plan revision, complete copy of the Plan was made available for public to review from November 7, 2019 to December 9, 2019. The availability of the document was publicized in *The Patriot News* and *The Paxton Herald* on November 6, 2019 and November 7, 2019, respectively. The published public notices contained a brief description of the Joint Plan, the dates and locations at which the Joint Plan was available for review by the public, and the length of time provided for the receipt of comments. A copy of the public notices are included in Appendix A. Public comments were again accepted for thirty (30) days following the publication date of the public notice. Several public comments were received. A public meeting was held on November 19, 2019 at the Lower Paxton Township Municipal Building to present the information contained in this Joint Plan to the public. Comments and questions regarding the Joint Plan were received during the public presentation. Copies of all public comments and the responses related to each comment, in addition to the public presentation and meeting minutes, are included in Appendix A.

SECTION B: MAP

The maps located in Appendix B of this Joint Plan, depict the Municipal Entities Municipal Separate Storm Sewer System (MS4) service area, as required by the National Pollutant Discharge Elimination System (NPDES) Individual Permit to Discharge Stormwater from Small Municipal Separate Storm Sewer Systems (MS4s) Application Instructions[3]. It should be noted that there are four (4) PRP planning areas, or sub-watersheds, included in the overall Joint Planning Area watershed (Table 1). As such, pollutant load reductions achieved in smaller sub-watersheds count toward meeting the pollutant load reductions requirements of the larger watershed in which it is contained (Exhibit 1). This is essential for understanding how pollutant load reductions will be shared for these interconnected planning areas.

Exhibit 1. Joint Planning Area Watershed Connectivity

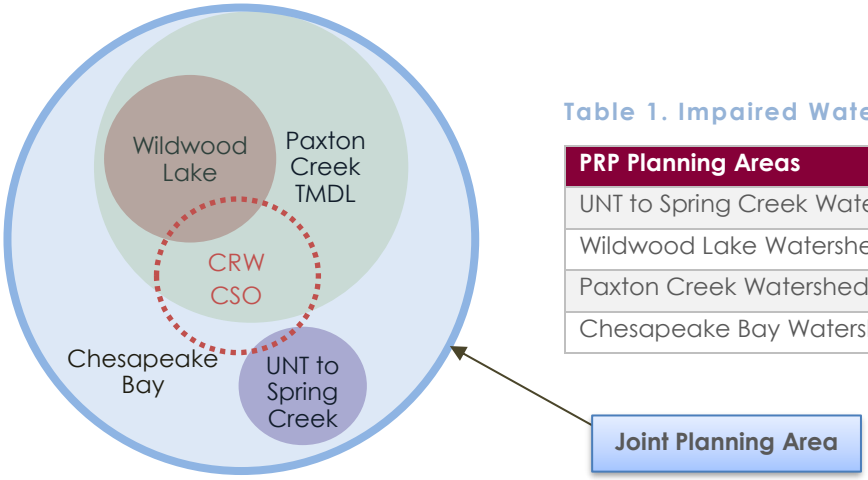


Table 1. Impaired Watersheds in Joint Planning Area

PRP Planning Areas
UNT to Spring Creek Watershed (Appendix-E PRP)
Wildwood Lake Watershed (Appendix-E PRP)
Paxton Creek Watershed (TMDL)
Chesapeake Bay Watershed (Appendix-D CBPRP

CRW Stormwater System Description

CRW is currently in the process of mapping its combined sanitary/storm and separate storm sewer systems and continues to more precisely identify its CSOs, MS4 outfalls, and the areas draining to each. CRW's system is characterized as follows:

- Most stormwater generated within the City of Harrisburg drains to CRW's combined sewer system and discharges to receiving waters at 59 combined sewer overflow (CSO) outfalls.
- CRW also owns and operates an MS4, consisting of underground storm sewers and connected inlets that drain a portion of the remainder of the City. Separate (to MS4 Outfall) areas differ from Table 2-15 of the 2008 TMDL Report due to corrections in the Paxton Creek watershed identified by CRW's current sewer system mapping efforts; delineation of the combined sewer system area, other MS4s, and direct drainage; and differences in the latest Harrisburg City municipal boundary.
- The City of Harrisburg continues to own and operate an MS4 consisting of ditches, curbs, gutters, and other surface drainage features within road right-of-way, as well as MS4s serving various City-owned properties (e.g. municipal buildings, parks, recreation centers). Most, but not all, of the City's MS4 discharges into CRW's MS4, with the remainder discharging directly to receiving waters.

[3] PADEP, form 3800-PM-BCW0200a, (rev. 1/2017)

Stormwater BMPs are installed within the City limits and will continue to be required to be installed for new land development projects, as regulated by local ordinance. As the overall combined and separate systems continue to be better defined and BMPs are mapped, those BMPs will be managed as part of the overall CRW MS4 permit program.

Lower Paxton Township and Susquehanna Township Stormwater System Description

The MS4s in each Township are similar in that they were constructed later than the system within the City limits and include outfalls, pipes, inlets, swales, and BMPs that discharge to the overall system. There are no combined sewer systems in the two townships. The Townships are largely suburban in nature, instituting flood mitigation regulations for new construction for decades, and land development projects constructed since the TMDL was established have been under stricter stormwater regulation than development constructed during the 1970s, 1980s, and 1990s. Between the municipal entities, the majority of recent development projects has occurred within the Townships' borders, and land development projects constructed since 2003 have been designed with BMP installations required by Act 167–compliant stormwater quantity and quality ordinances.

Planning Area Delineations

The urbanized area and topographic contributing drainage located within the municipal boundaries of the City of Harrisburg, Susquehanna Township, and Lower Paxton Township is considered to be the overall Joint Planning Area for the purpose of this Joint Plan. The Joint Planning Area incorporates the entire Paxton Creek Watershed, the entire Wildwood Lake Watershed, the watershed to unnamed tributary (UNT) 10126 to Spring Creek, as well as the regulated portions of the Chesapeake Bay Watershed for Harrisburg City (CRW), Lower Paxton Township, and Susquehanna Township. By virtue of the watersheds existing within the municipal urbanized areas, but not having specific impairments, the Joint Planning Area also encompasses portions of the Beaver Creek, Spring Creek, and Susquehanna River Watersheds. The planning area is characterized by primarily developed land of medium to high intensity with areas of open space and forest. Few agricultural uses exist within the Joint Planning Area (Appendix B – Land Use Map).

Table 2. Joint Planning Area Description of Various Land Uses and Drainage Area Categories

Land Use Code	Land Use	CRW (ac.)	Susq. Twp. (ac.)	Lower Paxton Twp. (ac.)	Total (ac.)
11	Water	2,287	1,178	9	3,474
21	Developed, Open Space	412	1,551	3,858	5,821
22	Developed, Low Intensity	1,139	2,666	5,011	8,816
23	Developed, Medium Intensity	1,846	1,170	1,737	4,753
24	Developed High Intensity	1,484	0	522	2,006
31	Barren Land (Rock/Sand/Clay)	0	413	0	413
41	Deciduous Forest	213	1,954	3,977	6,144
42	Evergreen Forest	3	2	9	14
43	Mixed Forest	0	8	5	13
52	Shrub/Scrub	0	6	11	17
71	Grasslands/Herbaceous	0	25	43	68
81	Pasture/Hay	40	561	2,402	3,003
82	Cultivated Crops	8	158	457	623
90	Woody Wetlands	29	22	9	60
95	Emergent Herbaceous Wetlands	12	2	3	17
				Joint Planning Area	34,829*
				* Based on Model My Watershed Land Use Analysis Results	
Within the Joint Planning Area:					
Separate Storm Sewer System (MS4) Area		885	4,878	9,901	15,664
Combined Sewer Service (CSS) Area		2,534	12	0.0	2,546

The Municipal Entities intend to provide a leadership role in achieving PADEP's pollutant reduction objectives throughout their jurisdictional boundaries; therefore, no parsing of the planning area is done with this plan update. The planning area and modeled pollutant loading area are equal. The planning area, however, is unique and comprised of the following types of stormwater runoff dischargers:

- Joint PRP MS4: This subarea results in pollutant loading calculations that are the direct responsibility of the Municipal Entities. It is determined by mapping of the MS4s operated by each of the Municipal Entities and using topographic information to delineate areas that drain into these systems.

- Combined Sewer System (CSS): This is the area within the City of Harrisburg served by combined sewers (i.e., a sewer designed to collect stormwater and wastewater in the same pipe), defined as the area tributary to the 59 combined sewer regulator structures that divert wastewater to CRW's Advanced Wastewater Treatment Facility (AWTF). It includes pockets of separate storm sewer that drain into a combined sewer. CRW's City Beautiful H2O Program Plan (CBH2OPP), CRW's Integrated Stormwater/Wastewater Management Plan prepared according to US EPA integrated planning guidelines, includes more detailed maps and descriptions of how this system was delineated an is available upon request of CRW.

For the purpose of this Joint PRP, pollutant contributions from and pollutant removal achieved by the CSS include both land-based sediment capture within the combined sewer area and streambank erosion control. These reductions are attributed to flow volume/velocity reductions from existing and proposed future combined sewer system operation. Combined sewer effects on flows and loads are credited in this PRP for two reasons: (1) The Paxton Creek TMDL appeared to include the CSS in its load calculation and (2) under US EPA integrated planning guidelines, communities are encouraged to seek the most cost-effective method of achieving water quality compliance, regardless of the permitting vehicle used to regulate discharges. Since CRW's CSOs contribute to water quality issues within the Joint Planning Area and CRW is required to reduce these CSOs, it is appropriate to include the combined sewer area in its overall Joint PRP strategy.

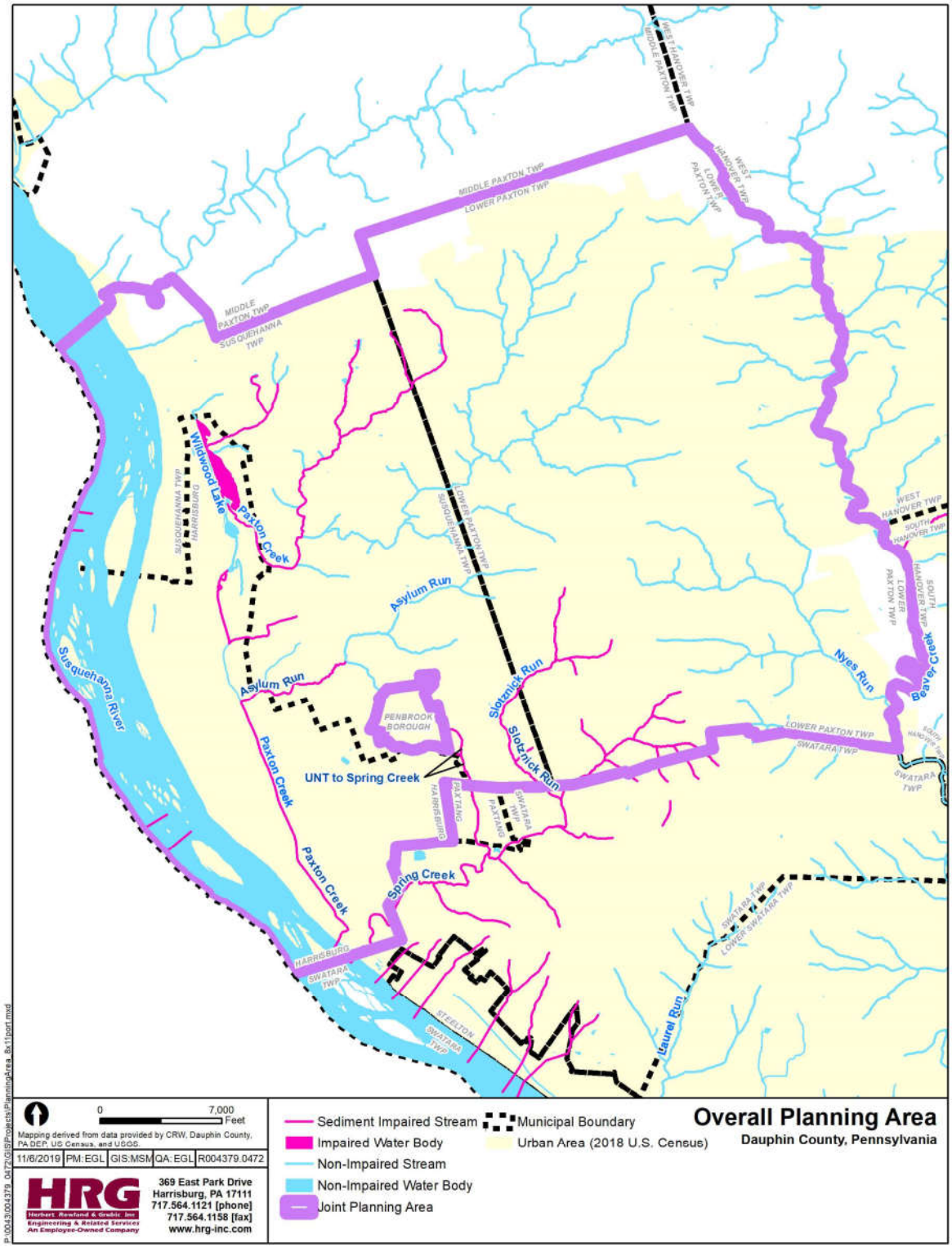
- Other Named MS4s and Industrial Permittees: There are several other entities in the Joint Planning Area that own/operate permitted storm sewer systems, including PennDOT, Dixon University, and the Lancaster County Solid Waste Authority. The Municipal Entities are already in collaboration with PennDOT on pollutant reduction projects and intend to collaborate with other permitted entities as opportunities arise.

- Public Properties with Direct Discharges: These public entities are not served by the MS4s operated by the Municipal Entities, and many own and operate drainage systems that may be considered "municipal" under US EPA and PADEP stormwater regulations, including the United States government, the Commonwealth of Pennsylvania (e.g., Farm Show property and other properties owned by the Commonwealth outside the CSS), Dauphin County, and public universities (e.g., Harrisburg Area Community College). These properties are subject to stormwater fees and/or considered potential participants in collaborative projects within the Joint Planning Area.

- Private Properties with Direct Discharges: These are properties abutting a Water of the Commonwealth that, based on available MS4 mapping and topography, do not appear to drain through an MS4 operated by a Municipal Entity but still contribute to the overall watershed impairment. This includes much of the major rail line passing through Harrisburg, which is served by its own drainage system that does not enter the MS4, based on best available information.

- Non-Urban Areas: These are the areas that are not considered to be urbanized according to the 2010 US Census and, per US EPA and PADEP regulations, are not considered part of the MS4 pollutant loading contribution. However, the updated MS4 regulations have clarified this characterization by indicating that if the non-urban areas are tributary to urban areas, they indeed are included in the planning area and contribute to water quality.

EXHIBIT 2. OVERALL PLANNING AREA MAP



SECTION C: POLLUTANT(S) OF CONCERN

The Pollutants of Concern for the Planning Area were determined by referencing the PADEP's Pollutant Aggregation Suggestions for MS4 Requirements Table (Municipal)[4]. A summary table of the Pollutants of Concern listed by the watershed is shown below (Table 3). The Requirements Table also indicate watersheds that are impaired for reasons that do not require a pollutant reduction plan. These requirements will need to be addressed in the future by way of pollutant control measures (PCMs), and those watersheds are also identified in Appendix C.

This Joint Plan's focus is for MS4 PRP Appendix D and E. As such, not all impairments listed in the Municipal Requirements Table are included as Pollutants of Concern for the purpose of this Joint Plan.

Table 3. MS4 Requirements Table Pollutant Reduction Plan Requirements

Impaired Watershed	Pollutants of Concern	DEP-Assigned Municipal Entity
Chesapeake Bay	Appendix D - Nutrients, Siltation (4a)	CRW, LPT, SUSQ
Paxton Creek TMDL	TMDL Plan - Siltation (4a)	CRW, LPT, SUSQ
Wildwood Lake	Appendix E - Siltation (5)	CRW, SUSQ
UNT to Spring Creek	Appendix E - Siltation (5)	CRW, SUSQ

Likely sources of these pollutants in the Municipalities have been identified by PADEP as follows:

Siltation - Sediment (TSS):
Streambank erosion
Construction / earth moving activities
Agricultural activities
Urban runoff

Nutrients (TN, TP):
Lack of adequate stream buffer
Heavy use of lawn fertilizers
Urban runoff

TSS – Total Suspended Solids
TN – Total Nitrogen
TP – Total Phosphorus

CRW – Capital Region Water
LPT – Lower Paxton Township
SUSQ – Susquehanna Township

[4] PADEP, MS4 Requirements Table (Municipal) (rev. 9/8/2017)

SECTION D: EXISTING LOADING FOR POLLUTANT(S) OF CONCERN

D.1 Paxton Creek TMDL Background

The basis of the Paxton Creek sediment TMDL was studied during the development of the 2015 TMDL Strategy. The Paxton Creek watershed (hydrologic unit code [HUC] 02050305) consists of approximately 17,421 acres of predominantly medium to high intensity urban development in and near Harrisburg, Pennsylvania. Table 4 shows the approximate breakdown of the watershed by jurisdiction and type of drainage, as understood during the development of the 2015 TMDL Strategy. A watershed analysis conducted at that time indicated that approximately fifty-five percent (55%) of the watershed discharges to Paxton Creek through MS4s, ten percent (10%) through combined sewer outfalls (CSOs), eleven percent (11%) through other MS4s, eight percent (8%) direct drainage to Paxton Creek, and sixteen percent (16%) outside urbanized areas. Notwithstanding that the urbanized area changed with the 2018 permit term and the planning area has increased with this 2019 plan revision, these percentages are still generally reflective of the watershed.

Table 4. Approximate Drainage Areas within Paxton Creek Watershed, from 2015 TMDL Strategy

Jurisdiction	Approximate Drainage Area (acres)					
	Separate (to MS4 Outfall)	Combined (to CSO)	Other MS4s[1]	Direct Drainage[2]	Non-Urban Area[3]	Total
Capital Region Water/ City of Harrisburg	148	1,720	461	254	765	3,348
Lower Paxton Township	4,664	0	254	592	1,885	7,395
Susquehanna Township	4,618	0	1,091	616	88	6,413
Middle Paxton Township	0	0	0	2	98	100
Penbrook Borough	132	0	31	0	0	163
Swatara Township	0	0	2	0	0	2
Total	9,562	1,720	1,839	1,464	2,836	17,421
Percentage of Paxton Creek Watershed	55%	10%	11%	8%	16%	100%

[1] For example, PennDOT, Commonwealth of Pennsylvania, Harrisburg Area Community College, Dauphin County

[2] Private property not discharging to an MS4, where known; included in Separate (to MS4 Outfall) area where unknown

[3] Non-urban areas are areas not defined as an urbanized area by the 2000 U.S. Census, as was the prevailing urbanized area determination at the time of the Strategy development

PADEP has determined that approximately thirty (30) miles of Paxton Creek and its tributaries fail to meet water quality standards and are listed on the 303(d) list of impaired waters for 2014. Section 303(d) of the Federal Clean Water Act requires States to identify all impaired surface waters not supporting designated uses even after required water pollution control technologies have been applied. Known as the 303(d) List, the DEP's report, *2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report,* identifies those water body segments that require the development of total maximum daily loads (TMDLs) to assure future compliance with water quality standards. The latest 303(d) data released in 2016 has been utilized to identify the impaired creek segments herein and, to the author's knowledge, no stream segment has been restudied by PADEP to date in an effort to remove them from the impairment list.

To efficiently assess stream impairment, PADEP primarily uses biological assessment of aquatic macroinvertebrates because aquatic life use is a reliable indicator of long-term pollution problems and stream degradation. Therefore, the stream and watershed characteristics that may have led to the Paxton Creek's degradation and subsequent 303(d) listing are primary indicators of stream habitat alterations, accelerated flow and erosion, and degraded riparian areas. Increased runoff volume and velocity from uncontrolled impervious surfaces can destabilize stream channels, particularly near unprotected outfalls. Stream encroachments can also lead to degraded riparian areas by removing natural ecosystems that protect streams (e.g., floodplains, riparian cover, etc.).

Previous watershed assessments have identified recurring themes of streambank erosion and instream erosion; however, at the time the studies occurred, the watershed still exhibited signs of past less-regulated land development practices. With the inception of new stormwater regulations in 2010 that required additional water quality practices and over-detention, in addition to tighter sediment and erosion controls during the construction phase, the stream should start to exhibit the benefits of those regulatory changes. Past assessments occurred at a time when a significant portion of the watershed was in development, likely 15-percent of the watershed on average at one time. To that end, continued stream assessment is warranted to determine biological indicators of improvement and visual indications of restored stream banks. Should additional water quality sampling, biological surveys, and habitat assessments be completed and used by PADEP in the future due to the anticipated work to be done in the watershed, it is possible for water quality attainment to be achieved and the desired warm water fishery (WWF) indicators to be restored.

Regarding one of the regulatory catalysts for this plan, the EPA regulatory document for the Paxton Creek sediment TMDL identified nonpoint sources, MS4 sources, and a combined sewer overflow (CSO) source, which are all required to reduce base load sediment by varying percentages equaling a 35% percent sediment load reduction for the watershed (Table 5). The purpose of this Joint Plan is to focus on the MS4 and CSO sources, though, due to a previous analysis of acreages associated with those sources, it is anticipated that the load allocations in the regulatory document should be refined based upon updated local mapping and analysis being completed during the development of CRW's LTCP. This Joint Plan focuses on the waste load allocation (WLA) related to MS4 land sources such as agriculture, forest, open space, low intensity development, and high intensity development and the MS4's in-stream erosion WLA. Nonpoint sources are not required to be mitigated by municipalities, and the CSO WLA is included in our plan by way of incorporating the land associated with the CSOs in the planning area.

Functioning as targets, the existing load by land use equates to the sediment loading the model identifies per land use type. The allocated load is the "pollution diet" that those land uses should be held to in order for the watershed to meet water quality goals. So, when the Municipal Entities meet or exceed the 35% sediment reduction goal, they will meet or exceed the allocated load. Table 5 is provided for regulatory reference; the load allocations are recalculated by way of this plan in order to determine a more accurate 35% reduction goal since the model used to develop the regulation is no longer available for use.

Table 5. Paxton Creek TMDL Allocations by Land Use/Source from 2008 EPA TMDL Report

Source	Land Use / Source	Existing Load (lb/yr)	Allocated Load (lb/yr)	Percent Reduction
Nonpoint Sources	Agriculture	4,400	3,800	14%
	Forest	17,600	17,600	0%
	Open Space	40,200	34,000	15%
	Low Intensity Development	26,200	22,200	15%
	High Intensity Development	28,800	24,400	15%
	Instream Erosion	793,400	485,800	39%
	Nonpoint Source Subtotal:	**910,600**	**587,800**	**35%**
MS4	Agriculture	22,000	18,800	15%
	Forest	86,400	86,400	0%
	Open Space	197,200	168,000	15%
	Low Intensity Development	128,600	108,800	15%
	High Intensity Development	141,400	119,600	15%
	Instream Erosion	3,901,000	2,388,800	39%
	MS4 Subtotal:	**4,476,600**	**2,889,600**	**35%**
CSO		29,000	24,600	15%
Permitted Facilities		14,000	14,000	0%
	Total:	**5,430,200**	**3,515,800**	

Note: Existing and allocated loads presented as shown in Table 7-7 Recommended TMDL Allocations for Paxton Creek in the 2008 EPA TMDL Report, converted to lb/year

The EPA regulatory document identifies that the majority of the sediment load in the Paxton Creek watershed eighty-six percent (86%) is derived from in-stream erosion, and it assigns the highest load reduction target to that source.

D.2 Baseline Pollutant Load Calculations

Joint Planning Area

Due to similar sediment reduction goals between municipalities and their impaired watersheds requiring PRPs, a large overall planning boundary was developed that encompassed each of the municipal PRP watersheds, as well as the Paxton Creek TMDL watershed, in order to incorporate all planning objectives into one (1) Joint Planning Area. This approach allows the three (3) participating Municipal Entities to share the burden of the required sediment loads necessary for MS4 permit compliance through a combined effort to implement well planned, cost-effective BMPs in the locations that offer the greatest water quality benefit to both the Paxton Creek and Chesapeake Bay Watersheds. The Joint Planning Area is an expanded planning area that encompasses the urbanized areas within the municipal jurisdictions, including the Paxton Creek watershed, Capital Region Water's CSS area, and the three Municipal Entities' required CBPRP planning areas.

By partnering with neighboring municipalities, each participant will achieve their individual municipal PRP sediment load reduction requirements while allowing proposed BMPs to be implemented in locations that best address the source of the sedimentation occurring throughout the impaired watershed of the combined Joint Planning Area watershed. This approach eliminates the need for municipalities to install BMPs in locations that may not be sources of pollution simply to theoretically satisfy prescribed regulatory load reduction goals. Not only is this integrated approach the most cost effective approach for the municipalities involved to meet their permit requirements, it is the most beneficial to the water quality of the local streams, as well as the Susquehanna River and Chesapeake Bay.

The joint planning area baseline and existing pollutant load calculations were computed using Model My Watershed (MMW), a watershed-modeling web app available through Stroud Water Research Center's WikiWatershed web based toolkit. Model My Watershed is a web-based watershed modeling tool that, in a similar manner to the previously utilized desktop version of the MapShed modeling software, "uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to model sediment and nutrient transport within a watershed[5]." This web application calculates the existing pollutant loading from the Joint Planning Area in terms of pounds per year (lbs/yr) and evaluates existing and proposed BMP-based pollutant reductions using PADEP-approved BMP effectiveness values.

Due to compatibility and stability issues with the now technically unsupported desktop version of MapShed modeling software used in the 2017 Plan, at PADEP's suggestion, MMW version 1.25.0 was used to calculate the baseline pollutant loading in pounds per year for the baseline pollutant load for the larger Joint Planning Area in this 2019 Plan. Like the desktop MapShed software, MMW utilizes the same Generalized Watershed Loading Functions - Enhanced (GWLF-E) model to simulate runoff, sediment, and nutrients (nitrogen and phosphorus) loads from a watershed over a multi-year time period, but is not reliant upon the unsupported MapWindow GIS Package.

An assumption that 20% of the existing streams in both planning areas were adjoined by a forested buffer area, 35-feet in width, was made based on a review of satellite imagery from April 2016 and based upon local knowledge. The existing buffer was incorporated into the MMW model to replicate actual field conditions of the modeled watersheds.

Existing detention basins were not included in the model, as MMW offers no water quality benefit to standard detention basins. Each municipality's baseline pollutant loads for the planning areas were determined using MMW's Urbanized Area tool.

The joint planning area MMW model was calibrated to determine sediment loads for the Joint Planning Area utilizing a Streambank Erosion Adjustment Factor of 0.74 in order to meet a baseload similar to the calibrated 2017 MapShed Model (Table 6). The described modeling approach and parameters were presented to and approved by PADEP's TMDL Section in October 2019, and are further described below.

Table 6. Joint Planning Area Calibration Output Comparison

Source	Joint Planning Area - Annual Sediment Load (lb/yr)		
	GWLF-E Model 2017 Baseline	Uncalibrated 2019 Model My Watershed Baseline	Calibrated 2019 Model My Watershed Baseline
Joint Planning Area Sediment Load	17,335,200	53,841,714	17,507,254

Table 7**Error! Reference source not found.** lists the MMW modeling results for the Joint Planning Area in terms of percentage of watershed land area and baseline sediment load by municipality. Because the municipalities are comprised of varying intensiveness of land uses, the land area does not equate to the sediment load.

[5]Evans, B., & Corradini, K. (n.d.). MapShed Overview Page. Retrieved August 18, 2015, from http://www.mapshed.psu.edu/overview.htm

Table 7. Municipal Baseline Pollutant Loading for the Joint Planning Area

MS4 Permittee	Percentage of Watershed	Baseline Sediment Load (lb/yr)
CRW (City of Harrisburg)	16%	3,667,006
Township of Lower Paxton	57%	9,324,542
Township of Susquehanna	27%	4,141,959
Joint Planning Area Total:	**100%**	**17,507,254***

*Total Baseline Sediment Load based on MMW results for the entire watershed, not the sum of the individual municipalities.
Refer to Appendix D of this report for modeling outputs.

Paxton Creek TMDL and UNT to Spring Creek Planning Areas

Notwithstanding that the Joint Planning Area is the prevailing sediment reduction target area, the subwatersheds with impairments were modeled separately in MMW in order to confirm that local impairment goals are met by focusing projects in the impaired subwatersheds. The original AVGWLF model and associated data sets used by U.S. EPA to develop the 2008 Paxton Creek TMDL were not available for use in the preparation of the this Plan or the 2017 Plan. As such, the process to develop, validate, and apply the model of the Paxton Creek watershed began by developing a new projected baseline, 2008 condition model to simulate average annual sediment loads from land sources (non-point) and instream erosion. A preliminary baseline model of the Paxton Creek watershed was conducted using the default parameters to determine the inconsistency between the results generated using the AVGWLF model of the 2008 TMDL Report and those calculated via the new Model My Watershed modeling application. The initial MMW baseline model for the Paxton Creek watershed yielded a total sediment load much greater than the 2,715.1 tons per year (5,430,200 lb/yr) baseline load cited in EPA's 2008 TMDL Report, whose sediment goals are a regulation influencing the pollutant reduction effort.

Similar to the 2008 Paxton Creek TMDL, the MMW model of the projected 2008 baseline sediment loads was created using the application's data sets without the addition of existing or proposed control measures or BMPs. Due to the significant discrepancy between the two models, the MMW model of the projected 2008 baseline was adjusted to achieve a baseline sediment load consistent with existing annual MS4 loads published in the 2008 TMDL Report. Specifically, the instream erosion sediment load was significantly greater, which can be attributed to differences in the lateral erosion rate calculation or the precipitation, land use, or runoff characteristics used to calculate stream flow between the 2008 AVGWLF model and the latest GWLF-E (MMW) model. The AVGWLF model incorrectly assigned much of the streambank load to agricultural sources (the prevailing assumption at the time), while the GWLF-E (MMW) incorrectly assigns higher bank erosion rates based on urban runoff rather than stream instability when estimating streambank erosion rates on a watershed basis. To account for the discrepancies between the differing models and remove the equivalent contributory load associated with the areas of direct drainage within the Paxton Creek Watershed that do not enter the MS4, the Streambank Erosion Adjustment Factor, was set to 1.05 in order to achieve a baseline sediment of relatively consistent with the 2008 Paxton Creek TMDL baseline and the previously submitted 2017 Joint Plan (Table 8).

Table 8. Paxton Creek TMDL Calibration Output Comparison

Source	Paxton Creek TMDL Watershed - Annual Sediment Load (lb/yr)		
	AVGWLF Model 2008 Baseline*	Uncalibrated 2019 Model My Watershed Baseline	Calibrated 2019 Model My Watershed Baseline
Land-Based Sediment Load	694,400	883,800	326,729
Instream Erosion Sediment Load	4,694,400	13,958,800	3,709,400
CSOs	29,000	Included in land-based and stream erosion sediment load	Included in land-based and stream erosion sediment load
Point Sources	14,000	Not modeled/ N/A	Not modeled/ N/A
Total	**5,430,200**	**14,842,600**	**4,036,129**
*From Table 6-8 of 2008 EPA TMDL Report, converted to lbs/yr			

The Spring Creek Planning Area did not require calibration to match previous modeling as the updated model actually yielded lower results than the 2017 GWLF-E model. A Streambank Erosion Adjustment Factor of 1.5 (default) was used (Table 9).

Table 9. UNT Spring Creek Planning Area Calibration Output Comparison

Source	UNT Spring Creek Watershed - Annual Sediment Load (lb/yr)		
	GWLF-E Model 2017 Baseline	Uncalibrated 2019 Model My Watershed Baseline*	Calibrated 2019 Model My Watershed Baseline*
UNT Spring Creek Sediment Load	85,000	45,137	45,137
*Default streambank erosion adjustment factor was used since the 2017 baseline was not exceeded			

D.3 Existing Pollutant Load Adjustment for Previously Implemented BMPs

Seven (7) existing stormwater quality projects (EX-01 through EX-07) were completed in the Paxton Creek Watershed prior to the completion of this Joint Plan and are being utilized as credit to reduce the baseline sediment loading estimates for the watershed (Table 12). These projects were installed after 2008 and meet the requirements for water quality credit regarding design and ongoing operation and maintenance. An additional existing stream restoration BMP (EX-07) was constructed in 2013 in the Spring Creek Watershed and is being utilized as credit to reduce the baseline loading estimates for the Joint Planning Area. Unfortunately, it is not located within the watershed of the UNT to Spring Creek, which has a local impairment for sediment. Existing BMP locations are provided on BMP Location Maps in Appendix B.

Further, pollutant load reductions associated with CRW's CSS have been included in the existing load calculations. The existing CSS provides pollutant reduction through the capture of approximately 50% of the combined sewage generated within a typical year, completely removing it from discharges to Paxton Creek and the Susquehanna River. The volume captured is conveyed to and treated at CRW's Advanced Wastewater Treatment Facility.

The 2008 Paxton Creek TMDL included the area served by CRW's CSS in the area attributed to CRW's (i.e., City of Harrisburg's) MS4. In this plan, we:

1. Divide the sediment loads attributable to CRW/Harrisburg between those associated with the CSS and the MS4,

2. Account for load reductions attributable to the current operation of CRW's CSS, which captures approximately 50% of the combined sewage volume (which is predominantly composed of stormwater) generated within the CSS during a typical year for treatment at CRW's AWTF, and

3. Account for future load reductions attributable to near-term enhancements to operation of CRW's CSS, which are projected to capture an additional 30% of the combined sewage volume generated within the CSS during a typical year for treatment at CRW's AWTF.

Long-term CSO control is required under CRW's Partial Consent Decree (PCD) with DEP and EPA. Estimates of stormwater volumes/loads within the CSS were informed by hydrologic and hydraulic modeling conducted with the US EPA Stormwater Management Model (SWMM) Version 5. CSS loads/load reductions were projected according to the methodology presented in the Paxton Creek Watershed TMDL Strategy (dated December 31, 2015), which was reviewed and discussed with DEP prior to preparation of the 2017 Joint PRP and 2019 revision.

In-stream erosion sediment load attributable to the CSS is defined as the share of the total streambank erosion sediment load from the TMDL and/or Model My Watershed calculations proportionate to the CSS area/land use characteristics (Exhibit 2). Table 3-4 and Appendix A.10 (page A-25) from the TMDL Strategy projected an estimated in-stream erosion reduction from a reduction in CSS volume captured. This value along with the estimated runoff volume from this Model My Watershed model projected an erosion rate reduction per unit volume (i.e. pounds of sediment reduced per million gallons of runoff volume reduced). This erosion reduction rate was then applied to the estimated combined sewer overflow volume reduction under a City Beautiful H2O Program Plan[6] (CBH2OPP) scenario to project an estimate of sediment load reduction from instream erosion. This value was then subtracted from the estimated streambank load estimates from the Model My Watershed results. Separate calculations were prepared for the Paxton Creek TMDL and Susquehanna Chesapeake Bay Pollutant Reduction Plan load reduction estimates.

Exhibit 2. In-stream Sediment Load Reduction Equation

Joint PRP In-Stream Sediment Load Attributed to CRW CSS

$$SBS_{CSS} = SBS_{CRW\text{-}TOT} - CSS_{VOL} * SBS_{Rate}$$

where:

SBS_{CSS} = Reduction In-Stream Sediment Load from CSS operation (lb)

$SBS_{CRW\text{-}TOT}$ = Total In-Stream Sediment Load attributed to CRW/Harrisburg (lb)

CSS_{VOL} = Estimated Volume Captured by Existing CRW CSS Operation (gal)

SBS_{Rate} = In-stream erosion rate (lb / gal), from 2015 Paxton Creek TMDL Strategy

Land-based runoff sediment load: To estimate the sediment load reduction from changes in land-based runoff, the iteration of available Model My Watershed model results prepared for the 2017 Joint PRP was utilized to estimate a land-based sediment load per unit volume (pounds of sediment reduced per million gallons of runoff volume reduced) for the entire CRW drainage area. The estimates of runoff and sediment provided by the Model My Watershed results were then apportioned by drainage area type and area (MS4, CSS, direct discharge) to estimate the land-based sediment load associated with CSS (

[6] https://capitalregionwater.com/cbh2o/

Exhibit 3). The estimates of sediment load were then reduced by the same portion as CSO volume reductions (i.e., 10% reduction in CSO volume equals 10% reduction in CSO sediment load). CSO volume estimates were provided by an estimate of CSO volumes projected by the current (at the time of plan preparation) CRW hydrologic and hydraulic model simulation, to account for a more calibrated model of the CSO system versus Model My Watershed, to estimate current and projected future runoff volumes for CSO system improvements. Separate calculations were prepared for the Paxton Creek TMDL and Susquehanna Chesapeake Bay Pollutant Reduction Plan load reduction estimates.

Exhibit 3. Land-Based Sediment Load Reduction Equation.

2017 PRP Land-Based Runoff Sediment Load from CSS changes calculation method

$LBS_{CSS} = LBS_{CRW\text{-}TOT} * A_{CSS} / A_{CRW\text{-}TOT} – LBS_{CRW\text{-}TOT} / CSS_{VOL} * CSO_{VOL}$

where:

LBS_{CSS} = Reductions in Land-Based Sediment Load from existing CSS operations (lb)

$LBS_{CRW\text{-}TOT}$ = Total Land-Based Sediment Load from CRW Harrisburg (lb)

A_{CSS} = Area draining to the CRW CSS (acres)

$A_{CRW\text{-}TOT}$ = Total Area in CRW/Harrisburg (acres)

$LBS_{CRW\text{-}TOT}$ =Total Land-Based Sediment Load from CRW/Harrisburg (lbs)

CSS_{VOL} = Runoff volume from CSS area (gal)

CSO_{VOL} = CSO volume from existing CSS operation (gal)

Table 10 provides estimates of sediment load reduction provided by the CSS discharging to Paxton Creek. It includes the corrected sediment load attributable to the CRW/City of Harrisburg sediment load as applicable to the TMDL. Table 11 provides estimates of sediment load reductions provided by the combined sewer system attributable to the Joint Planning Area (including those attributable to Paxton Creek in Table 10). For streambank erosion sediment load reductions, this was based on an analysis using PADEP's MapShed simulation completed as part of the 2015 TMDL Strategy. The method assumed potential LTCP-related discharge reductions by removing the CSS drainage area and the resulting reductions in streambank erosion were related to a reduction in discharge volume. Further detail can be reviewed in the 2015 TMDL Strategy – Appendix A, Section A.10. For land based and point source reductions of sediment load, this was based on the reduction in discharge volume (i.e., reducing combined sewer overflow volume reduces sediment load by the same proportion).

Table 10. Summary of CRW/City of Harrisburg Paxton Creek Corrected Sediment Loads from the Combined Sewer System

Scenario	Land-Based Sediment Load (ton/yr)	Streambank Erosion Sediment Load (ton/yr)	Total CSS Sediment Load (ton/yr)	Total CSS Sediment Load (lb/yr)	Reduction from Existing
Sediment Load Reported in 2008 TMDL	18	364	382	764,000	---
Corrected Sediment Load from Existing Combined Sewer System	16	332	348	696,000	5%

Modeling results indicate that the existing CSS operation has resulted in a 32-ton load reduction attributed to the Paxton Creek Watershed for the TMDL, which equates to a 6,000 pound reduction. This reduction is credited as existing BMP CSS-01.

Table 11. Summary of CRW/City of Harrisburg Sediment Loads from the Combined Sewer System Attributable to the Joint Planning Area

Scenario	Land-Based Sediment Load (ton/yr)	Streambank Erosion Sediment Load (ton/yr)	Total CSS Sediment Load (ton/yr)	Total CSS Sediment Load (lb/yr)	Reduction from Existing
Sediment Load Reported in 2008 TMDL	51	1,547	1,598	3,197,000	---
Corrected Sediment Load from Existing Combined Sewer System	41	1,516	1,557	3,113,000	2%

Modeling results indicate that the existing CSS operation has already resulted in a 41-ton load reduction attributed to the Joint Planning Area, which equates to an 85,000-pound reduction, 17,000 pounds more than the Paxton Creek Watershed TMDL sediment load reduction. The existing BMP sediment load reduction values for CRW's CSS operation are indicated as project CSS-01 (68,000 lb) and CSS-02 (17,000 lb) in Table 12.

Table 12. Installed BMPs.

Map Reference	BMP Name	Planning Area Credit	Sediment Load Reduction (lbs/yr)*
EX-01	Paxton Church / Reichert Rd. Rain Garden and Stream Restoration (240 ft.)	Joint Planning Area / Paxton Creek TMDL	40,012
EX-02	Fox Hunt Rd. Stream Restoration (375 ft.)	Joint Planning Area / Paxton Creek TMDL	43,125
EX-03	UNT to Asylum Run Retention Basin and Stream Restoration (350 ft.)	Joint Planning Area / Paxton Creek TMDL	72,025
EX-04	Elmerton Ave. Bio-retention Basin	Joint Planning Area / Paxton Creek TMDL	17,191
EX-05	Black Run Stream Restoration (800 ft.)	Joint Planning Area / Paxton Creek TMDL	92,000
EX-06	Asylum Run Bio-retention and Stream Restoration (400 ft.)	Joint Planning Area / Paxton Creek TMDL	73,617
EX-07	Dowhower Rd Buffer and Stream Restoration (1,220 ft.)	Joint Planning Area	140,300
CSS-01	CRW Combined Sewer System Sediment Capture Performance to Paxton Creek Watershed Allowance	Joint Planning Area / Paxton Creek TMDL	68,000
CSS-02	CRW Combined Sewer System Sediment Capture Performance to Susquehanna River Allowance	Joint Planning Area	17,000
		Total Existing BMP Sediment Load Reduction:	**563,270**

*BMP reduction values derived using Joint Planning Area Model My Watershed parameters

The existing sediment loading for each planning area adjusted down for the installed existing BMPs listed in Table 12 is shown on Paxton Creek **Baseline Sediment Load by Municipality –** Municipal baseline sediment load values compared to percentage of land area within the Paxton Creek Watershed.

MS4 Permittee	Percentage of Paxton Creek TMDL Planning Land Area	Baseline Sediment Load (lbs/year)
CRW (City of Harrisburg)	19.5%	990,680
Township of Lower Paxton	43.1%	1,595,261
Susquehanna Township	37.4%	1,456,454
Paxton Creek TMDL Planning Area Total:	**100%**	**4,036,129***
*Total Baseline Sediment Load based on MMW model results for the entire watershed, not the sum of the individual municipalities.		

Paxton Creek Watershed Planning Area Baseline Sediment Load = 4,036,129 lbs/yr

Existing BMP Sediment Load Reduction for the Paxton Creek TMDL Watershed =

40,012 lbs + 43,125 lbs + 72,025 lbs + 17,191 lbs + 92,000 lbs + 73,617 lbs + 68,000 lbs **= 405,970 lbs**

Municipal Entities' Paxton Creek TMDL Planning Area Existing Sediment Load

Adjusted Existing Sediment Load = Baseline Sediment Load – Existing BMP Sediment Load Reduction

Adjusted Existing Sediment Load = 4,036,129 lbs – 405,970 lbs = **3,630,159 lbs**

and is calculated out on the following pages. Simply, the existing sediment baseline loads for each planning area were determined by subtracting the existing BMP sediment load reduction from the respective planning area's baseline sediment load.

Paxton Creek Baseline Sediment Load by Municipality – Municipal baseline sediment load values compared to percentage of land area within the Paxton Creek Watershed.

MS4 Permittee	Percentage of Paxton Creek TMDL Planning Land Area	Baseline Sediment Load (lbs/year)
CRW (City of Harrisburg)	19.5%	990,680
Township of Lower Paxton	43.1%	1,595,261
Susquehanna Township	37.4%	1,456,454
Paxton Creek TMDL Planning Area Total:	**100%**	**4,036,129***
*Total Baseline Sediment Load based on MMW model results for the entire watershed, not the sum of the individual municipalities.		

Paxton Creek Watershed Planning Area Baseline Sediment Load = 4,036,129 lbs/yr

Existing BMP Sediment Load Reduction for the Paxton Creek TMDL Watershed =

40,012 lbs + 43,125 lbs + 72,025 lbs + 17,191 lbs + 92,000 lbs + 73,617 lbs + 68,000 lbs **= 405,970 lbs**

Municipal Entities' Paxton Creek TMDL Planning Area Existing Sediment Load

Adjusted Existing Sediment Load = Baseline Sediment Load – Existing BMP Sediment Load Reduction

Adjusted Existing Sediment Load = 4,036,129 lbs – 405,970 lbs = **3,630,159 lbs**

Joint Planning Area Baseline Sediment Load by Municipality – Municipal baseline sediment load values compared to percentage of land area within the Joint Planning Area Watershed.

MS4 Permittee	Percentage of Joint Planning Area	Baseline Sediment Load (lbs/yr)
CRW (City of Harrisburg)	16.0%	3,667,006
Township of Lower Paxton	57.0 %	9,324,542
Township of Susquehanna	27.0%	4,141,959
Joint Planning Area Total:	**100%**	**17,507,254***

*Total Baseline Sediment Load based on model results for the entire watershed, not the sum of the individual municipalities.

Municipal Entities' Joint Planning Area Baseline Sediment Load = 17,507,254 lbs/yr

Existing BMP Sediment Load Reduction for the Joint Permit Area =

40,012 lbs + 43,125 lbs + 72,025 lbs + 17,191 lbs + 92,000 lbs + 73,617 lbs + 140,300 lbs + 68,000 lbs + 17,000 lbs **= 563,270 lbs**

Municipal Entities' Paxton Creek TMDL Planning Area Existing Sediment Load

Adjusted Existing Sediment Load = Baseline Sediment Load – Existing BMP Sediment Load Reduction

Adjusted Existing Sediment Load = 17,507,254 lbs – 563,270 lbs = **16,943,984 lbs**

Table 13. Existing Sediment Loading by Planning Area, Adjusted for Existing BMPs (Model My Watershed Model Summary)

Planning Area	Drainage Area (acres)	Adjusted Existing Sediment Load (lbs/yr)
Paxton Creek TMDL Watershed	17,053	3,630,159
Joint Planning Area Watershed	34,829	16,943,984

SECTION E: WASTELOAD ALLOCATION(S) (WLAs)

On June 30, 2008, EPA established nutrient and sediment TMDLs for the Paxton Creek Watershed. In a letter dated August 15, 2013, EPA withdrew the nutrient TMDL based on Pennsylvania's 2012 Integrated Report that revised the impairment status of Paxton Creek. The sediment TMDL remains and assigns a sediment (total suspended solids) waste load allocation (WLA) to each MS4 in the Paxton Creek Watershed. In order for each Municipal Entity to meet their respective WLA, each Municipal Entity is required to complete a 35% reduction of the total existing sediment load (Table 14).

Table 14. Paxton Creek Watershed - Waste Load Allocations (WLAs) and Required Reductions*.

MS4 Permittee	Baseline Sediment Load (lb/yr)	Approved Sediment WLA (lb/yr)	Percent Reduction Required
CRW (City of Harrisburg)	803,000	518,200	35%
Lower Paxton Township	1,660,800	1,072,000	35%
Middle Paxton Township	400	200	35%
Penbrook Borough	48,800	31,600	35%
Susquehanna Township	1,949,200	1,258,200	35%
Swatara Township	14,400	9,400	35%
Paxton Creek Watershed Total:	**4,476,600**	**2,889,600**	**35%**

* Note: WLAs provided in EPA regulatory document, Table 7-4, Paxton Creek MS4 Wasteload Allocation by Municipalities from the August 28, 2013 errata document issued by EPA, converted to lb/yr.

Further, a WLA is provided in the EPA regulatory document for the CSO in the Paxton Creek Watershed. Since that area is included in the overall Joint Planning Area and the original CSO WLA calculation has not been able to be replicated, it is anticipated that sediment load reductions achieved through implementation of Capital Regional Water's Community Greening Plan (April 2017), which establishes guidance for green infrastructure for stormwater maintenance activities to remove accumulated sediment from CRW's combined sewer system, will be attributable to the Joint Planning Area sediment reduction goals. Additionally, implementation of CRW's Long Term Control Plan as well as operational changes related to CSO regulators, pumping stations, and/or the Advanced Wastewater Treatment Facility in accordance with CRW's CSO Nine Minimum Control Plan will all result in significant sediment load reductions attributable to the Joint Planning Area sediment reduction goals. Simply, it is anticipated that work completed to comply with CSOs will count toward the Municipal Entities' water quality goals.

For the purpose of this Joint Plan and in order to be able to implement the plan based on the latest available model, the EPA WLAs were re-modeled according to the 35% reduction requirement. So, the WLAs will be met when the modern model (Model My Watershed) yields a 35% reduction of the modeled baseline rather than the approach of calculating reductions using incompatible methods in order to meet the 2008 WLA lb/yr goal.

SECTION F: ANALYSIS OF TMDL OBJECTIVES

F.1 Long-Term TMDL Sediment Load Reduction

The Municipal Entities intend to achieve the required long-term 35% sediment load reduction goal prescribed by the EPA's Paxton Creek Watershed TMDL Report during the upcoming five-year MS4 permit term. Because other pollutant reduction goals overlap, and projects can be focused within the area of greatest impairment (the Paxton Creek Watershed), the Municipal Entities intend to accomplish this through the construction of BMPs necessary to achieve the larger Appendix D CBPRP 10% sediment load reduction (Table 16) for the Joint Planning Area during the upcoming five (5) year permit term. It is more cost-effective to focus the efforts on the Paxton Creek to fulfill the objectives of the long-term TMDL goal and the short-term (five-year) Chesapeake Bay PRP goal.

Table 15. Long-Term Pollutant Load Reduction for the Paxton Creek Watershed Planning Area

Watershed	Impairment	Existing Pollutant Load (lb/yr)	Percent Reduction Required	Long-Term Load Reduction Goal (lb/yr)
Paxton Creek TMDL	Sediment / Siltation	3,630,159	35%	**1,270,906**

F.2 Short-Term TMDL Sediment Load Reduction

The minimum 10% short-term sediment load reduction required for the Paxton Creek TMDL Watershed will be accomplished upon completion of a portion of BMPs proposed herein. BMPs proposed in this Joint Plan have been located throughout the Paxton Creek Watershed in order to achieve the entire required sediment load reduction in both the TMDL (Table 15 and Table 16) and Chesapeake Bay planning areas (Table 17), as well as the two (2) impaired Appendix E, PRP watersheds (Table 18). Short-term sediment load reduction requirements have been quantified for the TMDL Planning Area (Table 15).

Table 16. Short-Term Pollutant Load Reduction for the Paxton Creek Watershed

Watershed	Impairment	Existing Pollutant Load (lb/yr)	Percent Reduction Required	Short-Term Load Reduction Goal (lb/yr)
Paxton Creek TMDL	Sediment / Siltation	3,630,159	10%	**363,016**

F.3 CBPRP (Joint Planning Area) Sediment Load Reduction Goal

Utilizing the "Presumptive Approach," as described in PADEP's PRP Instructions,[7] the Municipal Entities intend to achieve the required 10% Appendix-D, CBPRP sediment load reduction goal through construction, operation and maintenance of the sediment load reducing BMPs proposed in this Joint Plan. The pollutants of concern for the Appendix D, CBPRP are total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN) with required loading reductions of 10%, 5%, and 3%, respectively. However, it is presumed that within the Joint Planning Area watershed, the TP and TN goals will be achieved when a 10% reduction in

[7] PADEP, Document 3800-PM-BCW0100k, Rev. 3/2017

sediment is achieved[8]. Therefore, only the required 10% sediment load reduction goal is calculated herein as a requirement for the Appendix D CBPRP (Table 17).

Table 17. Appendix D, CBPRP Sediment Load Reduction

Watershed	Impairment	Existing Pollutant Load (lb/yr)	Percent Reduction Required	Pollutant Reduction Goal (lb/yr)
Joint Planning Area	Sediment / Siltation	16,943,984	10%	**1,694,398**

F.4 Appendix-E Sediment Load Reduction Goal

Two (2) watersheds within the Joint Planning Area have water quality impairments required to be addressed as a result of regulation through PAG-13 General Permit, Appendix-E (nutrients and/or sediment in stormwater discharges to impaired waterways), which is anticipated to be the basis of the Individual Permits for which the Municipal Entities are required to apply. Appendix-E impairments for siltation require a minimum 10% sediment reduction within the impaired water planning area. Refer back to Exhibit 1 for a graphic representation of the overlapping sediment load reduction goals across the Joint Planning Area.

Since the 19-square mile Wildwood Lake Watershed lies completely within the larger Joint Planning Area, the required Appendix-E sediment reductions will be accomplished implicitly through implementation of this Joint Plan. The majority of the tributary improvements proposed herein address upstream erosion and sedimentation that will provide benefit to Wildwood Lake.

The 0.5-square mile watershed to the impaired UNT to Spring Creek also is located within the larger Joint Planning Area. The required Appendix-E sediment reductions will be accomplished through implementation of this Joint Plan, and BMPs targeting that watershed have been identified. Pollutant loading and the associated sediment reduction goals are a subset of the overall Joint Planning Area reduction goal (Table 18).

Table 18. Appendix E, Sediment Load Reduction for Impaired Streams

Watershed	Impairment	Existing Pollutant Load (lb/yr)	Percent Reduction Required	Pollutant Reduction Goal (lb/yr)
Wildwood Lake	Sediment / Siltation	2,825,290*	10%	**282,529**
UNT to Spring Creek	Sediment / Siltation	45,137	10%	**4,514**
*70% of the baseline sediment load for the Paxton Creek Watershed, based on drainage area				

[8] PADEP - PRP Instructions, Document # 3800-PM-BCW0100k, Rev. 3/2017

SECTION G: SELECT BMPS TO ACHIEVE THE MINIMUM REQUIRED REDUCTIONS

G.1 Paxton Creek TMDL Watershed Sediment Load Reductions

G.1 Stream Assessment and Field Investigations

Detailed stream assessments and storm sewer system investigations were conducted during development of the Paxton Creek Watershed TMDL Strategy in 2015, and additional field assessments were carried out in spring 2017 in support of the development of this Joint Plan. The Unified Stream Assessment (USA) methodology was utilized in an effort to establish a baseline valuation of stream quality as it relates to the potential for erosion and sedimentation within the watershed, in line with the targeted stream assessment completed in 2015. A detailed description of the methodological approach can be referenced in Section 5 of the 2015 TMDL Strategy.

The results of the Model My Watershed modeling calculations, coupled with the findings of the extensive field work effort, helped to identify streambank erosion as the primary source of sediment generated within the urbanized portion of the Joint Planning Area. For this reason, coupled with the greater sediment reduction efficiency value of 115 lbs/ft approved by PADEP during the two year gap between when the Paxton Creek TMDL Strategy was developed and the creation of the 2017 Joint Pollutant Reduction Plan, targeting the contributory factors of streambank erosion by means of floodplain restoration, bank stabilization and riparian buffer establishment along streams provides the greatest sediment load reductions on a per project and per cost basis. The use of the 115 lbs/ft sediment reduction efficiency value, which will need to be verified on a project by project basis during plan implementation based on the prevailing DEP guidance of the time, reduced the length of stream work necessary to meet the reduction requirements identified in the Paxton Creek TMDL Strategy. Additionally, runoff capture via combined sewer system upgrades and installations of proposed green infrastructure projects associated with CRW's LTCP and Community Greening Plan will greatly reduce erosive conditions in the Lower Paxton Creek watershed and improve water quality in the Susquehanna River and Chesapeake Bay.

Upon recognizing streambank stabilization as the most advantageous BMP approach, stream reaches with severe degradation within the Paxton Creek Watershed, as identified in 2015 during the Initial Stream Assessment outlined in Section 5 of the TMDL Strategy, and additional reaches within the impaired UNT to Spring Creek Watershed identified during the 2017 site selection effort, were chosen as a pool of Potential BMP Candidates from which to establish Final BMP Selections that achieve the minimum required reductions.

In addition to the severity of stream bank degradation and potential for sediment load reduction through BMP implementation, there were several other factors which influenced the selection of the final BMP sites. Constructability issues (site constraints, accessibility, staging and stockpiling needs) and project costs, outlined in detail herein, were important considerations, as were specific recommendations from the Municipal Entities. Candidate project sites demonstrating threats to buildings and/or infrastructure, such as exposed utilities due to severe stream erosion, were given priority when choosing final projects to include in the Joint Plan as they stand to provide the greatest benefit to the Municipal Entities and their constituents. Further, as individual goals for Paxton Creek and UNT to Spring Creek were better understood, projects were prioritized accordingly.

One such site was an existing basin located along Walker Mill Road in Susquehanna Township. It was a strong candidate because it is a municipally owned standard detention basin that could easily be retrofitted to provide additional water quality benefits and sediment reductions. In addition, the outlet structure was failing and needed repaired. This basin is located just upstream of a degraded stream reach of Paxton Creek.

During the Initial Stream Assessment for the TMDL Strategy, the impaired individual stream reaches were identified in the report as numbered Stream Segments (e.g. SS-1, SS-2, etc.). Since the TMDL Strategy served as the basis for this Joint Plan, and in an effort to maintain uniformity throughout the BMP selection process, this nomenclature was maintained in the Joint Plan. The expanded set of Stream Segments that make up the Potential BMP Candidates considered during BMP selection, as well as the Final BMP Selections, including the Walker Mill Road Basin BMP are presented on the BMP Prototype Key Map included in Appendix F.

It is important to note that the proposed concept designs outlined in this report were developed for modeling purposes intended to demonstrate the potential for required sediment load reductions to be achieved during detailed restoration design outside of the scope of this plan. The final BMP selections are subject to change during detailed construction design and permitting efforts or based upon changes or other unforeseen circumstances related to the evaluation criteria. For this reason, the BMP Prototype Key Map, and the Detailed Concept Cost Opinions and Prototype Cost Estimates presented in detail in this report to function as planning tools to be utilized to efficiently and effectively identify quality alternative BMPs in the event one of the project sites becomes ineligible for any of the reasons outlined above.

G.1.2 Concept Site Selection

Based upon the findings of the field assessments, four (4) reaches within the assessment area were selected to serve as prototypical representations of the various stream reaches present throughout the Joint Planning Area. The initial concept sites included 1,070 LF of Black Run immediately downstream of Shutt Mill Park; 1,430 LF of Asylum Run through the Stonebridge Apartments originating from an outfall below Colonial Road across from the Colonial Park Mall; 840 LF of an unnamed tributary to Asylum Run at Veteran's Park; and 710 LF of Paxton Creek through the Harrisburg Area Community College (HACC) campus. Detailed surveys and existing conditions analyses were conducted at the four (4) concept sites to provide thorough insight into stream characteristics throughout the Joint Planning Area. During the detailed existing conditions investigation, the HACC Campus site was eliminated from consideration for Streambank Stabilization efforts based upon the limited potential for sediment load reduction to be achieved from BMP implementation outlined in detail in the modeling discussion.

G.1.3 Existing Conditions Hydraulic Modeling

The existing conditions of the concept sites – excluding the HACC Campus Site – and the vast majority of the assessment reaches exhibit obvious signs of horizontal and vertical degradation directly related to unstable channel dimensions and disassociation with the active floodplain. The incised channel conditions prevent high flows from accessing the floodplain resulting in high flow velocities and excessive shear stresses within the channel during even mild runoff events, and, in turn, significant channel and bank erosion. Hydraulic models of the existing site conditions were developed using the United States Army Corps of Engineers HEC-RAS version 5.0.3 two-dimensional (2D) model. Site survey and hydrology data were utilized along with LiDAR contours from the DCNR's PAMAP program provided the basis for the model.

The HEC-RAS model was run using the 100-yr flow rate from the Paxton Creek Act 167 hydrology model for each site. While each of the existing conditions concept models, excluding the HACC Campus site, demonstrate erosive potential resulting from even the 1- and 2-yr flow events, utilizing the 100-yr flow rate provides a conservative condition to ensure proposed concept designs are capable of withstanding extreme flow conditions. Designing the proposed concept sites to withstand a lesser flow condition leaves the potential for the sites to degrade and fail in more severe conditions, eliminating any limited benefit that may have been derived from preventing erosion during lesser events.

The 2D model provided hydraulic conditions, specifically shear stress results, used to analyze the potential for channel and bank erosion in the existing geometry and flow conditions. The shear stress results of the existing conditions modeling, as well as the proposed concept modeling discussed subsequently in this report, are presented on sheets 4, 6, and 8 of 9 in the accompanying figures in Appendix F.

Black Run Site (SS-03) - Existing Conditions

At the upstream portion of the Black Run site, the stream sits against a steep valley wall on the right bank with four to five foot tall eroded banks along private lawns on the left bank. The stream cuts across the valley approximately 600-feet downstream of Shutt Mill Park becoming pinned against the steep left valley wall with vertical bank heights of three- to four-feet on the right bank for the remainder of the reach. The existing conditions model at the Black Run site exhibits significant shear stresses upwards of three-pounds per foot in the existing channel for the majority of the assessment reach, with the highest shear stresses nearing five-pounds per foot where the channel transitions across the valley.

Stonebridge Apartments Site (SS-14) - Existing Conditions

The Stonebridge Apartments existing conditions model demonstrates erosive conditions for the majority of the site with shear stresses in excess of three-pounds per foot and over six-pounds per foot in some locations. The most significant shear stresses occur in the upstream portion of the reach at the outfall beneath Colonial Road, at sharp meanders in the existing channel, and at encroachments in the form of pedestrian footbridges. The downstream-most 200-feet of the site are protected during high flows by a backwater condition created by the culvert crossing at North Arlington Avenue.

Veteran's Park Site (SS-18) - Existing Conditions

The existing reach at Veteran's Park is characterized by its steep valley slope and highly eroded channel with vertical bank heights in excess of six-feet. The 2D model reveals shear stresses greater than eight-pounds per foot throughout the reach during the 100-year flow event. It is also worth noting that the highly channelized system prevents even the 100-year event from escaping the channel and accessing the floodplain.

HACC Campus Site (SS-20) - Existing Conditions

The HACC Campus reach, along with the majority of Paxton Creek downstream of Wildwood Lake, differs from the rest of the watershed in that the site exhibits relatively stable banks and significant sediment deposition. The existing conditions indicate that the reach is not the most beneficial location to focus restoration efforts. This was corroborated through the 2D modeling results. Low slopes and frequent crossings result in backwater conditions through this reach, which tends to protect the bed and banks from scour. The dam at Wildwood Lake also serves to mitigate the peak flow during rainfall events, limiting the impact downstream of the lake. While dredging efforts within Paxton Creek downstream of the Wildwood Lake dam and behind the dam itself may provide ecological uplift outside of the scope of this project, the 2D model yielded shear stress results of less than two pounds per square foot through the reach during the 100-year flow event, indicating very little likelihood of stream bank erosion in the existing condition. For this reason, the HACC Campus site was removed from consideration as a concept prototype. That being said, structural failures causing localized erosion or infrastructure degradation may exist in this reach that may warrant additional consideration for restoration.

G.1.4 Proposed Restoration Concept and Hydraulic Analysis

Conceptual restoration design approaches were developed for each of the three (3) viable restoration sites with the intent of minimizing erosion potential, creating stable stream banks, and demonstrating a site concept that may be applied at the prototype locations throughout the Joint Planning area to achieve minimum required reductions. The concept grading for the three (3) sites were developed using the 2D model to refine the design over multiple iterations in order to optimize results. The shear stress results of the final proposed concept designs are presented in Appendix G alongside the existing conditions results for comparison. The shear stress results serve to demonstrate the feasibility of the concept restoration approaches to reduce erosion rates. Conceptual Renderings are provided along with comparisons of the existing and proposed shear stress results from the hydraulic analysis in Appendix F.

The proposed restoration concepts provide low-energy stream channel systems with good floodplain connectivity and stable epifaunal substrate. The concept grading allows increased flows to access the entire floodplain, allocating energy uniformly throughout the site and eliminating points of concentrated high shear stresses. This distribution of shear stress across the floodplain not only reduces erosion rates for the extent of the site, but also provides the potential for sediment entering the site from upstream to deposit on the restored floodplain, reducing the amount of sediment passing through the site and continuing downstream.

Black Run Site (SS-03) – Floodplain Restoration Concept – Proposed Conditions

The Floodplain Restoration Concept design includes significant floodplain cutting to reduce the bank heights below one-foot, providing floodplain connectivity during high flow events. The 2D model demonstrates successful mitigation of the high shear stresses present in the existing condition as the concept grading results in shear stresses under 1.5-pounds per foot for the majority of the site. Higher shears near 3-pounds per foot at the up and downstream tie-ins are expected as flow transitions between the restored concept site and the constricted existing condition.

Stonebridge Apartments Site (SS-14) – Constrained Corridor Concept – Proposed Conditions

The 20-feet wide floodplain proposed at the Constrained Corridor Concept results in shear stresses reduced from near 6-pounds per foot in the existing condition to less than 2.5-pounds per foot in the proposed condition. The grading extents are limited by apartment buildings, pedestrian bridges and onsite utilities. These constrictions may require armoring in addition to that required at the upstream tie-in. The downstream tie-in remains protected during high flows by a backwater condition created by the culvert crossing at North Arlington Avenue.

Veteran's Park Site (SS-18) – Steep Slope Concept – Proposed Conditions

The Steep Slope Concept requires filling the existing channel to achieve a widened, stable floodplain. The concept yields improved shear stress results – less than 2.5-pounds per foot for the majority of the reach. These stresses increase over 6-pounds per foot at the bottom portion of the site as the slope must increase and floodplain width decrease in order to tie-in to the existing main stem. A step-pool channel system through this portion is proposed to effectively mitigate the erosion potential posed by high shear stresses.

Comparison of the existing and proposed concept shear stress figures demonstrates a reduction of the most severe shear stresses, with stresses distributed uniformly across the concept sites, avoiding excessive shears at any one location and reducing the potential for erosion. The 2D modeling provides justification that the concept designs may be applied throughout the Joint Planning Area prototypes to achieve target sediment load reductions.

G.1.5 Prototype Development and Application

The concept designs described above were applied to the remaining assessment reaches based upon criteria outlined below. The prototype assignments are presented on the BMP Prototype Key Map (Appendix F) and in Table 19.

The Floodplain Restoration Concept {Black Run Prototype} sites consist of 2nd and 3rd order perennial streams generally characterized by valley slopes less than 3.5%, 100-year peak flows over 1,200 cubic feet per second (cfs), and drainage areas greater than one-square mile. The site locations contain relatively few buildings of structures likely to impact restoration efforts. The restoration approach consists of significant floodplain cutting to achieve stable channel depths and valley slopes and widths. Structural armoring is minimal and generally limited to upstream and downstream tie-ins.

The sites that fall under the Constrained Corridor Concept {Stonebridge Apartment Prototype} consist of intermittent or perennial 1st and 2nd order streams generally characterized by valley slopes less than 3.5%, 100-year peak flows less than 1,200 cfs, and drainage areas less than one-square mile. Restoration efforts likely require less cut than the Black Run Prototype sites and may be limited to some extent by adjacent buildings or structures. The restoration approach requires cutting to achieve stable channel depths and valley slopes and widths. Structural armoring may be required where site constraints exist in addition to upstream and downstream tie-ins.

Steep Slope Concept {Veteran's Park Prototype} sites consist of 1st or small 2nd order streams generally characterized by valley slopes greater than 3.5% and drainage areas less than one-square mile. The restoration approach requires significant fill in the existing channel to achieve stable valley widths. The approach requires extensive structural armoring due to steep slopes with heavily armored step-pool systems utilized in some instances.

Table 19, below, provides the Prototype assigned to each assessment stream segment. The total breakdown shows eight (8) Floodplain Restoration sites, ten (10) Constrained Corridor sites, and four (4) Steep Slope sites. Stream Segment SS-20 was represented by the HACC Campus concept site which was eliminated from consideration as previously discussed.

Table 19. Prototype Application to Assessment Stream Segments

Assessment Stream Segment	Prototype	Length (LF)
SS-01	Constrained Corridor	2,262
SS-02	Constrained Corridor	6,838
SS-03*	Floodplain Restoration	8,195
SS-04	Floodplain Restoration	594
SS-05	Constrained Corridor	2,769
SS-06	Floodplain Restoration	2,794
SS-07	Constrained Corridor	4,270
SS-08	Constrained Corridor	2,703
SS-09	Floodplain Restoration	9,110
SS-10	Floodplain Restoration	2,090
SS-11	Constrained Corridor	2,312
SS-12	Constrained Corridor	1,110
SS-13	Constrained Corridor	11,219
SS-14*	Constrained Corridor	4,834
SS-15	Constrained Corridor	2,162
SS-16	Steep Slope	4,789
SS-17	Steep Slope	1,060
SS-18*	Steep Slope	2,761
SS-19	Floodplain Restoration	5,954
SS-20	Downstream of Wildwood Lake – eliminated from consideration	
SS-21	Steep Slope	1,879
SS-22	Floodplain Restoration	3,866
SS-23	Floodplain Restoration	1,786
An asterisk (*) denotes a concept site along all or part of the assessment reach		

The prototypes are intended to serve as a planning tool to map potential restoration efforts that may be applied to degraded reaches throughout the watershed in order to achieve sediment load reduction targets outlined in this Joint Plan. During plan implementation, detailed site design efforts may reveal unforeseen circumstances which may impact final BMP site location. Should some of these sites prove to be more successful than others, the project list may be revised to target optimal site locations in order to provide the most cost-effective BMPs with the highest likelihood for success.

G.2 BMP Selection Process

The results of the existing conditions Model My Watershed model demonstrate that the majority of the sediment load generated within the urbanized area of the Joint Planning Area originates from streambank erosion. As such, project locations identified herein for improvement are based on the ability to implement streambank stabilization and riparian buffer restoration BMPs, rather than land-based BMPs, such as bio-retention or infiltration BMPs. BMP locations came as a result of the aforementioned stream assessment conducted in 2015 and 2017, and from recommendations by municipal staff. Candidate project sites demonstrating threats to buildings and/or infrastructure, such as exposed utilities due to severe stream erosion, were given priority when choosing final projects to include in the Joint Plan. The remaining sites were evaluated and chosen based upon which sites offered the greatest potential for sediment load reduction in locations that offered accessibility and promising community support. BMP Location Maps are included in Appendix B.

The Final BMP Site selections outlined in this Plan were determined based upon careful scrutiny of the field assessment findings and the concept analysis efforts while building upon the findings of the TMDL Strategy and taking into special consideration the needs of the Municipal Entities regarding which projects provide the greatest added benefit to the community for the lowest anticipated cost.

The selected BMP sites represent an optimized approach to meeting the following goals for each of the participating Municipal Entities in the first permit term, beginning upon approval of this Joint Plan and the municipal Individual Permits.

- Short-term sediment load reduction of 10% for the Paxton Creek TMDL
- Long-term 35% sediment load reduction necessary to meet the prescribed WLAs for Paxton Creek TMDL
- Appendix-D CBPRP, 10% sediment load reduction for the Municipal Entities' combined Chesapeake Bay Planning Areas (Joint Planning Area)
- Appendix-E Siltation, 10% sediment load reduction for Wildwood Lake
- Appendix-E Siltation, 10% sediment load reduction for the UNT to Spring Creek

Proposed BMPs include detention basin retrofit/bioretention and floodplain restoration projects that provide streambank stabilization and establish riparian forest buffers (Table 20) located throughout the urbanized area of the Municipal Entities' respective jurisdictions.

Many of the floodplain restoration projects being proposed are located in Susquehanna Township due to the findings of the Joint Planning Area field assessment. The assessment showed that while not pristine, the streams located in the head-waters of the watershed, namely those located in Lower Paxton Township, displayed little streambank erosion, and contained very few areas of significant silt and sediment deposition compared to the Susquehanna Township sites. Many reaches located further downstream in Susquehanna Township exhibited moderate to severe streambank erosion, undercutting and bank failure. These reaches offer the greatest potential for reducing the amount of silt and sediment impacting the Paxton Creek, Spring Creek and Chesapeake Bay Watersheds. For that reason, many of the stream restoration project locations chosen as a result of the stream assessments lie within Susquehanna Township and the Spring Creek Watershed. By concentrating efforts on heavily impacted streams, rather than simply dividing the number of proposed BMPs projects evenly between the participating Municipal Entities, the Joint Plan offers an optimal approach to achieving the sediment load reductions assigned to each municipality.

The proposed BMP sites align closely with the findings of the TMDL Strategy which served as the foundation for the Joint Plan. Section 6 of the 2015 TMDL Strategy identified eighteen (18) potential "early-action" projects (EAPs) exhibiting evidence of severe degradation and significant restoration potential. Of the thirteen (13) floodplain restoration BMPs proposed in this plan, six (6) sites were included in the TMDL Strategy as EAPs. The remaining proposed BMPs are located along stream segments that were unable to be evaluated during development of the 2015 TMDL Strategy.

The proposed BMP projects have not undergone engineering design. The project descriptions are conceptual and intended for planning purposes. Proposed projects have been evaluated in terms of preliminary feasibility and anticipated pollutant load reductions in order to meet the goals of this Joint Plan.

The proposed BMPs will be designed in accordance with the Pennsylvania BMP Manual design guidance and all local ordinances. Additionally, as many of the proposed projects are primarily floodplain restorations, additional details and calculations for each proposed project developed during the design and implementation project phases will be documented in the Annual MS4 Status Reports.

A summary of the type and scale of BMP projects included in this Joint Plan is listed in Table 20. The table references the assessment stream segment from which the BMP was derived and also indicates whether the BMP was presented as an EAP in the 2015 TMDL Strategy. It should be noted that the BMP Stream Lengths may not match the Assessment Stream Segment Lengths presented in Table 20, as the BMPs may cover only a portion of the initial stream segment based upon the site characteristics and sediment reduction goals.

The sediment load reductions achieved through the implementation of each floodplain restoration presented in this Joint Plan were determined using a value of 115 lb/ft, per PADEP guidance[9]. A comprehensive list of the individual BMP projects to be implemented is provided in Appendix G and their locations are shown on the BMP Location Maps in Appendix B and BMP Prototype Key Map in Appendix F.

[9] PADEP, TMDL Plan Instructions, Form 3800-PM-BCW0200d,(Rev. 3/2017)

Table 20. Proposed Floodplain Restoration Projects

Map Reference	Floodplain Restoration BMP Name	Assessment Stream Segment	Early Action Project	Lat./ Long.	Planning Area	Stream Length (LF)	Reduction (lbs)
BMP-01	Fox Hunt - Stream Restoration	SS-21	EAP-1	40.335491° -76.879814°	Paxton Creek / Joint Plan	750	86,250
BMP-02	Stonebridge Apartments	SS-14	EAP-2	40.301103° -76.823866°	Paxton Creek / Joint Plan	1,450	166,750
BMP-03	Wildwood Lake, Black Run	SS-01	N/A	40.307771° -76.882665°	Paxton Creek / Joint Plan	1,075	123,625
BMP-04	Veteran's Park South	SS-18	N/A	40.293398° -76.859017°	Paxton Creek / Joint Plan	1,000	115,000
BMP-05	Veteran's Park North	SS-18	N/A	40.294232° -76.860350°	Paxton Creek / Joint Plan	1,150	132,250
BMP-06	CWP – Shutt Mill Rd/Walker Mill Road	N/A	EAP-3	40.306631° -76.870776°	Paxton Creek / Joint Plan	4,400	505,171
BMP-07	Susquehanna Union Green	N/A	EAP-4	40.325675° -76.855535°	Paxton Creek / Joint Plan	2,600	505,70010
BMP-08	Bradley Dr	N/A	N/A	40.319371° -76.860073°	Paxton Creek / Joint Plan	950	109,250
BMP-09	Black Run - North	SS-03	EAP-5	40.316022° -76.870342°	Paxton Creek / Joint Plan	3,368	387,320
BMP-10	Black Run - South	SS-03	EAP-6	40.311085° -76.871213°	Paxton Creek / Joint Plan	2,000	230,000
BMP-11	Pines Apartment Complex	SS-16	N/A	40.289522° -76.840440°	Paxton Creek / Joint Plan	1,450	166,750
BMP-12	Capital Area Greenbelt	SS-23	N/A	40.272602° -76.841858°	UNT Spring Creek / Joint Plan	1,800	207,000
BMP-13	Walker Mill Road Stream Only	N/A	EAP-7	40.305650° -76.866050°	Paxton Creek / Joint Plan	600	69,000

Notwithstanding that implementation of the 2015 TMDL Strategy was not required until approved by PADEP, a few early action projects have been acted upon by the Municipal Entities. Stonebridge Apartments (BMP-02 and EAP-2) is under design and is anticipated to include floodplain restoration and select streambank stabilization. The actual reduction credit will be calculated upon final design. The project is funded through a Commonwealth Finance Agency Watershed Restoration and Protection Grant.

[10] Expert Panel Report Credit Protocols

Further, land-based BMP opportunities will be implemented where feasible. A detention basin retrofit project is proposed for an existing detention basin along Walker Mill Road in Susquehanna Township, paired with stream restoration in its vicinity (Table 21). The basin serves as the primary stormwater management facility for a large residential housing development and currently discharges to an impaired section of Paxton Creek. The retrofit is likely to include modifications to the existing outlet structure, excavation and soil modification in the basin floor, wetland plantings, shrubs, shade trees, and naturalized basin walls. A concept design rendering for the proposed Walker Mill detention basin retrofit has been included in Appendix H of this plan.

Table 21. Proposed Detention Basin Retrofit Project.

Map Reference	Early Action Project	BMP Name	Lat./Long.	Drainage Area (Acre)	Reduction (lbs)
BMP-13	EAP-8	Walker Mill Road Basin Retrofit Only	40.305650° -76.866050°	23.4	21,473
				Totals:	**21,473**

Further, Capital Region Water is proposing to conduct street sweeping at the credit-required frequency rate on a portion of its service to provide additional sediment reduction credit to the Joint Plan. Both Lower Paxton Township and Susquehanna Township currently perform street sweeping, but not as frequently. CRW's workforce will utilize a regenerative air vacuum sweeper and sweeping will be conducted at a frequency of no less than twenty-five (25) times per year in accordance with current PADEP guidelines. The expected annual sediment load reduction achieved through CRW's street sweeping efforts is 29,864 pounds (Table 22) based on a managed impervious street surface area of 166 acres located in CRW's MS4 service area. As per PADEP PRP Instructions, sediment load reduction values for the proposed street sweeping activities were not calculated using Model My Watershed, but rather with the following calculation using PADEP approved loading rates and a removal efficiency of 9%.

Impervious Road Surface Area x Sediment Loading Rate[11] x Reduction Efficiency[12] = Load Reduction

Table 22. Proposed Street Sweeping Reduction Credit

BMP #	Early Action Project	BMP Name	Managed Area (Acre)	Reduction (lbs)
BMP-15	EAP-9	CRW Street Sweeping (25 times per year)	166.0	29,864
			Totals:	**29,864**

As described in general terms herein, CRW is currently developing its CSO Long-Term Control Plan (LTCP)[13] under the terms of a Consent Decree between CRW, EPA, and PADEP. The LTCP will address sediment load reductions attributed to the combined sewer system (CSS). Load reduction opportunities will be more specific as the LTCP evolves. CRW anticipates that several early action projects may be defined and partially implemented during the five-year implementation time frame of the Joint Pollution Reduction Plan.

Table 23 provides estimates of sediment load reduction provided by the CSS discharging to Paxton Creek. It includes the corrected sediment load attributable to CRW/City of Harrisburg sediment load as applicable to the TMDL. Table 24 provides estimates of sediment load reductions provided by the CSS attributable to the Joint Planning Area and directly attributable to Paxton Creek. For streambank erosion sediment load reductions, this was based on an analysis using PADEP's MapShed simulation completed as part of the 2015

[11] PADEP PRP Instructions Form 3800-PM-BCW0100k (rev 3/2017)

[12] Pollution Reduction Plan: A Methodology – Street Sweeping Expert Panel Report, from Fall 2016 MS4 Workshop

13 Due for submittal to DEP on April 1, 2018

TMDL Strategy. The method assumed potential LTCP-related discharge reductions by removing the CSS drainage area and the resulting reductions in streambank erosion were related to the reduction in discharge volume. Further detail can be reviewed in the TMDL Strategy - Appendix A, Section A.10. For land based and point source reductions of sediment load this was based on the reduction in discharge volume (i.e., reducing combined sewer overflow volume reduces sediment load by the same portion).

Table 23 and Table 24 scenarios are described as follows:

The Sediment Load Reported in 2008 TMDL is the adjusted sediment load to match 2008 Paxton Creek TMDL Study, matching the CRW/City of Harrisburg baseline pollutant load from **Error! Reference source not found.**.

The Corrected Sediment Load accounting for Combined Sewer System performance is a representation of Harrisburg's combined and stormwater systems accounting for reductions in sediment load provided by combined sewer system operation.

The Rehabilitated Combined Sewer System performance is a representation of the Capital Region Water combined and stormwater sewer systems after several remedial improvements have been completed. These include cleaning of the interceptors, reduced combined sewer regulator restriction due to Brown & Brown regulator control operation, and the utilization of a new Front Street Pump Station.

The Optimized Combined Sewer System is a representation of the Capital Region Water combined and stormwater sewer systems after improvements to the combined sewer regulators to maximize flow to the interceptors while limiting sewer surcharging.

Table 23. Summary of Paxton Creek CSO Sediment Load Reductions

Scenario	Land-Based Sediment Load (tons)	Streambank Erosion Sediment Load (tons)	Total CSS Sediment Load (tons)	Total CSS Sediment Load (lbs)	Reduction from Existing
Sediment Load Reported in 2008 TMDL	18	364	382	764,000	---
Corrected Sediment Load from Existing Combined Sewer System	16	332	348	696,000	5%
Rehabilitated Combined Sewer System	14	292	306	612,000	12%
Optimized Combined Sewer System	7	178	185	370,000	31%

Future combined system rehab/optimization will reduce an additional 41 to 102 tons which exceeds the 10% load reduction required for the Paxton Creek TMDL (Table 23).

Table 24. Summary of Total Susquehanna River CSO Sediment Load Reductions from the Combined Sewer System using Model My Watershed Assumptions.

Scenario	Land-Based Sediment Load (tons)	Streambank Erosion Sediment Load (tons)	Total CSS Sediment Load (tons)	Total CSS Sediment Load (lbs)	Reduction from Existing
Sediment Load Reported in 2008 TMDL	51	1,547	1,598	3,196,000	---
Corrected Sediment Load from Existing Combined Sewer System	41	1,516	1,557	3,114,000	2%
Rehabilitated Combined Sewer System	33	1,476	1,509	3,018,000	5%
Optimized Combined Sewer System	18	1,361	1,379	2,758,000	11%

Future combined system rehab/optimization will remove an additional 47 to 112 tons which has the potential to exceed the 10% load reduction required for the Chesapeake Bay PRP (Table 24).

UNT to Spring Creek – Appendix E Sediment Load Reduction Strategy

Several additional projects were included in the Joint Pollutant Reduction Plan to adequately address the Appendix-E PRP requirements prescribed to CRW and Susquehanna Township for UNT 10126 to Spring Creek. CRW is proposing three (3) water quality BMPs within the Harrisburg City municipal boundary and will conduct street sweeping activities on approximately 15 acres of impervious roadway to achieve further sediment load reductions for the unnamed tributary. The BMPs will be implemented through CRW's Green Infrastructure Program. Due to the anticipated primary and secondary benefits, a stream restoration project (BMP-12) is proposed to add further water quality benefit to the impaired stream (Table 25). The project will be located along the Capital Area Greenbelt and will likely facilitate a continued partnership with the Capital Area Greenbelt Association and the municipal entities.

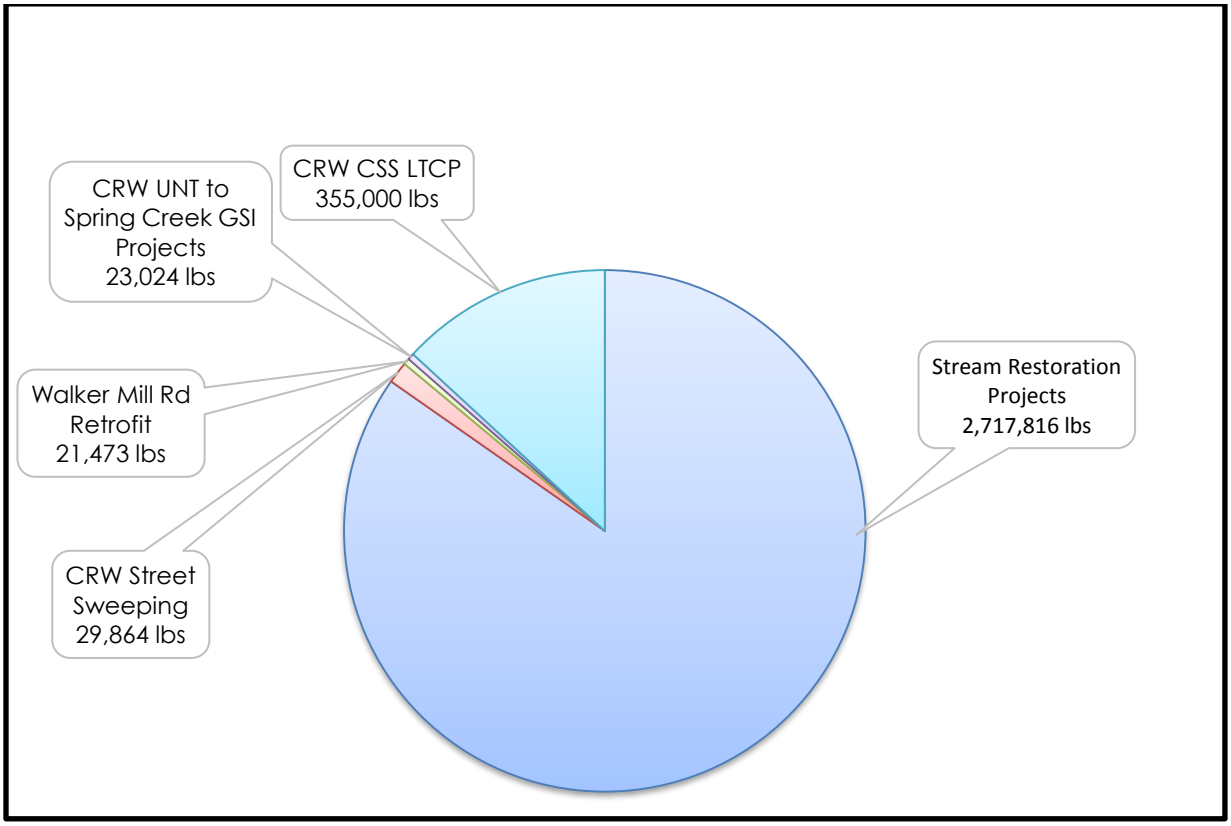
Table 25. UNT to Spring Creek Projects

Map Reference	Early Action Project	Alternate BMP Name	Lat./ Long.	Stream Length (ft)	Reduction (lbs)
BMP-12	N/A	Capital Area Greenbelt Stream Project	40.272602° -76.841858°	1,800	207,000
BMP-14	EAP-10	CRW UNT to Spring Creek GSI Projects	40.269089° -76.844171°	N/A	23,024
			Totals:	**1,800**	**230,024**

Implementation of the proposed BMPs listed in Table 25 (BMP-12 & BMP-14) will result in a total sediment load reduction of 230,024 pounds, exceeding the Appendix-E PRP sediment load reductions required of CRW and Susquehanna Township for the UNT to Spring Creek (Table 18). This provides a significant credit cushion for compliance for the impairment goal and the five-year implementation time frame.

A mixture of proposed projects have been identified by the Municipal Entities according to the feasibility of installation, cost effectiveness, and local buy-in. Exhibit 4 describes the proportionality of stream restoration projects and land-based/utility improvement-based projects proposed for consideration to meet the sediment reduction goals.

Exhibit 4. Proposed Sediment Load Reduction for the Joint Planning Area by Source.



Total Proposed Joint Planning Area Sediment Load Reduction Potential =
Floodplain Restoration Projects +
Detention Basin Retrofit +
Street Sweeping +
UNT to Spring Creek Projects +
CSS Optimization (CRW LTCP)

2,717,816 lbs. + 21,473 lbs. + 29,864 lbs. + 23,024 lbs. + 355,000 lbs. = ***3,147,177 lb Reduction Potential***

Joint Planning Area Sediment Load Reduction Goal = 1,694,198 lb

Alternate Projects

The inherent complexity of implementing numerous, large-scale projects in a five-year timeframe with limited annual cash flow and limited land control, necessitates a significant number of alternate projects be identified and included in this plan in order to provide flexibility during implementation. Early action projects are identified with an "EAP" notation. As projects are completed and reported on in each MS4's Annual Reports, plan implementation progress will be quantified. The plan goal will be accomplished once the implemented projects meet the joint planning area load reduction goal. For those planned projects that

are not completed during the individual permit term because the goal has been met, the MS4s reserve the possibility of implementing the projects in the future should there be a new regulatory water quality improvement goal.

Additional stream restoration project locations (Table 26) have been identified as alternate sites should any stream restoration projects proposed in Table 20 be deemed to be unachievable during the five-year plan implementation. The Municipal Entities recognize their ability to review and revise the sediment reduction strategy put forth in this Joint Plan and may elect to do so in at some point in the future in accordance with PADEP regulations. Projects on the primary BMP project lists may shift to the alternative project list based upon actual feasibility upon initiation of the project and, conversely, alternate stream restoration projects may shift to the primary project list. The prototypes will also serve as a long-term tool to select future project locations and anticipate the type of approach to take. Actual stream restoration project implementation will occur based on the anticipated stream reduction credit potential based upon the prevailing PADEP guidance at the time of implementation.

Table 26. Alternate Stream Restoration Projects

Map Reference	Alternate BMP Name	Lat.	Long.	Stream Length (ft)	Sediment Reduction (lb/yr)
ALT-01	Edgemont Rd. at Locust Ln.	40.301103°	-76.823866°	1,450	166,750
ALT-02	Valley Road	40.304856°	-76.835807°	1,800	207,000
ALT-03	Earl Drive Ph. 01	40.316231°	-76.813565°	1,560	179,400
ALT-04	Earl Drive Ph. 02	40.317573°	-76.808472°	900	103,500
ALT-05	Earl Drive Ph. 03	40.317575°	-76.803402°	2,435	280,025
ALT-06	Hankin Property Stream	40.317949°	-76.818916°	3,162	363,630
ALT-07	Fairfax Village Stream	40.341735°	-76.822635°	2,885	331,775
			Totals:	**14,192**	**1,632,080**

The Municipal Entities in no way commit to implementing each of projects listed in this Joint Plan as "Proposed" or "Alternate" within the upcoming five-year permit term to commence upon permit issuance by PADEP. The Municipal Entities reserve the right to select any number or combination of projects proposed herein, either in-part or in-total, in order to meet their prescribed sediment load reduction requirements.

G.3 General Project Concept – Floodplain Restoration, Streambank Stabilization, Grade Controls and Buffer Establishment

Floodplain restoration and associated streambank stabilization efforts directly address the causes of erosion and sedimentation and prevent further erosion and degradation by replacing disturbed or cut back streambanks with stable, shallow channels, restoring floodplain connectivity and ultimately resulting in lower sediment and nutrient loads entering the watershed. Dense vegetative cover will be established throughout

the floodplain to provide further stabilization while also serving to promote plant uptake of pollutant laden runoff in order to reduce the amount of nutrients and sediment eventually reaching the local waterways. Vegetative stabilization relies on the root structures of established plantings to stabilize the streambank and provide scour protection. In addition, incised streambanks will be regraded at a reduced slope to prevent further incision by allowing the stream to reconnect to the surrounding floodplain. This method offers a relatively low-maintenance and inexpensive means of stabilization and provides a naturalized appearance to the rehabilitated streambank that is conducive to flood control and restoring natural habitat.

Velocity reduction will be achieved by creating a condition in which increased flows distribute evenly across the extent of the densely vegetated floodplain. Reduced flow depths, uniform slopes and increased surface roughness from vegetative cover all contribute to help minimize flow velocity. Subsurface grade control structures may be utilized to prevent downcutting within the channel, while above-ground instream structures, including rock vanes and step pools, will only be utilized to prevent erosion when high shear stress and high flow velocities are otherwise unavoidable, such as the up- and downstream extents of a restoration site. The structures will be constructed of natural materials such as rock, root wads, and logs. The exact number and locations for the proposed instream structures will be determined during the completion of the engineering design and upon approval of the Joint Plan.

The Municipal Entities intend to perform riparian buffer restoration on the segments of stream to be stabilized. The goal of the riparian buffer projects is to naturalize the existing floodplain and reestablish buffer areas along the stream segments to a minimum width of 35 feet. The restorations will include the removal and replacement of dead, diseased, and/or invasive vegetation; as well as new plantings in areas where buffers have diminished in size. The riparian buffer restoration projects will be implemented concurrently with the stabilization projects in order to maximize the nutrient load reduction potential of each segment of stream to be enhanced and will be incorporated into the engineered design.

The proposed floodplain restoration projects will contribute to restored stream and enhanced buffer in the Joint Planning Area, greatly reducing the amount of sedimentation due to instream erosion. Further details regarding stream restoration techniques and Concept Renderings of each restoration approach are included in Appendix F.

G.4 General Project Concept - Detention Basin Retrofit

It is proposed in the Joint Pollutant Reduction Plan to perform one (1) detention basin retrofit on an existing 16,500 square foot detention basin, located along Walker Mill Road in Susquehanna Township. The basin retrofit project was chosen as a proposed BMP due to the existing structural integrity issue with the berm that needs to be addressed, and it discharges to Black Run, which is impaired for sediment. The detention basin retrofit will incorporate stabilization of the basin outfall and the adjoining stream, providing improved water quality and enhanced flood control. Detention basins are designed to receive, temporarily hold, and discharge stormwater at a controlled rate. While they can provide rate and volume mitigation, detention basins traditionally offer limited water quality benefit. Detention basin retrofits transform these simple catch, store, and release ponds into BMPs which provide infiltration, bioretention, and improved sediment and nutrient removal capabilities. This is achieved by extending the storage time with structure modifications, improving soil conditions to allow for greater infiltration rates, and naturalizing the basins with native and/or wetland plant species. While the extent and

nature of the retrofit will rely on the results of future engineering investigations, the proposed basin retrofit will reduce the quantity and increase the quality of the stormwater runoff reaching the impaired streams.

The location of the proposed detention basin retrofit project is displayed on the BMP Prototype Key Map in Appendix F. Should property owners indicate to the Municipal Entities that they have interest in retrofitting detention basins they own, it is anticipated that those completed projects will be included in the Annual MS4 Status Reports and count toward the Joint Plan sediment reduction goals. Detention basin retrofits may become more cost-effective during plan implementation, and new candidates identified during the five-year term will be reviewed for inclusion in this plan.

G.5 Cost Opinion

Cost opinions were developed to support the municipal entities' continued planning and funding efforts. A detailed cost opinion was created for each of the three (3) concept prototype designs, outlined subsequently in this section. A unit cost per linear foot was established for each prototype based on the detailed concept cost estimates and applied to the final BMP sites to provide an approximation of the total costs required to achieve all sediment load reduction goals.

One of the primary cost considerations is the amount of cut material generated or fill material required depending on the concept. It was assumed that additional cut material generated during construction will be disposed of on site or hauled no more than three (3) miles from the site. For the Steep Slope Concept Site which requires significant fill material, it is assumed that clean fill will be imported from within three (3) miles of the site. Due to the cut volumes generated at some sites and significant fill volumes required at others, and based upon the aggressive BMP implementation schedule, outlined in Section G.6, and proximity of BMP locations in relation to each other, construction may be coordinated to haul cut from one BMP site to be stockpiled at sites requiring fill. The soil is assumed to be clean and free of contaminants.

The detailed concept cost opinions are intended to provide an estimate based upon the prototype definitions presented in Section G.1.4., so site features unique to the specific concept but not characteristic of the prototype in general were excluded from the detailed concept cost opinions to avoid influencing the prototype unit cost approximations. For example, the Stonebridge Apartment site (SS-14) – the basis for the Constrained Corridor Concept – contains multiple pedestrian footbridges across the stream reach. The removal and replacement of these bridges would have a significant impact on the cost of implementing this project, however that cost was not considered for the cost opinion as footbridges are not present at the majority of the other constrained corridor prototype sites.

Additional exclusions from the detailed concept costs include:

- Compaction or soil testing
- Rock excavation, removal and disposal
- Relocation or repair of existing utilities
- Post construction monitoring and maintenance

G.5.1 Detailed Concept Cost Opinions

Floodplain Restoration Concept

The detailed Floodplain Restoration Concept Cost Opinion presented in Table 27 below, provides a total cost of $605,933 for the concept site. This cost is the highest of the three sites, which makes sense as the prototype represents the largest reaches in the Joint Planning Area. The primary cost driver for this concept is the total amount of estimated cut volume, which should serve as some indicator of the potential sedimentation load at these sites if left unmitigated. The unit cost opinion comes out to $566 per linear foot, which matches exactly the unit cost for the Steep Slope Concept. It was assumed that these two sites, while on opposite sides of the spectrum in terms of restoration approach, would have similar unit costs based on the significant amount of either cut or fill at these locations and the extensive intervention required at Steep Slope sites.

Table 27. Floodplain Restoration Concept Detailed Cost Opinion.

Description	Approx. Quantity	Unit	Unit Price	Total Price
Design/Permit	1	LS	$120,000	$120,000
Mobilization (% of total)	1	LS	N/A	$10,000
Survey & Construction Layout	1	LS	$3,600	$3,600
Clearing and Grubbing	1	LS	$18,000	$18,000
Erosion and Sedimentation Controls	1,070	LF	$24	$25,680
Excavation, Haul Over the Road within 3 mi	11,376	CY	$18	$204,768
Seeding/ Stabilization	107,500	SF	$0.54	$58,050
Wetland Planting - Herbaceous Plugs 1.5' o.c. (5500 sf)	2,800	EA	$3.60	$10,080
Native Tree Planting, #7	20	EA	$162	$3,240
Native Shrub Planting, #2	100	EA	$54	$5,400
Educational Signage (18x24" NPS Standard)	1	EA	$2,100	$2,100
As-Built Survey	1	LS	$2,100	$2,100
Construction Contingency	1	LS	$30,000	$30,000
Additional Cost to Provide Performance Bond, Construction Management Fees If Necessary (% of total)	10	%	N/A	$49,500
Prevailing Wage Multiplier (17% of total construction costs)	17	%	N/A	$63,415
			Total Cost Opinion (+/- 20%):	**$605,933**
			Unit Cost Per Linear Foot:	**$566 / LF**

Constrained Corridor Concept

The Constrained Corridor Concept represents the cheapest unit cost of the three restoration approaches at a cost of $360 per linear foot and an overall opinion of $514,696. However, it is worth noting these constricted sites are more likely to be impacted by adjacent buildings or other infrastructure including utilities, sidewalks and pedestrian bridges. As mentioned previously, these types of constraints are unique to each site and, therefore, were not included in the cost estimate; however, they must be accounted for on a project-by-project basis during engineering design.

Table 28. Constrained Corridor Concept Detailed Cost Opinion.

Description	Approximate Quantity	Unit	Unit Price	Total Price
Design/Permit	1	LS	$120,000	$120,000
Mobilization (% of total)	1	LS	$10,000	$10,000
Survey & Construction Layout	1	LS	$3,600	$3,600
Erosion and Sedimentation Controls Budget	1,430	LF	$13	$18,590
Clearing & Grubbing	1	LS	$9,000	$9,000
Excavation, Haul within 3 mi	3,625	CY	$45	$163,125
Seeding/ Stabilization	30,000	SF	$0.75	$22,500
Native Tree Planting, #7	10	EA	$162	$1,620
Native Shrub Planting, #2	50	EA	$54	$2,700
Meadow - Steep Slope Seeding & Stabilization	60,000	SF	$0.5	$30,000
As-Built Survey	1	LS	$6,000	$6,000
Educational Signage (18x24" NPS Standard)	2	EA	$2,100	$4,200
Construction Contingency	1	LS	$30,000	$30,000
Additional Cost to Provide Performance Bond, Construction Management Fees If Necessary (% of total)	10	%	N/A	$42,134
Prevailing Wage Multiplier (17% of total construction costs)	17	%	N/A	$51,227
			Total Cost Opinion (+/- 20%):	**$514,696**
			Unit Cost Per Linear Foot:	**$360 / LF**

Steep Slope Concept

As previously discussed, the unit cost opinion of $590 per linear foot matches that of the Floodplain Restoration concept. The overall cost opinion for the Steep Slope Concept is $495,912. The volume of imported fill is one of the primary cost drivers, along with the extensive armoring/slope intervention effort anticipated at these locations. At the Steep Slope concept site, the "armoring" is in the form of a step-pool system at the downstream tie-in. Other potential "armoring" efforts at steep slope sites include scour pools, rock underlayment and armored banks. It is recognized that simple armoring with rock or other means may not meet the intent of the stream restoration credit but may be the right solution for a project, especially in the instance of protecting utilities and structures. Those hard-armored areas would not be included in the ultimate project credit calculation.

Table 29. Steep Slope Concept Detailed Cost Opinion

Description	Approximate Quantity	Unit	Unit Price	Total Price
Design/Permit	1	LS	$120,000	$120,000
Mobilization (% of total)	1	LS	$10,000	$10,000
Survey & Construction Layout	1	LS	$3,600	$3,600
Erosion and Sedimentation Controls Budget	840	LF	$26	$21,840
Clearing & Grubbing	1	LS	$18,000	$18,000
Floodplain Fill	1,638	CY	$31	$50,778
Rip Rap Fill	1,486	CY	$66	$98,076
Rock Step Pools	65	LF	$510	$33,150
Seeding/ Stabilization	26,000	SF	$0.45	$13,000
As-Built Survey	1	LS	$6,000	$6,000
Educational Signage (18x24" NPS Standard)	1	EA	$2,100	$2,100
Construction Contingency	1	LS	$30,000	$30,000
Additional Cost to Provide Performance Bond, Construction Management Fees If Necessary (% of total)	10	%	N/A	$40,655
Prevailing Wage Multiplier (17% of total construction costs)	17	%	N/A	$48,713
			Total Cost Opinion (+/- 20%):	**$495,912**
			Unit Cost Per Linear Foot:	**$590 / LF**

Walker Mill Road Basin Retrofit Concept Cost Opinion

The cost opinion for the Walker Mill Road Basin Retrofit totals $604,244. This cost covers improvements to the existing basin as well as the cost of scour pool stabilization and armoring at the basin outfall. No unit cost is provided for the basin retrofit as the concept is unique to this location and will not be applied elsewhere to achieve the reduction goals of the Joint Plan.

Table 30. Walker Mill Road Basin Retrofit Concept Cost Opinion

Description	Approximate Quantity	Unit	Unit Price	Total Price
Design / Permit	1	LS	$72,000	$72,000
Mobilization (% of total)	1	LS	$10,000	$10,000
Clearing and Grubbing (varies)	1,500	SF	$3.00	$4,500
Stake-out/Survey	1	LS	$3,600	$3,600
Rock Construction Entrance	1	EA	$3,000	$3,000
Construction Safety Fence	600	LF	$4.20	$2,520
Traffic Control	1	LS	$1,000	$1,000
R-5 Plunge Pool	175	TN	$78	$13,650
Steep Slope Stream Restoration	600	LF	$571	$342,600
Seeding and Soil Amendments	22,700	SF	$0.30	$6,810
Straw Mulch	2,700	SF	$0.18	$486
Misc E&S Controls	1	LS	$7,200	$7,200
Excavation and Hauling (3 mi radius)	440	CY	$21.90	$9,636
Ripping, Spread Compost (2.5" Depth), Final Grade	15,000	SF	$0.84	$12,600
Erosion Control Blanket; Single Net Straw - Biodegradable	2,222	SY	$3.3	$7,332
Herbaceous Wetland Plugs	400	EA	$5	$2,000
Native Conservation Plants; #3 Shrubs	15	EA	$78	$1,170
Deciduous Shade Trees; #10-15 Cont.	8	EA	$420	$3,360
Small Flowering Trees; #5-7 Cont.	15	EA	$108	$1,620
Footpath Repairs	100	LF	$18	$1,800
Construction Management	1	LS	$10,800	$10,800
As-built Survey	1	EA	$3,600	$3,600
Contingency for Unknowns	1	LS	$8,400	$8,400
Additional Cost to Provide Performance Bond, If Necessary (% of total)	1.5	%	N/A	$6,779
Prevailing Wage Multiplier (17% of Construction Costs)	17	%	N/A	$67,781
Total Cost Opinion (+/- 20%)				$604,244

G.5.2 Prototype Unit Cost Approximation

Table 31 presents approximated total costs for each of the selected BMPs as well as an overall cost for the implementation of all of the primary stream restoration and basin retrofit sites included in the plan. The cost of each project was calculated by applying the appropriate prototype unit cost for the length of the BMP reach. Cost estimates were provided in the 2017 Plan based upon construction costs from the three previous construction years. Since two construction seasons have passed since the 2017 Plan submission and local contractors are gaining more experience, the costs have been updated to reflect current market conditions observed through the public bidding process.

Table 31. Proposed Stream Restoration Projects' Cost.

Map Reference	Restoration BMP Name	Assessment Stream Segment	Prototype	Stream Length (LF)	Unit Cost ($/LF)	Total Cost ($)
BMP-01	Fox Hunt Stream Restoration	SS-21	Steep Slope	750	$590	$442,500
BMP-02	Stonebridge Apartments	SS-14	Constrained Corridor	1,450	$360	$522,000
BMP-03	Wildwood Lake, Black Run	SS-03	Constrained Corridor	1,075	$360	$387,000
BMP-04	Veteran's Park South	SS-18	Steep Slope	1,000	$590	$590,000
BMP-05	Veteran's Park North	SS-18	Steep Slope	1,150	$590	$678,500
BMP-06	CWP-Shutt Mill Rd / Walker Mill Rd	N/A	Floodplain Restoration	4,400	$566	$2,490,400
BMP-07	Susquehanna Union Green	N/A	Floodplain Restoration	2,600	$566	$1,471,600
BMP-08	Bradley Drive	N/A	Constrained Corridor	950	$360	$342,000
BMP-09	Black Run - North	SS-03	Floodplain Restoration	3,368	$566	$1,906,288
BMP-10	Black Run - South	SS-03	Floodplain Restoration	2,000	$566	$1,132,000
BMP-11	Pines Apartment Complex	SS-16	Steep Slope	1,450	$590	$855,500
BMP-12	Capital Area Greenbelt Stream	SS-23	Floodplain Restoration	1,800	$566	$1,018,800
BMP-13	Walker Mill Rd. Stream Restoration	N/A	Steep Slope	600	$590	$354,000
BMP-13	Walker Mill Rd. Basin Retrofit	N/A	Basin Retrofit	N/A	--	$604,244
Total Stream Restoration and Basin Retrofit Rounded Implementation Cost						**$12,795,000**

Note 1. Total cost if stream restoration projects proceed and the Municipal Entities elect to overshoot the Individual permit reduction goal or budget for future, as yet, unknown sediment reduction requirements

Note 2. Table 32 maps out a schedule for a combination of projects that are anticipated to meet the sediment reduction goal, including stream restoration and land-based sediment reduction projects. That implementation plan would cost on the order of **$8,923,000** for the stream restoration projects, in addition to the costs associated with street sweeping and GSI projects in the UNT to Spring Creek watershed. These costs might be shared with land developers and PennDOT.

G.6 Partnerships

The Municipal Entities continue to seek out partnerships for future stormwater management BMP accomplishments of other NPDES permit holders. Their accomplishments could count toward meeting the plan goals, provided that they meet pollutant reduction plan criteria and the Joint Plan is revised per PADEP guidance described in Appendices D and E of the 2018 PAG-13 NPDES permit. A few specific partnerships are described herein.

PennDOT Partnership

It is required for municipalities to develop a plan assuming no reliance on other entities with which there is no cooperation agreement. However, it is anticipated that the Municipal Entities will continue to engage PennDOT during the implementation of the plan so that joint credit opportunities can be identified and achieved. Further, PennDOT has indicated that there is an intention to coordinate PennDOT projects with local municipalities during the permit term to coordinate water quality opportunities.

Specific to the Paxton Creek watershed, PennDOT Central Office developed a Paxton Creek Flood Control and Rehabilitation study, and they have met with DEP Southcentral Regional Office and the Municipal Entities to describe the anticipated restoration plan and benefits. The work is intended to mitigate flooding conditions through the lower end of the Paxton Creek watershed, primarily benefiting the city-limits, while constructing a stream ecosystem. One of the plan goals is to restore the Paxton Creek channel from its outlet to Wildwood Lake to the Susquehanna River. A restoration concept plan goal, as of the date of this Pollutant Reduction Plan, is to reduce the 100-year flood elevation by three (3) feet (from 317 feet to 314 feet). Removal of a box culvert under an abandoned Norfolk Southern railroad spur south of Paxton Street is essential to make the project feasible because it is the most significant obstruction identified in the reach and restricts the flow of the creek during flood events. The restoration concepts include ecosystem support and water quality benefits that will be intended to be tied to the overall pollutant reduction goals in this Plan and the LTCP. Three restoration design segments are considered

1. North Paxton Greenway
    a. Location: Wildwood Park Drive to Herr Street
    b. Stream Restoration Length: 7,600 linear feet
2. Paxton Creek Park
    a. Location: Herr Street to Berryhill Street
    b. Stream Restoration Length: 5,300 linear feet
3. South Paxton Greenway
    a. Location: Berryhill Street to the Susquehanna River
    b. Stream Restoration Length: 5,400 linear feet

It is anticipated that water quality BMPs incorporated into PennDOT's Plan will improve water quality in the Paxton Creek, Susquehanna River, and Chesapeake Bay Watersheds. At a minimum, the Plan is likely to contain volume and rate controls that will reduce streambank erosion throughout the western portion of the Joint Planning Area.

As other opportunities become available, PennDOT and the Municipal Entities will share any reductions achieved through partnership projects, provided the Municipal Entities either contribute funding or agree to perform the long-term operation and maintenance responsibilities for the additional or enhanced stormwater controls. As part of the Annual MS4 Status Reports submitted under this permit, PennDOT will provide a list of actions taken by the Department to support municipalities in achieving their PRP goals in sediment-impaired watersheds in urbanized areas.

Other Reportable BMPs

Notwithstanding that the Joint Plan outlines enough planned projects to meet the combined reduction goals, pollutant reduction planning requirements are also intended to be met through municipal actions and approvals. Examples of BMP reporting opportunities are described below. Any permit-eligible BMP documentation for pollutant reductions will be accepted for inclusion in the Annual MS4 Status Reports.

Stormwater Inlet Cleaning

As part of on-going MS4 maintenance, each of the Municipal Entities routinely remove solids from their MS4s. However, at this time, no pollutant reduction has been allotted to storm sewer system solids removal because tracking of this removed material has not been to the degree required to accurately calculate the pollutant load reduction as described in the PADEP BMP effectiveness values table[14]. It is anticipated that the Municipal Entities will track and record inlet cleaning in accordance with PADEP requirements and will report those activities in their respective Annual MS4 Status Reports. The reported reduction will contribute toward meeting the sediment reduction goal.

Land Development BMPs Installed on Sites with Less than One-Acre of Disturbance

To the extent that local municipal ordinances require the installation of stormwater BMPs at construction sites where land disturbance will be less than one-acre, those BMPs can be reported in the Annual MS4 Status Reports and the reported reductions will contribute toward the sediment reduction goal.

Street Sweeping

Municipalities that regularly conduct street sweeping (at least 25 times per year) may use this practice for pollutant load reduction credit as long as street sweeping is conducted in accordance with the minimum standards outlined in the Chesapeake Bay Program expert panel report for street sweeping and the guidance provided on the PADEP BMP Effectiveness Tables. The reported load reduction will contribute toward meeting the sediment reduction goal. This data will also be tracked and included in the Annual MS4 Status Reports and as credit toward the plan goal. It is planned for CRW to track street sweeping activities within the context of this plan. Should the Townships also start street sweeping at the prescribed frequency, that credit will be included in future Annual Reports.

G.7 BMP Implementation Schedule

A preliminary implementation schedule has been provided (Table 32**Error! Reference source not found.**); however, the exact order of construction of the proposed BMPs will rely on the results of the engineering investigation, design, and permitting process. The proposed stream restoration projects will likely require a Joint Permit Application (JPA) and will be subject to PADEP and United States Army Corps of Engineers (USACOE) review; restoration waivers will be pursued where applicable.

[14] PADEP Document 3800-PM-BCW010m, NPDES Stormwater Discharges from Small MS4s BMP Effectiveness Values (Rev. 5/2016)

Table 32. Implementation Schedule for Proposed Early Action BMPs

Map Reference	BMP Type	Permitting & Engineering Design (Permit Year)	Construction (Permit Year)[15]
BMP-01	Fox Hunt - Stream Restoration	2	2
BMP-02	Stonebridge Apartments	In Progress	2
BMP-07	Susquehanna Union Green	In Progress	3
BMP-06	CWP – Shutt Mill Rd/Walker Mill Road	2	3
BMP-13	Walker Mill Rd. Stream Restoration	1	3
BMP-13	Walker Mill Rd. Basin Retrofit	2	3
BMP-09	Black Run - North	2	4
BMP-10	Black Run - South	2	4
BMP-15	CRW Street Sweeping	Complete	1-5
BMP-14	CRW GSI Projects	4	5

G.8 Long-Term Paxton Creek TMDL Watershed Sediment Load Reductions

As previously stated, the Municipal Entities intend to achieve all required pollutant load reduction goals prescribed by the WLAs included in the Paxton Creek Watershed TMDL Report and those associated with PADEP's Appendix-D and Appendix-E pollutant reduction plans within five (5) years of PADEP's issuance to each municipality's Individual Permit. As such, the Municipal Entities maintain no quantifiable, long-term pollutant load reduction goals; however, the Municipal Entities will continue to maintain BMPs installed through the implementation of this Joint Plan. The Municipal Entities will also review and evaluate the effectiveness of the Joint Plan and make appropriate revisions should they be deemed necessary for the continuation of improving the water quality in local streams and national waterways.

[15] Anticipated permit years beginning in March of each year: 1 = 2020, 2 = 2021, 3 = 2022, 4 = 2023, 5 = 2024; the actual permit year will be based upon the date of Individual Permit issuance

G.9 Long Term Control Plan/Combined Sewer Overflows Stormwater BMPs

As previously stated, one of the Municipal Entities, CRW, is required to address stormwater discharges to the combined sanitary/storm sewer. CRW, with assistance from CDM Smith, has submitted a long-term control plan that addresses this issue. Previously, CRW identified green infrastructure strategies intended to be implemented that accomplish the long-term control plan goals through a Community Greening Plan – a Green Stormwater Infrastructure Plan for Harrisburg. Being that the majority of the goals of the Chesapeake Bay Pollutant Reduction Plan, MS4, Paxton Creek TMDL, and combined sewer overflow mitigation program ultimately rely on reduced stormwater velocities, thereby reducing the frequency and energy associated with discharges to streams, it is anticipated that as projects are implemented, sediment reduction credits may also result.

SECTION H: IDENTIFY FUNDING MECHANISMS

The Joint Pollutant Reduction Plan proposed herein will be implemented by the Municipal Entities as outlined in the Intergovernmental Cooperation Agreements ("Agreements") between each of the three (3) Municipal Entities. Funds will be sourced through a variety of mechanisms, including collected stormwater fees, municipal funds, available grants, partnerships, and public donation of materials and manpower.

All three Municipal Entities are currently in varying stages of assessing and implementing a municipal stormwater fee to help generate revenue to be used for the future implementation of the Joint Plan as well as addressing much needed improvements to the aging stormwater infrastructure in their respective communities. Lower Paxton Township began collecting stormwater fees in 2019 and a credit policy is anticipated to be developed in the near future. Susquehanna Township is amending its municipal authority's articles of incorporation to give it powers to manage stormwater and collect dedicated fee revenue for the stormwater utility. It is anticipated that stormwater billings will start during the second quarter of 2020. Capital Region Water's stormwater fee proposal is currently under public comment review but is planned for implementation in 2020.

A cost-sharing agreement between the Municipal Entities and PennDOT is currently being developed offering the potential of $1,000,000 in municipal funds (shared contribution from the Municipal Entities) and $1,000,000 in PennDOT funds to be used toward the project level costs of construction of water quality BMPs in the Joint Planning Area. The successful partnership between PennDOT and the Municipalities was the driving factor in the decision not to parse PennDOT roadways from the baseline sediment load if land parsing been an option for the complex planning area in MMW. Past PennDOT partnerships in central Pennsylvania have yielded a range of $/lb value. For the purpose of planning, we assume that should a project be let by PennDOT, it may yield a winning bid amount of $15/lb reduction. That means that a PennDOT/Municipal Entity project has the potential to yield an approximately 130,000 lb reduction. This plan currently does not rely on this contribution; it is also possible that the partially PennDOT-funded reduction may be accomplished by constructing one of the projects identified in this plan.

Future cost sharing will be conducted in a manner consistent with the executed Agreements (Appendix I). Per the Agreements: "Costs associated with implementation of the Plan and related BMPs shall be apportioned among the Participants based upon the percentage of load reduction attributed to each Participant in the Plan for each BMP, plus an equal share to apportion the percentage of load reduction outside of the municipal boundaries or service area of the Participants, until such time as additional contributions are received from other entities." The Agreements also states that "Each Participant shall be responsible for its own out-of-pocket costs and its own solicitor's fees."

SECTION I: OPERATIONS AND MAINTENANCE (O&M) OF BMPS

Once implemented, the BMPs outlined in this Joint Plan will be operated and maintained by the Municipal Entities to ensure that they continue to produce the expected pollutant reductions. The O&M activities will be reported in the Annual MS4 Status Reports submitted in accordance with the Individual Permit requirements.

The general list of the activities involved with O&M for each BMP and the frequency at which O&M activities will occur are as follows:

O&M requirements for the streambank stabilization and buffer restoration projects shall include:

- Ensure disturbed areas are kept free of foot and/or vehicular traffic until full stabilization has occurred – year round
- Regular watering of plantings during first growing season. Planting in the fall may reduce the need for additional watering – seasonally
- Conduct site visits to ensure plantings are healthy and sufficiently watered, weeds are properly managed, sufficient mulch is in place until site is stabilized and planting have become established – monthly
- Conduct site visits to ensure all disturbed earth remains stabilized and erosion or cutting of the streambank has not taken place. Any destabilized earth or active streambank erosion shall be repaired immediately upon discovery – monthly
- Conduct inspections once streambank is stabilized and plants have become established – biannually
- Immediately upon notice; repair any rills, gullies, or streambank cutting that may occur – year round
- Remove weeds and invasive plant species during each growing season. Naturally growing native vegetation should be left intact to promote stabilization of the streambank and surrounding area – seasonally
- Replace mulch as needed – biannually
- Remove accumulated trash and debris – monthly
- Remove and replace dead and diseased plantings – biannually
- Keep machinery and vehicles away from stabilized areas – year round

O&M requirements for the retrofit bio-retention basins shall include:

- Conduct regular inspections until site is stabilized and plantings are established – monthly
- Immediately upon notice, repair any erosion issues in the basin – year round
- Remove and replace dead or diseased plantings – biannually
- Remove weeds and invasive species from the basin – quarterly
- Remove accumulated sediment and debris – monthly
- Mulch as necessary – biannually
- Use no chemical herbicides or pesticides – year round
- Maintain a "No Mow Zone" around the perimeter of the basin – year round
- Ensure outlet structures remain unobstructed and free of debris – monthly

The contractor shall be responsible for the operation and maintenance of all streambank restoration, basin retrofits and riparian buffer projects until all features of the project have been successfully constructed to the specifications and design standards set forth by the Design Engineer. The Contractor shall remain responsible for operation and maintenance of the streambank restoration and buffer project(s) until 70% permanent vegetative stabilization has been achieved. Once construction of the project(s) is complete and stabilization has occurred, the Municipal Entities shall be responsible for implementing all Operation and Maintenance procedures to ensure the streambank stabilization and buffer improvements remained operationally functional and physically consistent with the original design.