Section 1

Overview of the Program Plan

This section provides an overview of Capital Region Water's (CRW's) *City Beautiful H_2O Program Plan* (Program Plan). An Executive Summary preceding this Section provides a concise description of the Program Plan, why it is needed, what it will accomplish, and how the total cost was established. The Program Plan is divided into eleven sections, and each section is summarized briefly in this overview.

1.1 Requirements and Objectives of the CRW Program Plan

1.1.1 Regulatory Requirements

On February 10, 2015 CRW became party to a Partial Consent Decree (PCD) with the U.S. Department of Justice (US-DOJ), U.S. Environmental Protection Agency (US-EPA), and Pennsylvania Department of Environmental Protection (PA-DEP). Consent Decrees and PCDs have been issued to municipalities and sewer authorities across the nation to establish compliance requirements and schedules beyond the framework of a traditional National Pollution Discharge Elimination System (NPDES) Permit. The PCD is consistent with objectives set by the federal Clean Water Act, the Combined Sewer Overflow (CSO) Control Policy, federal/commonwealth regulations for pollutant discharges from municipal separate storm sewer systems (MS4s), as well as state laws and regulations. Its objective is to improve water quality in receiving waters as necessary to achieve their designated waterway uses (e.g., drinking water, recreation, aquatic life, and others) and protect public health, safety, and welfare. The primary PCD requirements are to:

- Conduct comprehensive inspections of the CRW conveyance and collection systems, (see **Section 3.2**) and implement required rehabilitation measures to resolve deferred maintenance and correct identified critical structural and/or maintenance deficiencies,
- Develop and implement a CSO Nine Minimum Control (NMC) Plan, incorporating the MS4 Six Minimum Control Measures (MCM), that provides minimum technology-based controls and practices to address wet weather problems without extensive engineering studies or significant construction costs, prior to implementing long-term control measures,
- Develop a Long-Term Control Plan (LTCP) to resolve hydraulic capacity constraints and control the frequency, duration, and volume of CSOs being discharged into Paxton Creek and the Susquehanna River, and

- Eliminate sanitary sewer overflows (SSOs) and other unauthorized discharges.

1.1.2 Program Plan Objectives

The objective of this Program Plan is to identify and prioritize affordable activities that CRW will undertake to comply with the Federal Clean Water Act (CWA) and the Commonwealth's Clean Streams Law. It is intended to meet the LTCP requirements of the PCD and incorporate other CRW program initiatives to comply with the PCD, following US-EPA's Integrated Municipal Stormwater and Wastewater Planning Approach Framework (Integrated Approach). The Program Plan describes each activity and its projected level of control in the following areas:

- ***Rehabilitation of the conveyance and collection systems***: catch-up on previously deferred operation and maintenance needs, and implement a comprehensive asset management system to ensure the sewer system continues to provide reliable service to CRW customers,
- ***Wet Weather Control:*** Reduce CSOs, SSOs, unauthorized releases, and MS4 discharges to improve the health of local waterways, and protect public health, safety, and welfare.

The Program Plan divides the CRW service area into 15 planning areas, located mostly within the City of Harrisburg (City) and generally coinciding with City neighborhoods. This structure allows the Program Plan to establish the needs, priorities, recommended activities, and consequent levels of control for each planning area, then roll these up into the full Program Plan. A map of the designated planning areas is provided in **Figure 1-1**.

1.2 Public Engagement and Participation

Capital Region Water's (CRW) challenge is not unlike those of the nearly 800 other CSO cities across the United States. It must finance an expensive, long-lasting and disruptive project via ratepayers who already have serious affordability concerns. A critical part of the solution is a thorough public engagement strategy involving CRW's City Beautiful H_20 brand and the use of partnerships with community and environmental organizations. CRW's public participation activities for the draft Program Plan built upon previous efforts and were designed to engage the public by bringing the information to a number of different audiences through various communication methods and outreach events.

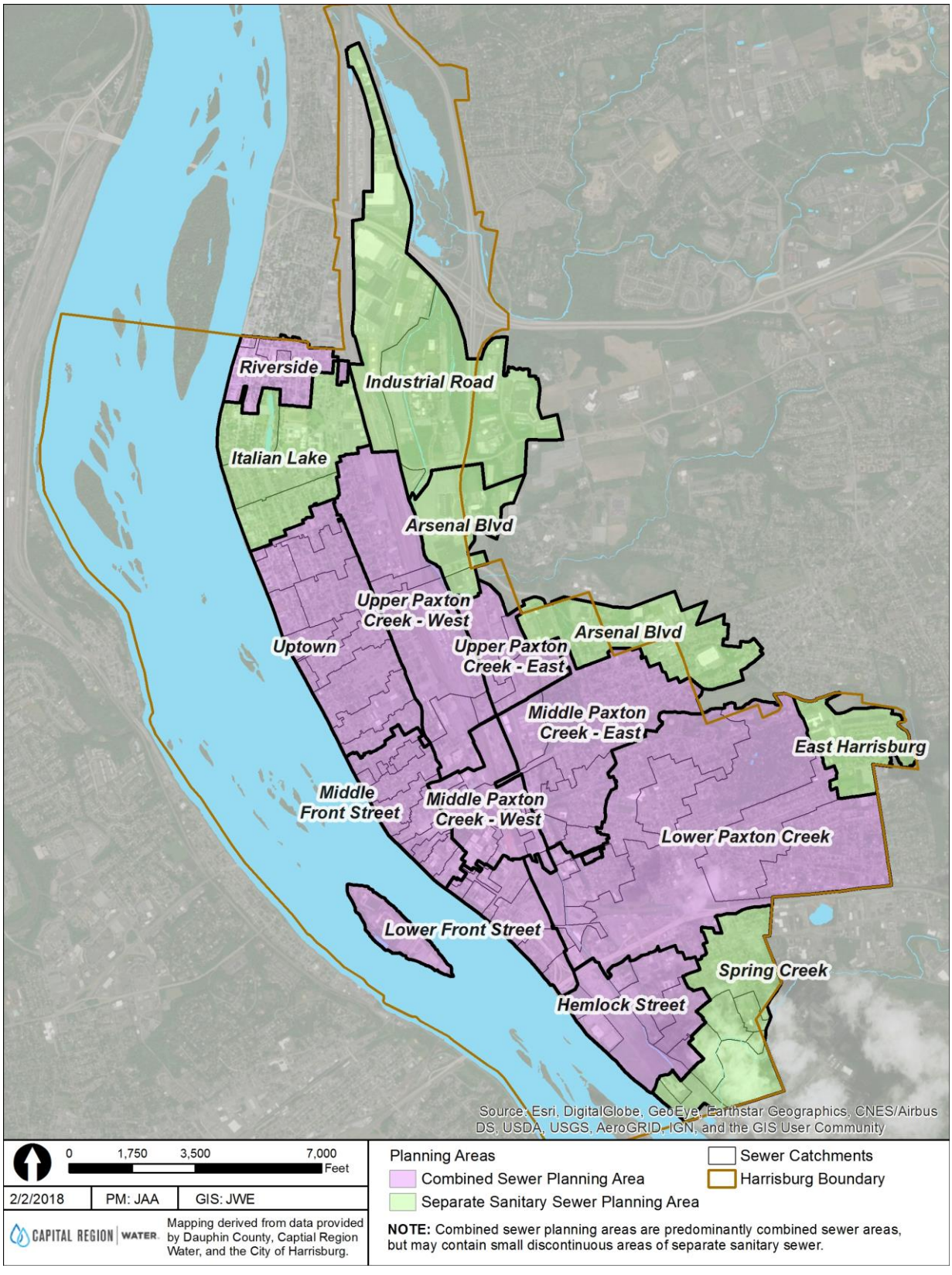
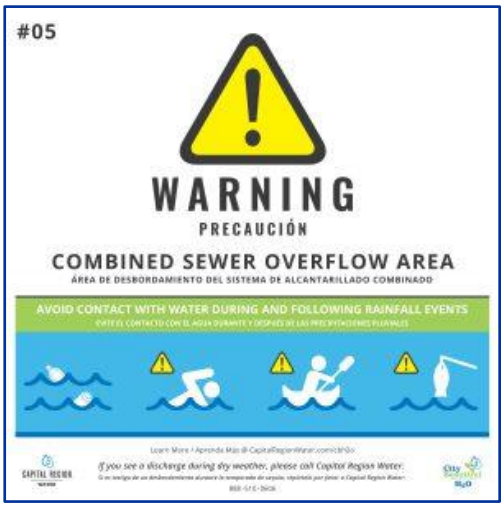


Figure 1-1: Designated Planning Areas within the CRW Service Area

1.2.1 Existing Public Involvement Programs

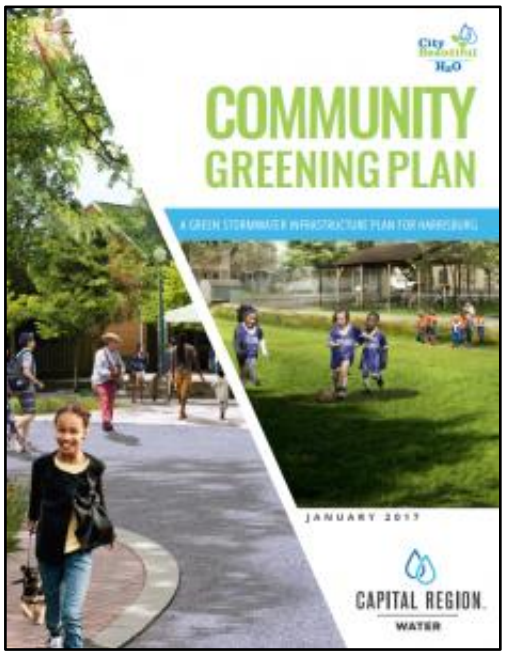
CRW's on-going public involvement program and activities are documented in the Nine Minimum Control (NMC):

- Minimum Control 7 requires the development and implementation of pollution prevention and public education programs. Pollution prevention programs are part of the public education process and can help reduce the amount of contaminants and floatable materials that enter the Susquehanna River and Paxton Creek via CSO/MS4 discharges. CRW was successful in implementing programs such monthly trash clean-ups, an annual city-wide clean-up event, and street sweeping operations.



- Minimum Control 8 requires the development and implementation of public notification programs. Public notification programs also are part of the public education process and intended to ensure the public receives adequate information about CSOs, their potential health and environmental impacts, and precautions concerning recreational activities, such as swimming, during and immediately after CSOs. Therefore, the CRW public notification program informs people using the Susquehanna River or Paxton Creek for recreation about the potential associated health risks.

These minimum controls also achieve PA-DEP's MS4 stormwater permitting requirements for public education/outreach (Minimum Control Measure 1) and public participation/involvement (Minimum Control Measure 2).



Community engagement also was an essential component in the preparation of CRW's Community Greening Plan, the green stormwater infrastructure masterplan for Harrisburg that was released in January 2017. Two large public engagement phases, one in the winter of 2016 and one in the summer of 2016, were held including several large events and more than thirty smaller engagement opportunities throughout the process. The process engaged over 1,000 residents from all areas of the city.

1.2.2 Public Involvement during the Release of the Draft Plan

CRW implemented a public involvement program to support development of this Program Plan that builds on the public involvement approaches and activities described in the NMC Plan, and the experience gained during preparation of the Community Greening Plan. This program provides several avenues for public involvement in the refinement and finalization of the draft Program Plan. A Companion Document that provided summary explanations of the Program Plan was prepared and distributed. The official public review and comment period for the Program Plan commenced on February 12, 2018 and extended through March 9. CRW conducted three large public involvement meetings for the Program Plan. The locations were selected with guidance from CRW's Community Ambassadors.

These meetings were organized in an open house format with five stations to explain the Program Plan and gather input from the public. Each station was led by a subject matter expert with assistance from community volunteers. Food and activities for kids were made available for free at each meeting to make it more convenient for families with children to attend. Attendees were asked to sign in when they entered the meeting and received a companion document, comment form, and pen. Attendees were then free to visit all 5 stations, listen to each speaker, and ask questions.

Meeting 1: Southern Harrisburg
Date: Thursday, February 15, 6:00 – 8:00 PM
Location: Sylvan Heights Science Charter School
915 South 13th Street, Harrisburg, PA 17104
Number of attendees: 5
Number of comments received from attendees: 0

Meeting 2: Lincoln School
Wednesday, February 21, 6:00 – 8:00 PM
Location: Lincoln School
1601 State Street, Harrisburg, PA 17103
Number of attendees: 13
Number of comments received from attendees: 2

Meeting 3: Camp Curtin YMCA
Thursday, March 1, 6:00 – 8:00 PM
Location: Camp Curtin YMCA
2135 North 6th Street, Harrisburg, PA 17110
Number of attendees: 11
Number of comments received from attendees: 2

CRW accepted public comments through an online form, in person at its Customer Service Center and its Administrative Office, and in person at its public meetings. In person comments were

documented using a comment form. CRW also accepted letters and emails submitted during the public comment period. All comments were scanned and archived.

1.2.3 Future Public Participation after Submitting the Plan

Moving forward, CRW will continue to perform the public education and involvement activities described in its NMC Plan and will also continue the public participation activities initiated in association with the development and initial implementation of its Community Greening Plan. These activities include developing regulations, policies, design/construction standards, and O&M agreements that require implementing Green Stormwater Infrastructure (GSI) principals in development and redevelopment projects, and proactively distributing and explaining them to existing and potential stakeholders. CRW will work toward developing proactive partnerships with future developers/redevelopers to implement collaborative public-private partnerships for development/redevelopment projects. CRW will also define stormwater fee credits and other incentives to spur property owners to install decentralized stormwater controls.

1.3 Characteristics of CRW's Wastewater/Stormwater System

The foundation for the *City Beautiful H_2O Program Plan* (Program Plan) is an accurate and up-to-date understanding of the sources of wastewater and stormwater within the CRW service area, the configuration and operation of CRW's sewer collection, conveyance, and treatment systems, and the surface waters receiving discharges from these systems. CRW developed and implemented a series of data collection and analysis programs, and incorporated the data and analysis results into a hydrologic and hydraulic (H&H) model of the CRW system. The data and the model were used as tools to quantify and characterize existing system configurations and flows, and establish a baseline condition on which to develop alternative CSO and SSO control measures.

1.3.1 CRW Service Area

Located along the east shore of the Susquehanna River, CRW is a municipal authority that provides wastewater and stormwater collection, conveyance, and treatment services to over 17,200 customer accounts in the City of Harrisburg. CRW assumed operation and maintenance responsibilities for the wastewater and stormwater collection and conveyance systems in late 2013, which followed decades of deferred maintenance. CRW also provides wastewater conveyance and treatment services to six suburban communities as wholesale customers. These suburban communities are identified below:

- Lower Paxton Township
- Paxtang Borough
- Penbrook Borough
- Steelton Borough
- Susquehanna Township
- Swatara Township

CRW owns, operates, and maintains the wastewater and stormwater infrastructure within the City of Harrisburg and receives wastewater flow from the suburban communities through four gravity points of connection and a pump station force main. A map of the CRW service area,

including the service area of each suburban community collection system, is provided in **Figure 3-1** (in the main body of the Program Plan).

1.3.2 Advanced Wastewater Treatment Facility (AWTF)

CRW owns and operates the AWTF located at 1662 South Cameron Street in Harrisburg. It is among the largest publicly owned treatment facilities in the Commonwealth and currently the largest in Pennsylvania within the Chesapeake Bay Watershed. CRW's AWTF treats wastewater from the City of Harrisburg and the six suburban communities located within its service area. The 5-year average annual wastewater flow at the AWTF during 2013 to 2017 was 21.4 million gallons per day (MGD). The permitted monthly average daily design capacity of the AWTF is 45 MGD.

AWTF Hydraulic Capacity	
Headworks	80 MGD
Primary Clarifiers	80 MGD
Secondary Treatment	45 MGD
BNR	45 MGD
Disinfection	80 MGD

2017 Influent Flow to AWTF	
Average Daily Flow	20.9 MGD
Max Avg. Daily Flow	51.9 MGD
Max Monthly ADF	25.8 MGD
Peak Flow	74.1 MGD

1.3.3 Conveyance System Conditions

The CRW conveyance system consists of the following facilities:

- Two major pumping stations – Front Street and Spring Creek – with associated force mains, that convey all wastewater flow from the City and five of the six suburban communities. Steelton's combined sewage is pumped directly to CRW's AWTF.
- Six major interceptor sewers, 13.8 miles in length, ranging in size and shape from 24-inch circular, to 60-inch by 72-inch arch, or rectangular pipe. Two of the interceptors, Asylum Run and Spring Creek convey separate sanitary flow. The other four interceptors, Front Street, Paxton Creek, Paxton Creek Relief, and Hemlock Street, are combined sewers.
- 59 CSO diversion structures and 58 CSO outfalls (two structures share an outfall) distributed along the interceptor sewers, plus an emergency overflow outfall at each of the two pumping stations. Combined wastewater enters the diversion structures and under dry weather conditions, all the flow is diverted towards the interceptor sewer and AWTF. During wet weather, the rate and volume of stormwater flow from the combined sewers increases

significantly and can exceed the capacity of the regulators, downstream interceptor sewers and/or the treatment facility, causing a CSO. This process is shown in **Figure 1-2**.

Table 1-1 summarizes the length of the CRW's sewer systems, while maps of the CRW interceptor systems and regulator structures are provided in the Program Plan main body **Figures 3-6** and **3-7**.

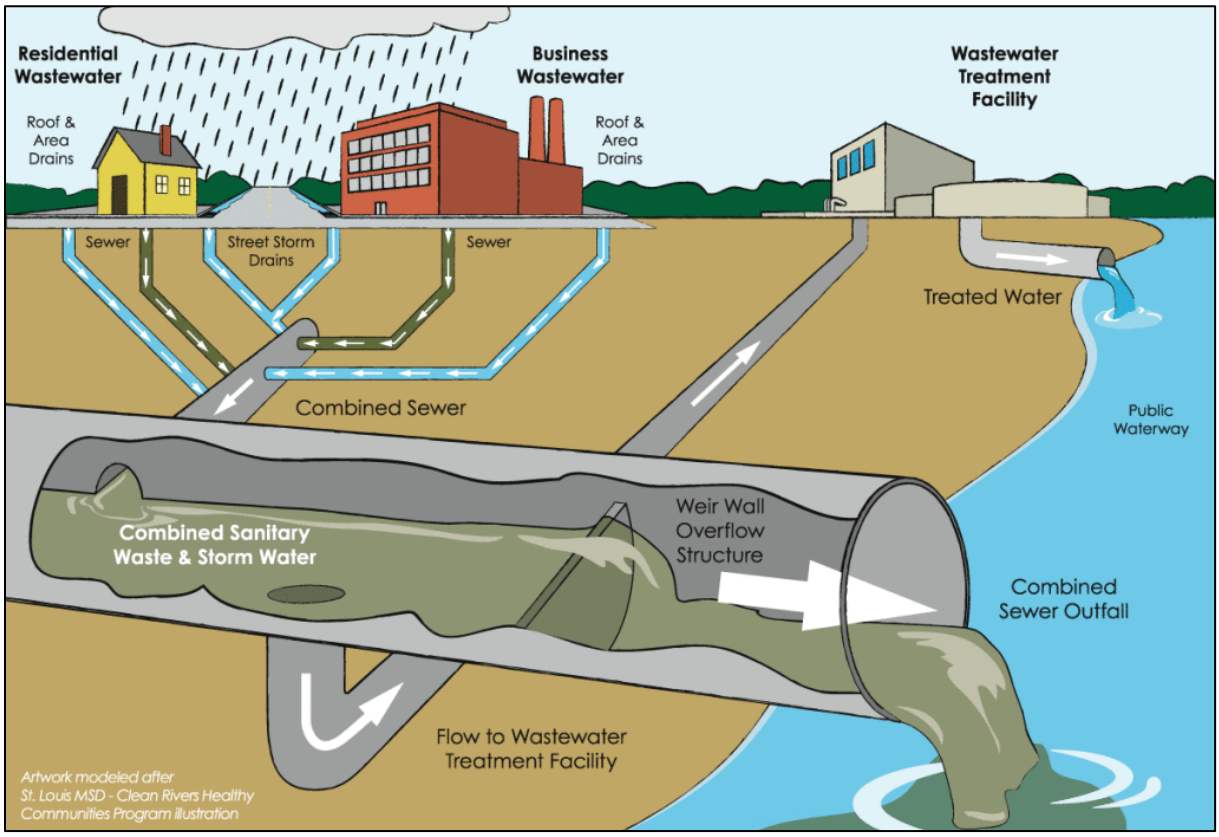


Figure 1-2: Typical Combined Sewer System with Regulator Structures

Table 1-1: Pipe Length Statistics

Pipe Class	Lengths (Miles)			
	Combined	Separate Sanitary	Separate Storm	Total
Interceptor	11.1	2.8	0	13.8
Collection System				
Trunk	24.3	5.4	0	29.7
Branch	62.7	27.8	40.0	130.5
Outfall Pipes	1.6	0	0	1.6
CSO Regulator Pipes	1.3	0	0	1.3
Total	**100.9**	**36.0**	**40.0**	**176.9**

1.3.4 Collection System Conditions

About 60 percent of CRW's wastewater and stormwater collection systems are comprised of combined sewers, some of which were built over a century ago. Steelton Borough also has a combined sewer system. In a combined sewer system, a single pipe carries sewage and stormwater. The remaining 40 percent of CRW's system, and the other five suburban community customers are served by separate and distinct wastewater and stormwater systems.

In the initial stages of the Program Plan, CRW needed to quickly update its original geographic information system (GIS) mapping of the configuration of the combined and separate sanitary sewer collection systems within the service area. The time required to perform a closed-circuit television (CCTV) inspection of the entire system exceeded the PCD schedule and milestone deadlines. Therefore, CRW elected to implement a Rapid Assessment Inspection Program, conducted via a pole camera inspection of every known manhole and connecting pipe within the collection system. The rapid assessment allowed CRW to:

- Collect the data necessary to build and apply its H&H model within PCD deadlines,
- Identify critical system blockages / failures visible from the manholes, and
- Develop and implement a prioritized CCTV inspection program to fully inspect the entire collection system and develop priorities for system rehabilitation.

Section 3.2.5 of the Program Plan describes the CRW collection system and the inspection investigations.

1.3.5 Regional Precipitation Characteristics

The median annual rainfall over the greater Harrisburg region is 39.6 inches. The median number of significant precipitation events is 86 storms per year. To quantify and characterize precipitation patterns, and support the development of the Program Plan, CRW successfully developed and implemented a precipitation gauge network consisting of eight tipping bucket rain gauges located throughout the CRW service area. Hourly rainfall data were also collected from the two National Weather Service gauges located at the Capital City Airport and at the Harrisburg International Airport. Like any rain gauge network, the CRW system cannot detect precipitation that occurs between the gauges. To fill these gaps and characterize the spatial variability of rainfall events throughout the CRW

Harrisburg Region Precipitation

Annual Precipitation Volume:

- Median: 39.6 inches
- Range: 31.7 to 47.9 inches

Annual Number of Precipitation Events:

- Median: 86
- Range: 74 to 98
- Volume: 0.46 inches per event
- Duration: 1.68 hours per event

Extreme (Design Storm) Rainfall:

Storm	24-hr. Volume (inches)	Peak Intensity (inch/hour)
2-year	2.90	3.3
5-year	3.67	4.1
10-year	4.36	4.8

service area, gauge adjusted radar rainfall (GARR) data were obtained and used along with the gauge network data.

A representative or typical year precipitation dataset for the CRW service area was created for use with a H&H model of CRW's conveyance system to establish the frequency, duration, and volume of CSO discharges; characterize their potential water quality impacts; and develop and assess alternative CSO control strategies.

To quantify and characterize specific locations with the potential for SSOs and unauthorized combined sewer discharges to occur within the CRW service area, a series of synthetic design storms (with 1-year, 2-year, 5-year and 10-year recurrence intervals) were developed and applied to the H&H models. **Section 3.3** of the Program Plan describes the precipitation data that were collected and the subsequent analyses that were conducted.

1.3.6 Wastewater Flow Monitoring

An accurate and up-to-date understanding was needed of existing wastewater flows generated within CRW's separate and combined catchment areas under dry and wet weather conditions, and the resulting flow along the CRW sewer interceptors. A flow monitoring plan was developed and implemented to collect the data needed to characterize the CRW system and to refine and validate the H&H model. Flow monitoring was performed at the following locations and more detailed descriptions of the monitoring program are provided in **Section 3.4.3**.

- At the four major points of connection (POCs) where wastewater flows from the suburban community collection systems are conveyed to the CRW system
- At five representative CRW separate sanitary sewer catchment areas to characterize base wastewater flow (BWF), groundwater infiltration (GWI), and rainfall dependent infiltration/inflow (RDII)
- At thirteen representative CSO regulator structures to characterize the hydrology of their tributary catchment areas
- At nine selected points along the CRW interceptor system to calibrate/validate hydraulic model of the conveyance system

1.3.7 Hydrologic and Hydraulic Modeling

CRW incorporated the sewer system information obtained through its completed facility inspection programs to update and refine its H&H model of the CRW conveyance system and major trunk sewers within its collection system. CRW utilized the precipitation monitoring and flow monitoring data to properly calibrate and validate its H&H model. The model was used to develop a thorough understanding of the wastewater and stormwater flow characteristics of its

sewer system in response to precipitation events of varying duration and intensity. The following goals were achieved:

- To quantify the hydraulic capacity along the conveyance and collection systems,
- To quantify and characterize sewer system overflows, and unauthorized combined sewer system discharges, and
- To support the development of the Program Plan.

The monitoring programs and the development and use of the H&H models are documented in Program Plan **Section 3.4**.

1.4 Problem Analysis and Priorities

CRW's *City Beautiful H_2O Program Plan* (Program Plan) seeks a balanced, affordable approach to addressing the following challenges with its separate and combined wastewater/stormwater collection, conveyance, and treatment systems:

- Equipment failure and structural/operational deficiencies attributed to decades of deferred maintenance at the AWTF,
- Structural/operational deficiencies and debris buildups attributed to decades of deferred maintenance along the conveyance and collection systems,
- Water quality degradation attributed to wet weather sewer discharges from CSOs and municipal separate stormwater sewer systems (MS4s) to receiving waters, and
- Separate sanitary sewer overflows (SSOs) from separate sewers and unauthorized releases from combined sewers (basement backups), attributed to hydraulic capacity limitations.

To develop an effective Program Plan, the specific problems identified within the existing CRW systems need to be characterized and prioritized so needed remediation measures can be developed and implemented.

1.4.1 AWTF Problems and Priority Repairs

Recent evaluations reveal that most treatment processes are in fair overall physical condition but require some capital replacement investments and additional O&M expenditures. The AWTF currently has no screening facilities and the design and installation of a screen system has commenced. Design has also begun for the rehabilitation of the existing primary clarifiers, including installation of baffles and other improvements to enhance hydraulic capacity and treatment efficiency. Other deficiencies have been identified within the anaerobic digester, waste activated sludge (WAS) thickening, trucked in/hauled waste, co-generation, dewatering, and gravity thickener facilities. CRW's estimated cost to accomplish needed AWTF

improvements is $70 million ($61 million in 2017 dollars), which are considered to be a high priority, needed to preserve/enhance existing capacity and to minimize the risk of major system failure.

1.4.2 Conveyance System Problems and Priority Repairs

Inspections identified structural and operational deficiencies and debris buildups, attributed to decades of deferred maintenance along the conveyance system. The inspections of the CSO regulators and outfalls found 15 CSO outfall pipes in need of repair and 40 CSO structures subject to potential river intrusion during a 2-year flood event or less. The interceptor system inspections prompted implementation of a cleaning program in 2016 where 1,800 tons of debris were removed and the pipes were re-inspected to confirm cleaning effectiveness and perform structural condition assessments. A scheduled interceptor system rehabilitation program was developed and is being implemented, and a 5-year cycle of re-inspection and cleaning has been recommended. Specific rehabilitation measures and upgrades have been recommended for the Front Street and Spring Creek wastewater pumping stations. CRW's estimated cost to accomplish these improvements is $39 million, which are also considered to be a high priority, needed to preserve/enhance existing capacity and to minimize the risk of major system failure.

1.4.3 Collection System Problems and Priority Repairs

CRW retained a contractor to perform the collection system Rapid Assessment Inspection Program in 2015 and 2016. CRW subsequently evaluated the collected data to assign condition scores to the assets. The results, which should not be confused with the level of confidence provided by full pipe televising, indicated that 17 percent of the inspected pipes were in excellent condition, 19 percent in good condition, 25 percent in fair condition, 21 percent in poor condition, and 17 percent in very poor condition. There were understood limitations to the information provided, so subsequently, CRW developed and is implementing a prioritized CCTV inspection program to fill in the information gaps at a pace within the capabilities of its equipment and staff.

CRW has developed an approach to identify and prioritize asset renewal needs as part of the overall Asset Management Program. This approach combines an asset's probability of failure and consequence of failure to determine the core risk, placing each asset in risk management zones, which in turn are used to develop priority levels. CRW has also implemented a stormwater inlet and catch basin cleaning and repair program, scheduled to be completed in 2021, to address inlets that are blocked with debris and those that require complete reconstruction when cleaned. Additional repair priorities will be established as condition assessment data becomes available. Existing structural and maintenance problems are documented in **Section 4.2** of the Program Plan.

1.4.4 Existing Discharges at CSO Regulators and Control Priorities

The results from the calibrated hydrologic and hydraulic model quantified wet weather sewer discharges from CSOs. The frequency, duration and volume (in million gallons) of CSO discharges

from each CSO outfall is provided in **Section 4.3** of the Program Plan. **Figure 1-3** illustrates the percent CSO capture by catchment within each of the 10 combined sewer planning areas, while **Table 1-2** summarizes this performance by interceptor. At EPA's request, discharges to the Susquehanna River are prioritized, with controls implemented within the financial capabilities of CRW and its customers.

Table 1-2: Existing CSO Discharge Statistics by Interceptor

Interceptor	Number of CSO Outfalls	Drainage Area (acres)	Captured Volume (million gallons)	Overflow Volume (million gallons)	Percent Capture	Annual Number of Overflows	Annual Overflow Duration (hours)
Front Street	27	723	302	247	55%	21 to 86	12 to 622
Paxton Creek	27	1,223	683	391	64%	9 to 74	2 to 620
Hemlock Street	5	124	40	28	59%	36 to 84	24 to 305
System Total	**59**	**2,900**	**1,024**	**666**	**61%**	**9 to 86**	**2 to 622**

1.4.5 Hydraulic Capacity Limitations Causing SSOs and Unauthorized Releases

Synthetic design storm rainfall was applied to the H&H model to estimate peak wastewater flows and water surface elevations within the existing separate sanitary sewer systems during the 2-year, 5-year, and 10-year 24-hour design storm events. The 2-year design storm has a 50 percent statistical probability of being equaled or exceeded in a given year. The 5-year design storm has a 20 percent probability of being equaled or exceeded in a given year, and the 10-year design storm has a 10 percent probability of being equaled or exceeded in a given year. The modeling results were able to identify specific locations where the design storm flows exceed sewer capacity, increasing the risk of unauthorized releases from the combined collection system and SSOs from the separate sanitary system. These pipe and manhole locations are depicted on maps provided in Program Plan **Appendix A** and the analyses are described in **Sections 4.4 and 4.5**.

The H&H model simulations also revealed limitations in the hydraulic capacity of the Spring Creek interceptor during the design storm events, increasing the risk of surcharging the interceptor and causing SSOs at manholes that have not been bolted down. Over 90 percent of the flow in the Spring Creek interceptor is generated by the suburban communities discharging into CRW's system, and a regional/intermunicipal solution is needed for the Program Plan. Unauthorized releases and SSOs caused by these hydraulic capacity limitations are prioritized primarily based on their relative risk to public health, safety, and welfare, with consideration of potential water quality impacts.

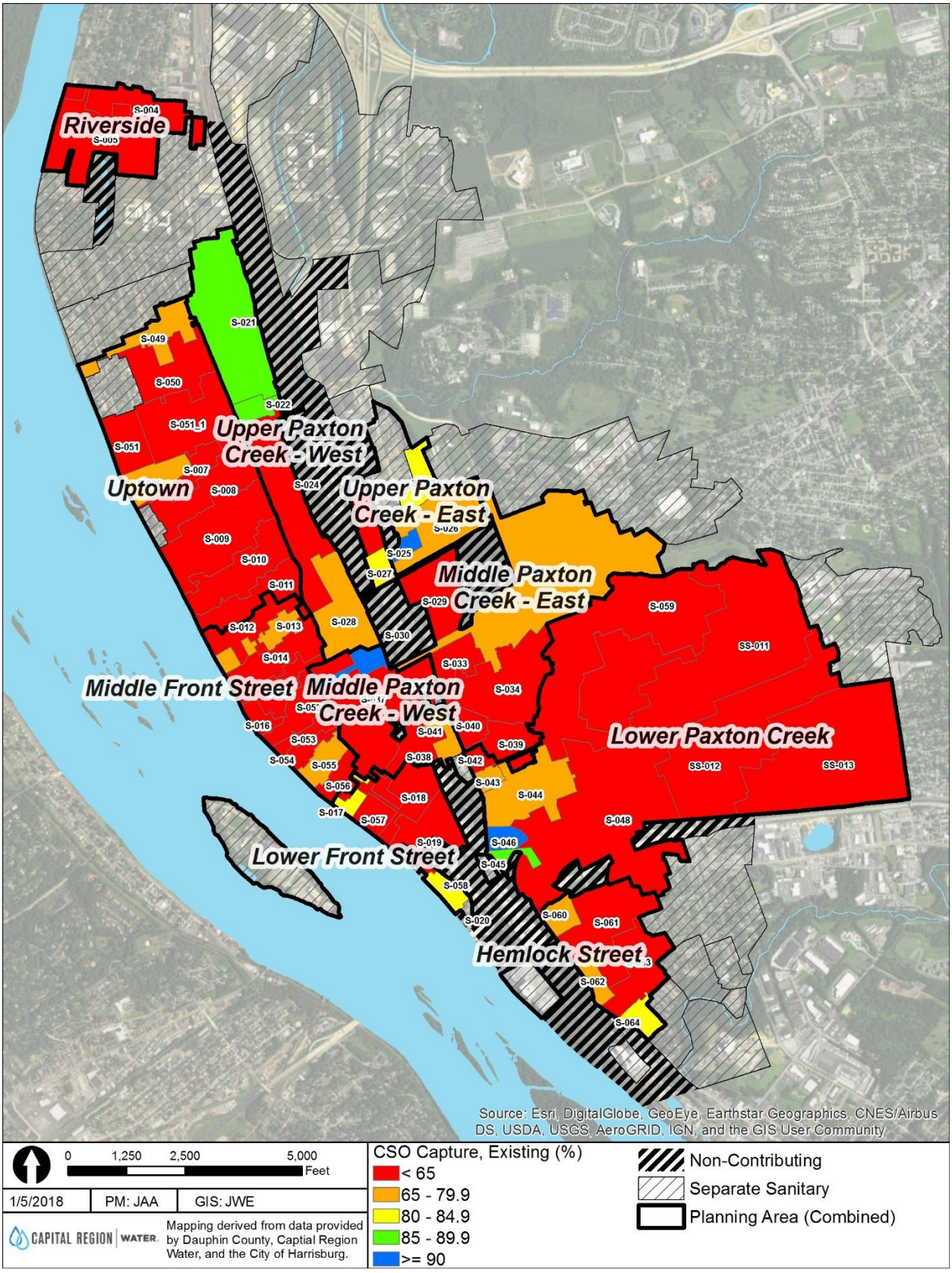


Figure 1-3: CSO Capture Achieved by CRW's Existing Combined Sewer System

1.4.6 Receiving Water Conditions

Over the past 10 years, extensive water quality monitoring and analysis has been conducted by CRW and PA-DEP on the two waterbodies receiving direct discharges from CRW's CSOs, the Susquehanna River and Paxton Creek. Conclusions were drawn from these data regarding CSO discharge characteristics, water quality, physical stream assessments, and biomonitoring. The primary pollutant of concern for the Susquehanna River is bacteria. The primary pollutants of concern for Paxton Creek are bacteria, sediments from excessive erosion, and oxygen-demanding substances that cause dissolved oxygen concentrations to fall below limits necessary to sustain aquatic life. Descriptions of receiving water quality are provided in **Section 4.6** of the Program Plan.

1.5 The Long-Term Planning Process

This section summarizes the governing principal objectives, approach, and planning process for developing CRW's *City Beautiful H_2O Program Plan* (Program Plan). The Program Plan meets the Long-Term Control Plan (LTCP) and integrated stormwater / wastewater planning requirements of the Partial Consent Decree (PCD). It provides a long-term, integrated strategy to address the hydraulic and structural deficiencies of CRW's wastewater and stormwater assets, improve in-stream water quality, beautify neighborhoods through community greening, and protect public health. **Figure 1-4** illustrates the major steps in this planning process, defined in more detail in the following sections.

1.5.1 Characterization and Problem Identification

The first major phase of the Program Plan development process was to implement the activities and processes required to fully understand the existing system; how it is configured, its current condition and defects, and how it performs hydraulically. CRW's characterization and problem identification process revealed substantial asset rehabilitation needs attributable to years of deferred maintenance throughout the treatment, conveyance, and collection systems. Hydraulic evaluation revealed frequent, short-duration overflows at each of CRW's regulated CSO outfalls, coupled with localized hydraulic constraints presenting increased risk of unauthorized releases and SSOs.

1.5.2 Control Technology Screening

The second major phase of Program Plan development process consisted of evaluating available stormwater/wet weather control technologies, categorizing them to fit the baseline, systemwide, and local control strategies, and eliminating from consideration technologies that are not feasible or relevant to implement within CRW's system. CRW's service area was divided into program planning areas, a standard procedure for the development of all Long-Term Control Plans. Fifteen planning areas were delineated, based on receiving water, interceptor sewershed, recognized neighborhoods, and logical groupings of catchments to support satellite control strategies.

1.5.3 Alternative Development and Evaluation

The third major phase of the Program Plan development process is to formulate feasible control strategies. Control strategies for the CRW service area involved both centralized strategies for the entire system, and decentralized strategies for each planning area. Within each of the program planning areas, these control strategies help to solve existing problems regarding uncontrolled CSO discharges, significant structural deterioration, and hydraulic pinch-points presenting a heightened risk of unauthorized discharges or SSOs (e.g. localized flooding and basement backups). Appropriate control technologies are selected for each control strategy, a "knee-of-the-curve" cost performance analysis was conducted, limitations on the level of control achievable within each strategy were defined, and the benefits of each strategy were evaluated using triple bottom line evaluation criteria. Specific control technologies were selected for each control strategy, as well as feasible levels of implementation based upon an evaluation of the opportunities and barriers to implementing these controls within CRW's system.

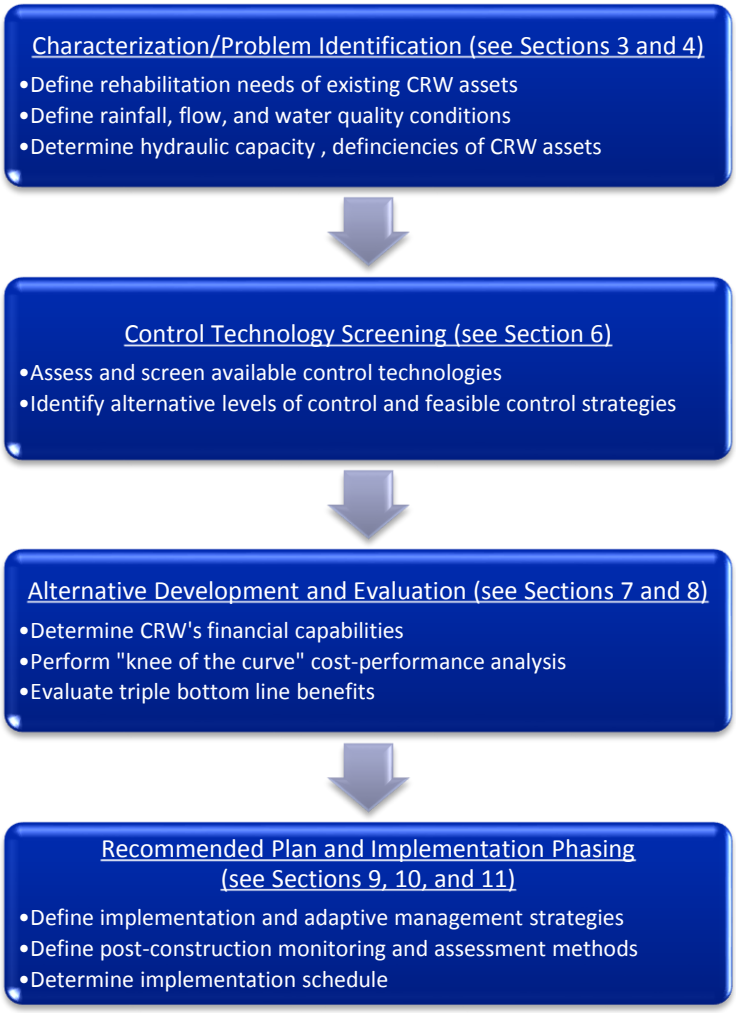


Figure 1-4: Summary of Integrated Wet Weather Control Plan Process

1.5.4 Recommended Control Plan and Implementation Phasing

The final phase of the Program Planning process is to use the findings of the screening activities and the selected control strategy/technology combinations to consider a range of facility sizes and associated control ranges, and to conduct affordability and cost-effectiveness analyses to identify the optimal control range and implementation schedule and duration. A control plan was selected that minimizes CSO discharges, improves water receiving quality, addresses stormwater management and local flooding, and meets affordable guideline constraints for rate payers. It must be understood that strongly desired projects and/or control facility elements may need to be ruled out, and not incorporated into the selected plan, because their costs are outside the range of affordability, even though the component may be "needed" or provide significant desired

benefits. The selected plan, as identified and defined in the Program Plan, will evolve over time under an adaptive management implementation approach.

1.6 Control Technologies and Screening

This section describes the potential CSO control technologies to be considered by CRW for integration into the *City Beautiful H_2O Program Plan* (Program Plan). The screening process evaluates available control technologies, identifying those that would be effective in the CRW system, and eliminating from consideration technologies that are not feasible or relevant to implement within CRW's system. The technologies included in the screening analysis are generally grouped into the following categories:

- ***Source Controls:*** Measures that reduce the volume, peak flow, or pollutant load of runoff, either before it enters the Collection System or is redirected to an MS4, including green stormwater infrastructure. Non-structural source controls are required under the minimum controls of the CSO policy and the MS4 permit, while structural source controls (e.g., green stormwater infrastructure) are implemented through a local, decentralized control strategy.

- ***Collection System Controls:*** Measures that restore and maintain the resiliency of CRW's sewer assets, increase their hydraulic capacity, and/or reduce the volume, peak flow, or pollutant load of flows within the Collection System. Collection system controls have localized effects on CSOs, SSOs, MS4 discharges, and unauthorized releases within a single catchment, and are also implemented through a local, decentralized control strategy.

- ***Conveyance System Controls:*** These controls are intended to increase the hydraulic capacity of the conveyance system (i.e., CSO regulators, interceptors, pump stations), and/or increase the wet weather treatment capacity of CRW's AWTF. Conveyance enhancements may be part of satellite control strategies (i.e., consolidation sewers that convey flow from the collection system to a satellite control site), or as part of a strategy to enhance capacity. Conveyance system controls affect the performance of the entire sewer system and are implemented through a systemwide control strategy.

- ***Storage Technologies:*** In-line and off-line storage for wet weather flows that are detained during significant storm events and released once rainfall/snowmelt has ended and treatment and conveyance capacity have been restored. This category of control is typically deployed at or near a CSO outfall (or consolidated set of outfalls), providing storage upstream of the AWTF. Storage technologies may be implemented through local, satellite control

strategies or, for larger facilities that affect the performance of the entire sewer system, through a systemwide control strategy.

- ***Treatment Technologies:*** Technologies that treat the wet weather flow prior to discharge from the conveyance system to reduce pollutant load to the receiving waters. This category of control is also typically deployed at or near a CSO outfall (or consolidated set of outfalls), providing treatment upstream of the AWTF. Satellite controls were evaluated for each of the various planning areas established within CRW's service area. Treatment technologies may be implemented through local, satellite control strategies or, for larger facilities that affect the performance of the entire sewer system, through a systemwide control strategy.
- ***Receiving Water Technologies:*** Methods for removing pollutants after they have been discharged to the receiving waters. Streambank stabilization measures recommended under the Joint Pollution Reduction Plan for Paxton Creek and other receiving waters utilizes receiving water technologies.
- ***Not Applicable/Not Feasible:*** Some controls may not be applicable to CRW's system, or may not be feasible to implement within CRW's system. Not applicable/not feasible control options are not considered further in this plan.

1.7 Financial Capability Analysis

Paragraph 18 of the PCD required that the draft *City Beautiful H_2O Program Plan* (Program Plan) include a final Financial Capability Assessment (FCA) as described in the 1994 US EPA CSO Control Policy and subsequent guidance documents. The FCA is a two-phased process. The residential indicator (RI) is the percentage of median household income (MHI) expended on wastewater and stormwater services annually. US EPA considers that expenditures exceeding 2.0 percent of MHI impose a high burden. Therefore, the upper limit of affordability within the City of Harrisburg (City) is the point where the total cost for wastewater and stormwater services exceeds 2.0 percent of the City's MHI.

The second phase of the FCA provides a financial indicator (FI) of the permittee's ability to finance capital CSO controls. The financial capability indicator assesses debt burden, socioeconomic conditions, financial operations, and certain economic and demographic conditions such as the area's unemployment rate and MHI compared to those of the entire United States. The RI and FI are combined into a financial capability matrix to determine the level of financial burden on households and permittees.

The FCA methodology identified in the US EPA guidance presents a "snapshot" view of affordability which assumes that all capital expenditures will occur simultaneously. It starts with the current wastewater system annual costs, onto which are added to the incremental debt service and operation and maintenance costs in current dollars resulting from CSO controls and all other known capital improvements, e.g. collection system rehabilitation. The percentage of costs attributable to residential users is identified and the typical costs per household is

calculated using the number of households. Using this methodology, total future capital expenditures by CRW attributable to the City of Harrisburg of approximately $185 million (in 2017 dollars) would trigger the 2.0 percent high burden RI for the City residents.

The US EPA "snapshot" methodology is very limited in its ability to account for the impact that long term capital improvement programs will have on community, customer bills, and affordability. In order to present a more comprehensive picture of the City of Harrisburg's financial capability and customer affordability a comprehensive long-term financial planning model was prepared that is based on the model that CRW uses to evaluate budgets and set wastewater rates, and to assess the impacts of program alternatives on customer bills. This model includes known and necessary priority capital expenditures. These expenditures total approximately $315 million (escalated), or $253 million (in 2017 dollars), largely for critical investments in existing treatment and conveyance facilities.

The long-term financial planning model indicates that significant wastewater rate increases will be needed over the first five years of the plan. Including the 7.1 percent rate increase that was adopted by CRW in 2017 for 2018, the financial plan would require cumulative increases in wastewater rates of 75.4 percent over the period of 2018-2022. After 2022, the residential bill as a percentage of MHI approaches 2 percent and remains at this level throughout the remaining portion of the 20-year period (2023-2037).

To hold the Harrisburg RI at the 2.0 percent high burden threshold, future annual capital expenditures will need to be limited to projected expenditures in years 11 through 20 through 2047 when current 30-year debt is paid off. Strategically, three categories of investment will need to be funded through this available amount: collection system rehabilitation / renewal, decentralized green and grey CSO controls, and new operational and administrative activities required to implement the nine minimum controls and the decentralized green and grey controls.

While the long-term financial plan and affordability model was designed to keep total annual City residential customer cost for wastewater and stormwater service at or below 2 percent of MHI, it is anticipated that there will still be financial capability and affordability issues for some customers within the City. For some customers within the City, the cost as a percentage of income will far exceed 2 percent. The cost as a percentage of income for some Census tracks within the City, representing approximately 17 percent of the population, are anticipated to exceed 3 percent, of MHI, and several census tracts, representing an additional 4 percent of the population, will be in the 2.5 – 3.0 percent range. This indicates that the increases in wastewater and stormwater costs to residential customers within the City may be unaffordable and result in significant economic hardship for some customers, even if the cost as a percentage of the MHI stays at or below 2 percent.

Given these considerations, CRW should receive the maximum schedule relief possible for implementing its Program Plan. The implementation schedule presented in this report, is a

reasonable timeline to take into account affordability considerations and concerns in the more vulnerable areas of the CRW's service area.

1.8 Development/Evaluation of Alternative Control Strategies

The PCD requires that the Program Plan assess the potential size and cost of alternative control technologies to reach various levels of control. This evaluation defined the level of CSO discharge control (i.e. the reduction in the frequency, volume and duration of discharges during typical year precipitation) that could be achieved by each technology over a range of sizes. The CRW H&H model was used to perform what is called a "knee-of-the curve" cost performance evaluation, required by the Partial Consent Decree. These cost-performance curves were used to indicate the level of control needed to reach certain control objectives:

- A ***baseline level-of-control***, defined as the level of CSO control achieved through imlementation of the system rehabilitation measures outlined in **Section 4**.
- An ***affordable level of control***, defined as additional wet weather controls that can be implemented within CRW's financial capabilities, as presented in **Section 7**,
- A ***cost-effective level of control***, defined as the additional wet weather controls at the "knee of the curve", where the inflection point along each cost curve indicates the level of control above which any additional control measures would be less cost effective, and
- A ***presumptive level of control***, defined as the controls necessary to capture and treat 85 percent of the systemwide combined sewage during the typical year.

A graph showing the results of a typical knee-of the curve analysis is provided in **Figure 1-5**. Knee-of-the-curve analyses were conducted for two systemwide control strategies and three local control strategies within the 15 planning areas composing CRW's service area.

1.8.1 Baseline Level of Control

The ***baseline level of control*** involves multi-objective projects that rehabilitate priority system assets by optimizing existing sewer system performance. It includes relatively low-cost operating changes, repairs, and small-scale capital projects that can improve the capacity, efficiency, and performance of the combined sewer system in the near term. **Figure 1-6** illustrates the CSO capture achieved under the Baseline Control Strategy. The figure indicates, that systemwide CSO volume capture increases from 53 percent to 78 percent through implementation of baseline controls, achieved through a $2.2 million investment (in 2017 dollars) in regulator modifications and hydraulic enhancements achieved by previously scheduled re-investments in the AWTF, major pumping station, and interceptor sewers described in **Section 4**. The baseline level of control is the recommended foundation for evaluation of alternative control strategies, with baseline control investments representing the highest priority projects and activities under this plan, with implementation anticipated during the first 10 to 15 years following approval of this Program Plan.

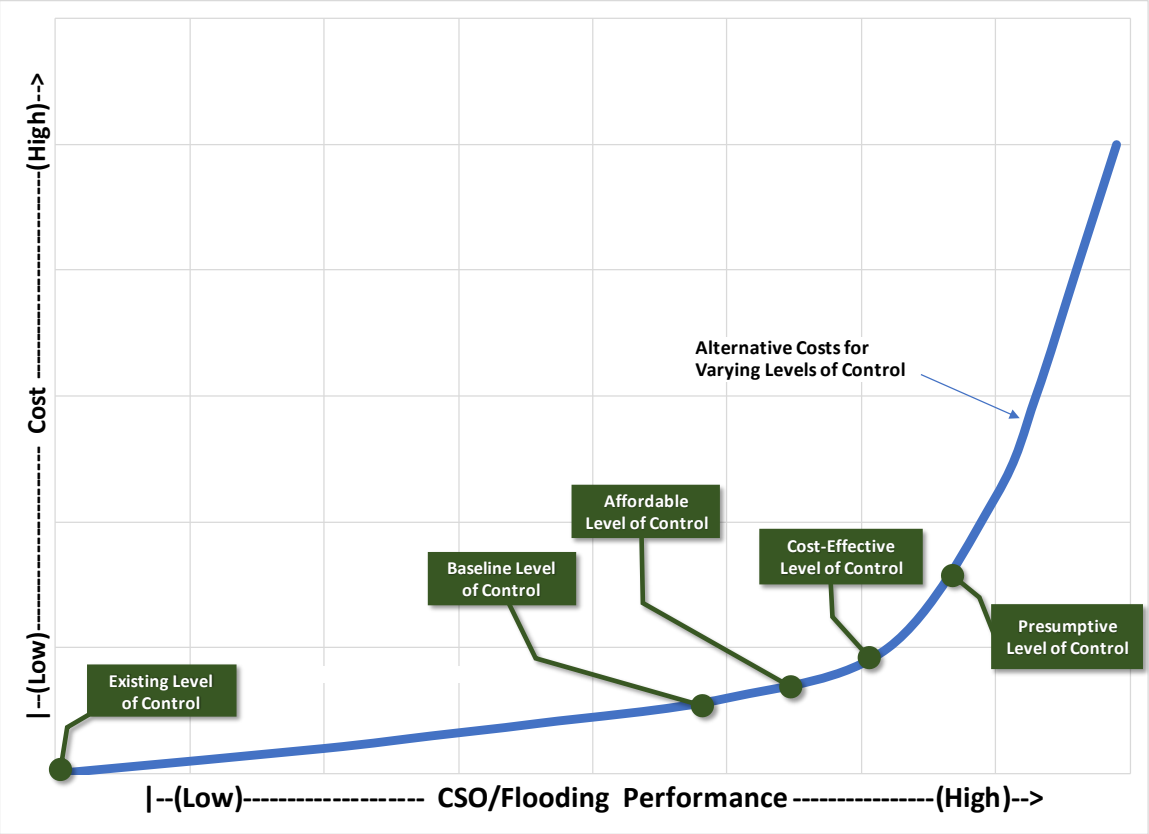


Figure 1-5: Idealized "Knee-of-the-Curve" and Potential Level of Control Objectives

1.8.2 Development of Alternative Control Strategies

The following ***alternative control strategies*** were developed by combining a unique set of the stormwater/wet weather control technologies previously evaluated in **Section 6**:

Systemwide Control Strategies

Systemwide control strategies focus on feasible technologies that further enhance the control of stormwater and wet weather flow within CRW's conveyance and treatment systems, i.e., the AWTF, major pump stations, interceptors, and/or regulator structure. Systemwide control strategies enhance system resiliency and contribute to receiving water quality improvement, but are ineffective at addressing sanitary sewer overflows (SSOs) and unauthorized releases (i.e. sewage backup into basements and manhole flooding into streets) within the collection system. Two alternative systemwide strategies were evaluated.

Systemwide Strategy 1: *Enhanced Conveyance and Increased AWTF Capacity* increases existing conveyance capacity by upgrading interceptors, regulators, major pump stations, and the AWTF. This strategy only provides a single control option within CRW's affordable level of control range, offers no opportunity to address unauthorized releases from the combined sewer system, and involves significant major capital projects, restricting CRW's ability to address critical collection system rehabilitation needs.

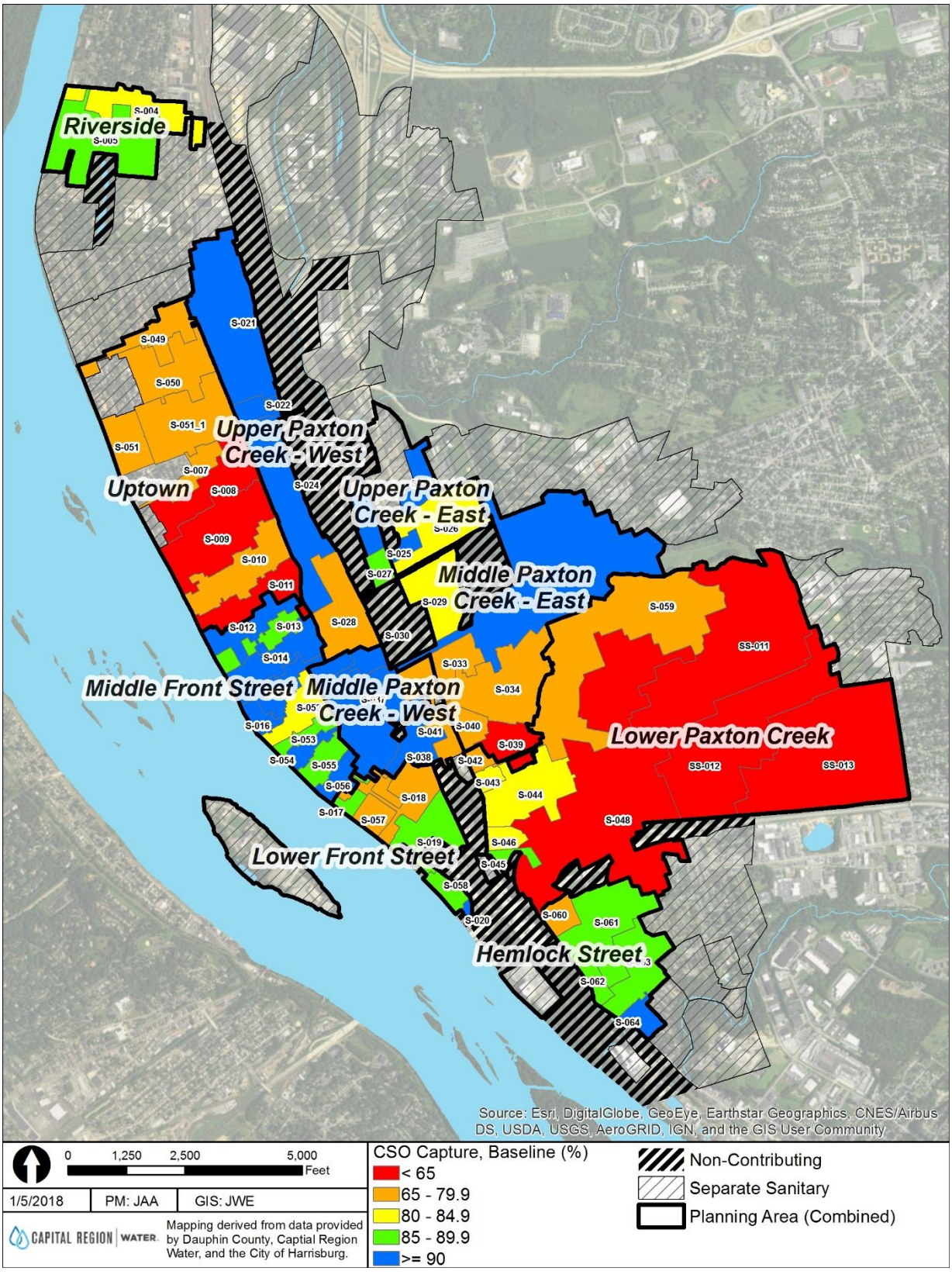


Figure 1-6: CSO Volume Capture by Catchment under the Baseline Level of Control

- ***Systemwide Strategy 2:*** *Build a deep tunnel* involves collecting/storing combined sewage flows exceeding the existing conveyance capacity, with post-storm dewatering to the AWTF. The smallest feasible control level under this strategy, a 14 million gallon tunnel is unable to be phased / financed within CRW's remaining financial capability, costs approximately four times more than the upper limit of CRW's affordable level of control range, and costs over twice as much as Enhanced Conveyance and Increased AWTF Capacity to achieve an equivalent level of CSO control. As a result, it is not considered to be a feasible control strategy for CRW's system.

Local Control Strategies

Local control strategies place technologies within CRW's collection system to address both neighborhood flooding and water quality impacts of discharges to receiving waters. Local control strategies use decentralized or local planning basin area approaches that implement various combinations of the grey control technologies and the green control technologies that were selected through the previously completed control technology screening process.

- ***Local Strategy 1:*** *Decentralized controls* (green-grey) within neighborhoods and individual catchment areas to reduce CSOs/SSOs/ unauthorized discharges, and MS4 discharges; maximize triple bottom line benefits, and leverage non-traditional funding sources.
- ***Local Strategy 2:*** *Satellite controls* place storage/treatment/conveyance facilities near outfalls to control CSOs, with limited opportunities to control SSOs, unauthorized releases, and MS4 discharges.
- ***Local Strategy 3:*** *Separation* of stormwater and wastewater sewers within catchment areas where the baseline strategy does not achieve the desired level of control, accompanied by green infrastructure sized to treat stormwater.

A subsection was created for systemwide control strategies and local control strategies for each of the 15 designated planning areas that comprise the City of Harrisburg (City). Each planning area subsection contains the following three map figures:

- A map figure depicting existing CSO discharge statistics at each outfall, hydraulic bottlenecks and surface flooding, and structural problems,
- A map figure depicting targeted areas for decentralized green and grey infrastructure implementation, the intersection of (a) impervious areas with high to moderate potential for control with green infrastructure, (b) areas of high risk for unauthorized releases/SSOs, (c) catchments with high CSO volumes / frequencies, and (d) potential integration with high priority sewer rehabilitation projects, and
- A map figure depicting satellite treatment and/or storage opportunities and the resulting improvements to CSO discharge statistics at each outfall.

1.8.3 Evaluation of Alternative Control Strategies

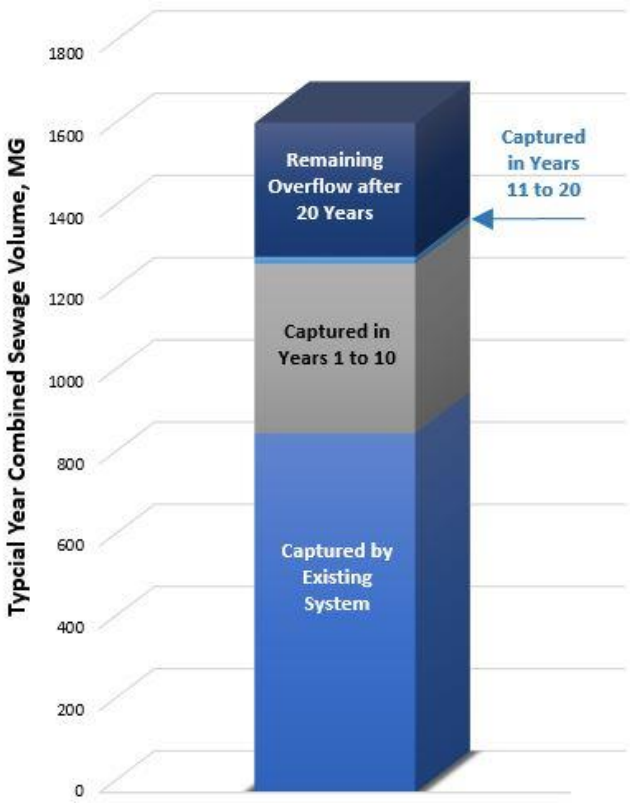
Each planning area subsection also provides a graphical representation of the results of the knee-of-the-curve analysis showing the CSO capture performance (representing the water quality

benefit) versus the associated opinion of probable cost. Cost curves show the baseline level of control allocated to each planning area, as well as the level of control achieved by each alternative systemwide and local control strategy. Also depicted on the graphic are the costs associated with the alternative levels of control (baseline, affordable, cost-effective, presumptive). The following conclusions about a systemwide and decentralized/local control strategy are drawn from the cost performance evaluation.

- Five of the fifteen planning areas are served by separate sanitary and storm sewer systems. H&H modeling revealed a limited number of locations where sewer surcharging may increase the risk of basement backups/SSOs. These areas will be monitored for customer complaints about basement backups to establish the priority for considering system improvements, as CRW has not received reports of basement backups in these areas to date. In addition, CRW has not observed or received reports of SSOs on the Spring Creek interceptor since CRW bolted down select manholes. Flow equalization storage is considered the recommended alternative for reducing this surcharging, however the need, priority, and phasing of this project will depend upon additional monitoring and assessment.

- The baseline level of control is highly cost-effective and recommended for implementation. It leverages planned investments in rehabilitation of CRW's AWTF, major pumping stations, and interceptors, increasing the overall hydraulic and primary treatment capacity of this system to 80 mgd. An additional $2.1 million investment to renovate CRW's CSO regulators and outfalls with modern flow regulating technology directs more flow into the interceptor, pumping stations, and AWTF, utilizing CRW's full hydraulic and primary treatment capacity. The baseline level of control also dramatically decreases CSO volumes and durations.

- The baseline level of control is able to achieve or exceed the presumptive level of control (i.e., capture 85 percent of the combined sewage volume in a typical year) in seven of the ten Planning Areas served by combined sewers. As such, these seven planning areas are considered to be a low priority for additional CSO control during the 20-year planning horizon of the Program Plan. Opportunities for additional control in these planning areas will depend on sewer rehabilitation priorities assigned through CCTV inspections of collection system sewers and development/public works projects that may be able to cost-effectively incorporate stormwater management controls.



- In the remaining three planning areas, the baseline level of control does not achieve the presumptive level of control (i.e., capture 85 percent of the combined sewage volume in a typical year). These three planning areas are considered to be a high priority for additional CSO control during the 20-year planning horizon of the Program Plan. In these areas, Local Control Strategy 1: Decentralized controls (green-grey) consistently provides an equal or higher level of control for the same cost as the other two control strategies. The decentralized control strategy also provides CRW the greatest flexibility to integrate controls into development and public works projects while addressing critical collection system rehabilitation and mitigate potential unauthorized releases. CRW' remaining financial capability over the next 20 years must be balanced between collection system rehabilitation and wet weather control priorities.

- The systemwide control strategies involve large capital investments in expanding the conveyance and/or treatment capacity of CRW's interceptors, pumping stations, and AWTF. In general, the cost of even the most modest of these control strategies far exceeds CRW's remaining financial capability for additional capital projects over the next 20 years. In addition, projects under the systemwide control strategy do not address priority structural and hydraulic problems within CRW's collection system, and would divert CRW funding from these projects. As such, the systemwide control strategies are not considered an appropriate control strategy for CRW over the 20-year planning horizon of this Program Plan.

Clearly, achieving an increased level of control is limited by CRW's financial capability constraints highlighted in Section 7 and high-priority system rehabilitation needs identified in Section 4. The decentralized control (green-grey) strategy is affordable, cost-effective, and flexible, allowing continued progress at integrated stormwater and wastewater control. To implement this strategy, future investment decisions in both asset rehabilitation and decentralized control implementation will be guided by CRW's triple bottom line (TBL) framework that incorporates three dimensions of performance: social, environmental and financial. TBL is a concept which seeks to broaden the focus on the financial bottom line by including social and environmental responsibilities and Program Plan benefits.

The CRW planning process included preparing and considering three different (and quite separate) bottom lines. One is ***financial***, the traditional bottom line of the cost and benefit analysis. The second is ***social/community***, the bottom line of the Plan's "people account", a measure in some shape or form of how socially responsible the Plan is in improving the quality of life for CRW's customers. The third is ***environmental,*** the bottom line of the Plan's "planet account", a measure of how environmentally responsible it is. This TBL framework will be applied to guide adaptive management decision-making as the Program Plan is implemented.

1.8.4 Recommended Control Strategy

The alternative evaluation presented in **Section 8** indicates that Local Control Strategy 1 – Decentralized Controls (green-grey) is the preferred control strategy for CRW. In summary, the following major reasons support this recommendation.

- ***It is affordable and cost-effective***, meeting wet weather control objectives and supporting a multitude of multi-objective benefits, with significant opportunity for public-private partnerships to share implementation costs with CRW ratepayers.
- ***It is flexible,*** installed in small, incremental investments throughout the system, using technologies that can be designed to also address unauthorized releases and integrate with sewer rehabilitation projects, and suitable for integration with a broad range of redevelopment and public works projects. Indeed, with the limited financial capabilities of CRW and the remaining uncertainty in the magnitude of collection system renewal needs, it may represent the only viable strategy to begin meaningful wet weather control.
- ***It is balanced,*** providing CRW the opportunity to invest throughout the community as well as avoid areas of excessive community impacts. It does not favor or place undue burden on any part of the community and, in fact, is designed to "lift up" the community through strategic investments that benefit water quality, public health and safety, and promote re-investment in the community.
- ***It builds upon the baseline level of control,*** with its initial focus on the rehabilitation and enhanced reliability of CRW's AWTF and conveyance system, anticipated to provide significant wet weather control benefits within the first 10 years of program implementation, with deployment of decentralized controls in priority areas to "fill gaps" in existing system performance.
- ***It has community support,*** consistently demonstrated through public engagement opportunities, and representing the only strategy that "gives back" to the community, potentially providing ancillary economic benefits that enhance the financial capabilities of CRW and its ratepayers.

Table 1-3 indicates priorities for investment in decentralized controls, along with the anticipated time frame for implementation under the affordable level of control. According to a preliminary evaluation performed for CRW's Community Greening Plan:

- A high potential exists to control approximately 20 percent of the impervious area within the City with decentralized controls (green/grey).
- A moderate potential exists to control an additional 44 percent of the impervious area within the City with decentralized controls (green/grey), including 39 percent of the impervious area within the combined sewer system.

The decentralized control strategy will prioritize implementation of these high-to-moderate potential decentralized controls:

- Strategic control areas delineated to meet multiple control objectives (control CSOs, reduce unauthorized discharges, and maximize triple bottom line benefits) existing for approximately 29 percent of the impervious area within the combined sewer system,
- Planning-area-specific CSO control targets are established for the three planning areas (i.e., Uptown, Lower Front, and Lower Paxton) where baseline controls are less effective at reducing CSOs. As such, these planning areas should be considered a higher priority when determining where to site decentralized controls (green/grey) in the future.
- City-wide, non-priority/strategic controls are anticipated within the other planning areas via coordinated right-of-way/streetscape project, development projects, and/or other initiatives. Their effectiveness at controlling CSOs, unauthorized releases, and/or MS4 discharges will need to be determined based on their actual implementation location and design criteria.

Table 1-3: Summary of Preferred Control Strategy – Decentralized Controls (Green / Grey)

Planning Area	Impervious Area (Acres)	GSI Implementation Opportunities[1]			Cumulative GSI Implementation Targets	
		High Potential	Moderate Potential	Strategic[2]	Immediate (Years 1-10)	Near-Term (Years 11-20)
Combined Sewer System						
Riverside	53.7	13%	46%	10%	0%	0%
Uptown	246	18%	41%	24%	6%	9%
Middle Front Street	131	22%	31%	19%	0%	0%
Lower Front Street	59.1	19%	62%	48%	15%	15%
Upper Paxton Creek - West	162	33%	52%	47%	0%	0%
Upper Paxton Creek - East	28.5	15%	64%	52%	0%	0%
Middle Paxton Creek - West	97.3	44%	39%	69%	0%	0%
Middle Paxton Creek - East	201	22%	40%	9%	0%	0%
Lower Paxton Creek	510	15%	34%	25%	5%	10%
Hemlock Street	68.2	1%	15%	44%	0%	0%
Subtotal	**1556**	**20%**	**39%**	**29%**	**3%**	**5%**
Separate Storm/Sanitary Sewer System[3]						
Italian Lake	157	29%	46%	0%	N/A	N/A
Industrial Road	208	9%	80%	0%	N/A	N/A
Arsenal Blvd	120	39%	49%	0%	N/A	N/A
East Harrisburg	64	34%	60%	0%	N/A	N/A
Spring Creek	103	1%	35%	0%	N/A	N/A
Subtotal	**652**	**21%**	**57%**	**0%**	**0%**	**0%**
City-wide Non-Priority/Strategic						
	N/A	N/A	N/A	N/A	1%	2%
Total	**2208**	**20%**	**44%**	**20%**	**3%**	**5%**

1.9 Implementation and Adaptive Management Plan

The CRW Program Plan (Program Plan) involves a range of operational and administrative services to support implementation of the proposed controls. Four distinct strategies will be implemented under the Program.

1.9.1 Four Implementation Strategies

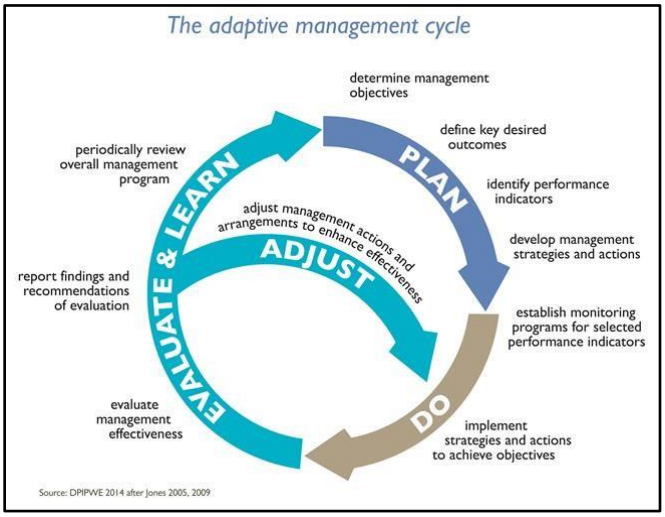
An ***Asset Rehabilitation and Renewal Strategy*** will entail the continual inspection, assessment, and prioritized renewal of CRW's wastewater/stormwater assets as part of the overall Asset Management Program. In this framework, there are two parameters used for prioritization decision-making. Asset Probability of Failure (POF) is a function of remaining service life and is correlated to the asset's physical condition and other performance considerations. Asset Consequence of Failure (COF) is evaluated based on estimating the environmental/regulatory, financial and social impacts of a defined failure of the asset. These two parameters are linked together and evaluated based on triple bottom line assessment of the failure of the asset.

A ***Decentralized Green / Grey Implementation Strategy*** will continually seek affordable and cost-effective opportunities to implement stormwater controls within the context of related infrastructure and community renewal and redevelopment projects. Under its Community Greening Plan, CRW will implement selected pilot projects aimed at demonstrating the utility of various green stormwater infrastructure (GSI) control technologies in highly urbanized areas, intended to help raise awareness of GSI among City residents and the regulatory community. GSI elements will be incorporated into public works projects by intent and/or through enhanced standardized design requirements. CRW will be demonstrating various GSI tools along streets including stormwater tree pits, curb cuts, bump-outs, porous pavement and tree trenches. CRW will evaluate implementing an impervious area-based stormwater fee to provide a fair and true cost of service allocation that provides incentives for non-residential and stormwater-only customers to incorporate stormwater management practices where practicable.

An ***Asset Operation and Management Maintenance Strategy*** will keep CRW's treatment, collection and conveyance assets in good working order, free from structural deficiencies, debris, and blockages, allowing them to continue to operate as designed. CRW will also seek opportunities to integrate monitoring and control technologies into its assets as part of rehabilitation projects, with a goal of implementing telemetered surveillance and control where proven to enhance system operation and performance. CRW will determine the maintenance needs associated with various types of stormwater control measures to guide their maintenance by public agencies and by private entities on private property.

An ***Internal and Intergovernmental Communications and Coordination Strategy*** will build implementation partnerships with various stakeholders. CRW will continue to promote effective interagency coordination to define strategic policies and streamline protocols and communication pathways to better align with full-scale GSI implementation. In addition, an Internal Communications Plan to improve synchronization within CRW will be developed. This communications plan will identify and evaluate policy barriers to implement the Program Plan, and will initiate strategies to address these challenges.

1.9.2 Adaptive Management Process



Implementation of the Program Plan elements will rely upon an Adaptive Management Process. This adaptive management approach will require flexibility and periodic program assessments throughout the implementation period. Adaptations in the management approaches are expected throughout this period to ensure that compliance goals are met, to optimize and enhance the program, to maximize benefits, and minimize the costs of implementation. Major decisions on management approaches will be made every five years based on progress toward the goals and will be described in Evaluation and Adaptation Plans (EAPs).

- ***Adaptive Management Triggers:*** This Program Plan outlines an adaptive management process with "decision points" every five years. These decision points are used to evaluate progress towards Program Plan implementation and determine refinements to the implementation approach gained from "lessons learned" and new information acquired during the implementation period.

- ***Financial Capability Re-Assessment:*** Financial capability will help determine what programmatic changes will be feasible, necessary, and achievable. Local economic conditions, including changes in household income, revenue, capital spending in response to new regulations or requirements, construction and operating costs, and CRW's financial position and cost of capital, will be assessed. Adjustments to the program that either increase the rate of progress toward goals or decrease spending to avoid economic hardship will be considered.

- ***Evaluation and Adaptation Plans:*** A series of EAPs will be created at 5-year intervals. The first EAP will be developed and submitted after 10 years of Program Plan implementation. Each EAP will be a comprehensive assessment of CRW's progress towards full implementation of the approved Program Plan with descriptions of program elements expected to be implemented in the next five-year period. The EAP will include a description of the outcome of adaptive management decisions and changes in implementation for the following five years. Any proposed change in priorities or approach for meeting the milestones in the following five years will be described, including altering approaches to implementing GSI and, if necessary, targeted traditional infrastructure investments or changes in design approaches.

- ***Adaptive Management Reporting:*** Through CRW's annual reporting process, continuous updates on the adaptation of the implementation program will be provided. if the CRW were to fail to achieve one or more of the metrics documented in an EAP, the subsequent Annual Reports will include an update describing CRW's progress towards meeting those metrics. Such updates will be provided in subsequent Annual Reports until all the applicable metrics have been achieved.

1.10 Post Construction Monitoring Plan

Post-construction compliance monitoring is a required element for all long term wet weather plans, and is intended to provide sufficient information to estimate the effectiveness of the control measures implemented under the *City Beautiful H_2O Program Plan* (Program Plan). The Post Construction Monitoring Plan (PCMP) for the CRW Program Plan was developed to verify that activity commitments have been implemented and to quantify and characterize the efficacy of CRW Program Plan improvements. PCMP reporting will have two aspects:

- ***Annual reporting****,* implemented through the existing series of annual Chapter 94 Reports submitted to the US-EPA and the PA-DEP.

- A ***comprehensive report****,* prepared and submitted after the Program Plan has been implemented, anticipated approximately ten years following approval of this Program Plan.

Eight categories of monitoring and reporting are included in the PCMP and summarized below.

- ***Administrative Monitoring and Reporting:*** Accounting-based factors including impervious area draining to green infrastructure, miles of rehabilitated sewers, annual debris removal volumes, system maintenance efforts, and other appropriate measures will be documented and reported to verify Program Plan commitments have been implemented.

- ***Precipitation Monitoring and Assessment:*** The existing gauge network and gauge adjusted radar rainfall (GARR) data will be used to quantify and characterize precipitation for the PCMP. The current typical year precipitation volumes and frequencies will be used by the updated hydrologic and hydraulic (H&H) models to quantify and characterize typical year CSO discharge statistics. The high resolution, spatially distributed GARR precipitation data will be used by the H&H models to provide the annual CSO discharge statistics for each CRW CSO outfall location.

- ***Interceptor Monitoring and Assessment:*** The existing network of nine interceptor monitoring sites will be used to quantify and characterize interceptor flow for the PCMP. Existing interceptor monitoring activities may be suspended until needed to assess the benefits of system improvements as key Immediate Implementation Phase Program Plan items are completed.

- ***Suburban Community System Monitoring and Assessment:*** The existing network of four points of connection monitoring sites will be used for the PCMP to quantify and characterize dry and wet weather flow from the suburban community separate sanitary sewer systems.

- ***CSO Regulator Structure Monitoring and Assessment:*** For annual reporting, the daily inspections conducted by CRW crews at all the CSO regulator structures will continue as the Program Plan is implemented. Wooden blocks placed on the crests of the diversion weirs indicate CSO activity and observations will continue to be logged on a daily basis in the Cityworks asset management system for the PCMP. To support preparation of the comprehensive report for the Immediate Implementation Phase, the PCMP will also include installing area-velocity meters at 10 selected CSO regulators for a 6-month duration. The resulting data from the inspections and monitoring will be used to validate the revised H&H model.

- ***CSO Discharge Projections through H&H Modeling:*** The calibrated CRW hydrologic and hydraulic model will be used to simulate dry and wet weather flow from all catchment areas within the City of Harrisburg, for both separate and combined sewer systems, and from the suburban community systems. As system improvements are completed as part of the Program Plan, corresponding revisions and updates will be made to the H&H model to reflect these revisions. The improved condition model results for CSO discharges will be compared with the existing condition results to quantify and characterize the performance of the

improved CRW system and verify that the level of CSO reductions predicted in the Program Plan are achieved.

- ***Water Quality Monitoring and Assessment:*** Water quality monitoring and characterization for the CRW PCMP will be implemented by partnering with PA-DEP to collect and assess water quality data. The water quality parameters previously measured by PA-DEP have been total settleable solids, total suspended solids, BOD_5, total nitrogen, total phosphorus, and fecal Coliform bacteria.

- ***Paxton Creek Use Attainability Assessment:*** The water quality compliance strategy for Paxton Creek is to coordinate with PA-DEP to have a Use Attainability Study conducted that would change the use designation for the creek. For the PCMP, CRW will provide progress updates on its coordination activities with PA-DEP as part of its annual Program Plan reporting.

1.11 Recommended Plan and Schedule

The *City Beautiful H_2O Program Plan* (Program Plan) presents a long-term, integrated strategy to address the hydraulic and structural deficiencies of Capital Region Water's wastewater and stormwater assets, improve in-stream water quality, and protect public health. Many alternative technologies, specific control strategies, and levels of control were evaluated. This section summarizes the affordable and cost-effective measures recommended under the Program Plan for control of wet weather issues (CSOs, SSOs, and MS4 discharges), rehabilitation of CRW assets, and enhancing service area communities.

The Financial Capability Assessment (FCA) presented in **Section 7** is used to identify an affordable level of investment in this Program Plan. **Table 1-4** defines implementation phases, the anticipated level of CSO volume control achieved, and the estimated available level of expenditure within each phase to maintain CRW wastewater rates at no more than 2 percent of the mean annual household income within the City of Harrisburg ($33,289 in 2015). While CSO volume capture is presented as the primary metric for compliance during each implementation time frame, other, more affordable and cost-effective projects that improve water quality and/or reduce SSOs/unauthorized releases may receive a higher priority for implementation under the integrated stormwater/wastewater planning framework.

Table 1-4. Implementation Phases, Affordable Costs, and CSO Control Volume Targets

Phase	Anticipated Time Frame	Projected Type	Affordable Spending (Escalated)	Affordable Spending (2017$)[2]	CSO Volume Capture[3]
Existing	N/A	N/A	N/A	N/A	53%
Immediate	0-10 years	Rehabilitation	$165 million	$146 million	79%
		Wet Weather	$60 million	$50 million	
Near-Term	10-20 years	Rehabilitation	$49 million	$31 million	80%
		Wet Weather	$41 million	$26 million	
		Total	**$315 million**	**$253 million**	

[1] Partially funded via 30-year revenue bond
[2] Includes up to $5M annual stormwater fee revenue
[3] During the typical year

The following components would be funded from CRW's annual financial capability over the next 20 years, according to the FCA presented in Section 7:

- CRW's 2018 budgeted and anticipated operational expenses of $14.3 million annually (**Table 11-4** in the Program Plan main body),
- An estimated bond repayment amount of approximately $18.8 million annually, used to finance:
  - Past capital improvements (e.g., biological nutrient removal at CRW's AWTF),
  - Up to approximately $13 million (escalated and in 2017 dollars) for early action wet weather control projects,
  - Up to approximately $113 million (escalated), or $102 million (in 2017 dollars) for priority projects to address critical Advanced Wastewater Treatment Facility (AWTF) and conveyance system rehabilitation needs, some that also provide significant CSO control benefits,
  - Up to approximately $88 million (escalated), or $64 million (in 2017 dollars) for additional wet weather control projects, and
  - Up to $101 million (escalated), or $74 million (in 2017 dollars) be expended on collection system rehabilitation projects.

Figure 1-7 illustrates how the projected capital cost of $315 million (escalated), or $253 million (in 2017 dollars) is allocated between rehabilitation projects and wet weather control projects.

Specific investments to CRW's stormwater / wastewater assets will be defined periodically through a decision-making process, implemented through an ongoing adaptive management process, presented in Section 9, that weighs the following factors:

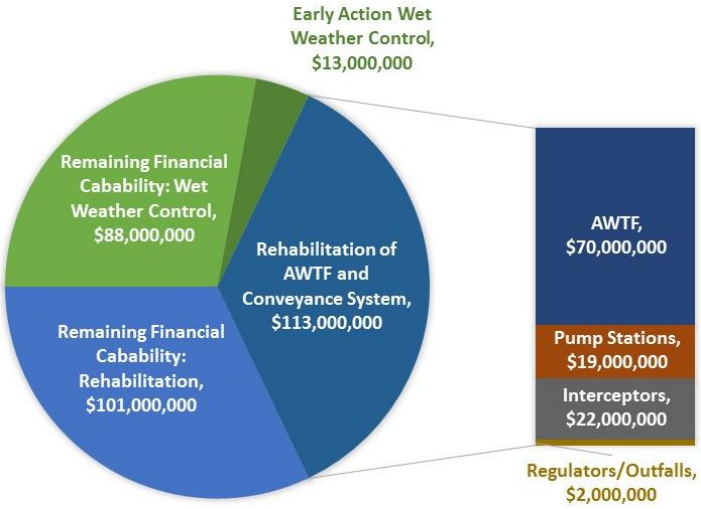


Figure 1-7. Estimated Capital Cost of Affordable Rehabilitation and Wet Weather Control Projects over the 20-year Planning Horizon

1. The Business Risk Exposure of each asset, established through CRW's asset management program.
2. The public health and welfare benefits to CRW ratepayers provided by the investment.
3. The degree of water quality enhancement achieved by the investment.
4. Synergies with other investments within the City of Harrisburg, including opportunities for collaboration with other implementation partners and/or sources of funding.
5. The affordability and cost-effectiveness of the investment.
6. The effectiveness of previous investments determined through post-construction monitoring and H&H modeling.
7. Appropriate phasing of investments to avoid short-term degradation to current conditions.
8. An appropriate investment in the operation and maintenance of the CRW wastewater/stormwater systems and administration of the Program.
9. Changes to the financial capabilities of CRW's ratepayers.

The *City Beautiful H_2O Program Plan* is an opportunity to select an alternative to bolster public support for improvements that address modern challenges to managing water resources and infrastructure in a sustainable way. CRW's recommended alternative provides a clear pathway that reinvests and rehabilitates wastewater/stormwater assets, brings community leaders, stakeholders, and residents together, and complies with environmental laws and regulations to improve the health of local waterways.