Section 4

Problem Analysis and Priorities

Capital Region Water's (CRW) *City Beautiful H_2O Program Plan* (Program Plan) seeks a balanced, affordable approach to addressing the following problems 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 Advanced Wastewater Treatment Facility (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 combined sewer overflows (CSOs) and municipal separate storm sewer system (MS4) discharges to receiving waters.
- Separate sanitary sewer overflows (SSOs) and unauthorized releases from combined sewers attributed to hydraulic capacity limitations.

This section summarizes the nature and severity of each of these four problem types, followed by a statement of CRW's approaches and priorities for resolving each.

4.1 Overview of Problem Analysis and Priorities

Program Plan Section 3.2 described the inspection and characterization activities conducted at the AWTF and along the conveyance and collection systems. This section summarizes the problematic conditions that were observed and the specific priorities established by this Program Plan.

Section 4.2 provides summaries of the structural and operational deficiencies and debris buildups, attributed to decades of deferred maintenance, at the AWTF, and along the conveyance and collection systems.

AWTF Risks and Priority Repairs: Recent evaluations reveal that most treatment processes are in fair overall physical condition, but require priority capital replacement investments and additional O&M expenditures to protect against the risk of major failure. 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.

Conveyance System Risks and Priority Repairs: The CSO regulators and outfalls were inspected in 2013, and subsequent analysis in 2016 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 interceptors were inspected in 2014, and in 2016 a cleaning program was implemented where 1,500 tons of debris were removed and the pipes were re-inspected to confirm cleaning effectiveness and the 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 and the Market Street stormwater pump station.

Collection System Risks 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 assets. The results 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 its financial capabilities. 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.

Section 4.3 describes the magnitude and frequency of wet weather sewer discharges from CSOs and MS4s to receiving waters.

Combined Sewer Overflow Risks: The calibrated hydrologic and hydraulic (H&H) model indicates the existing system, on average, captures and treats 53 percent of the combined wastewater volume, overflows from 9 to 95 times a year, depending on regulator structure, and discharges approximately 860 million gallons into receiving waters under typical year precipitation conditions. The annual frequency, duration and volume of CSO discharges are provided for each CSO regulator structure in the CRW system.

Municipal Separate Storm Sewer System Risks: MS4s serve a small portion of Harrisburg and are subject to Pennsylvania Department of Environmental Protection (PA-DEP) MS4 permitting requirements. An individual permit application submitted in September 2017 defined the area served by CRW's MS4s, known MS4 outfalls, and minimum control measures (MCMs) that will be implemented consistent with similar elements of the CSO NMC Plan. The permit application also included a Joint Pollution Reduction Plan (PRP) that indicates how CRW, Lower Paxton Township, and Susquehanna Township will collaborate to meet the Paxton Creek sediment TMDL (largely through streambank stabilization measures), as well as achieve initial PRP requirements for Wildwood Lake, an unnamed tributary of Spring Creek, and the Chesapeake Bay.

Section 4.4 provides the results of the hydrologic and hydraulic (H&H) modeling analyses that were conducted to identify specific locations where wet weather flows resulting from large design storms exceeded the capacity of the combined trunk sewers (described in Section 3.2.5), increasing the risk of unauthorized releases (e.g. surface flooding from surcharged manholes.) These locations are provided in a series of maps.

Section 4.5 defines the projected probability and locations of potential SSO discharges, including water in basements, within the CRW separate sanitary sewer system. Summary tables show how full the collection system pipes are flowing under a range of design storms characterizing the risk of an SSO discharge. Field reconnaissance and geographic information system (GIS) investigations were conducted to identify structures with the potential for basement flooding from sanitary sewer backups.

Section 4.6 summarizes the results of the receiving water depth monitoring and flooding frequency analyses that were conducted. It also describes the extensive water quality monitoring and analysis activities that have been conducted over the past 10 years on the two waterbodies receiving direct discharges from CRW CSOs and MS4s, the Susquehanna River and Paxton Creek. Analysis led to the conclusion that bacteria is the pollutant of concern for the Susquehanna. Along Paxton Creek, sediment, dissolved oxygen and bacteria are the three pollutants of concern. Due to the distribution of the 58 CRW outfalls along the receiving waters and the flow regimes of the receiving waters, there are no Sensitive Areas as defined in the National CSO Policy in the receiving waters that would directly require more attention than others in evaluating LTCP options. However, US-EPA has requested that priority be given to the Susquehanna River[1].

Section 4.7 provides a regulatory compliance framework that outlines the priorities and obligations for addressing each of these problems.

- A risk-based assessment of the condition and criticality of CRW's assets to support investment decisions into their rehabilitation and renewal, to address priority risks, and achieve an appropriate level of resiliency while meeting other objectives and obligations.
- The technology and water quality based requirements of the Clean Water Act, with investment decisions for CSO and MS4 discharge controls and in-stream erosion/habitat enhancements (required to address the Paxton Creek TMDL and other pollution reduction requirements under PA-DEP's MS4 permitting program). This framework could also lead to a reassessment of water quality objectives and designated uses (e.g., in recognition of hydromodification to Paxton Creek within Harrisburg).
- A risk-based evaluation of the frequency and impact of wet weather SSOs and unauthorized releases from the combined sewer system, considering public health, safety and property damage considerations.

4.2 Structural/Operational Deficiencies and Debris Buildup

Section 3 summarized CRW's wastewater / stormwater infrastructure and the investigations conducted to define its current condition. CRW's most recent Consulting Engineer's Annual Report (CEAR) includes a limited condition assessment of the key components of the CRW Wastewater System based upon available condition assessment summaries, discussions with CRW staff, and visual observations[2]. Facilities were rated according to their risk of failure in five categories: visual appearance, reliability, O&M performance, capacity, and regulatory compliance, concluding that existing system conditions present a moderate overall risk (e.g. aged or worn but generally in good operating condition). This section summarizes the known structural/ operational deficiencies and debris buildup that affects near and long-term system reliability.

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[1] USEPA, Technical Memorandum, *Sensitive Areas/Priority Areas in the Harrisburg Receiving Waters*, September 2016.

[2] Arcadis, *Consulting Engineer's Annual Report (CEAR), Wastewater System*, September 29, 2017.

4.2.1 Advanced Wastewater Treatment Facility Problems

4.2.1.1 Overview of the Advanced Wastewater Treatment Facility

CRW owns and operates one Advanced Wastewater Treatment Facility (AWTF) that receives all combined sewage conveyed through CRW's interceptors and pumping stations. The AWTF also receives the combined sewage from Steelton Borough, which is pumped directly to the facility. Combined sewage is treated by a series of unit processes including: grit removal, primary clarification, oxic/anoxic biological treatment, chemical addition, final clarification, and disinfection prior to discharge to the Susquehanna River. Waste biosolids are stabilized via anaerobic digestion, and dewatered by belt filter press prior to agricultural land application as Class B residuals. CRW completed major improvements to the biological treatment and final clarification processes at the AWTF in 2016 that enable compliance with effluent limits for nutrient removal.

4.2.1.2 Known Advanced Wastewater Treatment Facility Problems

Recent assessments and evaluations have revealed that numerous components of the AWTF have exceeded their life expectancies. In February 2017, a Biosolids Facilities Existing Conditions Report[3] provided an assessment of the current conditions of the solids treatment and handling systems at the AWTF, concluding that nearly all of the facilities and equipment, except the dewatering process equipment, are original equipment that have exceeded their useful design life, and are in need of replacement to increase reliability and reduce energy costs. In June 2017, a Biosolids Facilities Improvement Plan report[4] recommended rehabilitation and improvements projects for primary and secondary anaerobic digestion, gravity thickening, cogeneration and hauled waste processing. CRW is evaluating alternate approaches that will prove more affordable while maintaining efficient operations. Design has begun for a rehabilitation of CRW's existing primary clarifiers[5], including the repair and/or rehabilitation of each primary clarifier, its mechanical systems, and associated piping, pumping, and valves.

A listing of the recommended priority repairs at the AWTF is provided in **Table 4-1**. These necessary repairs have been identified as high priority needs to reduce the risk of hydraulic or treatment process failures, at an estimated opinion of probable cost in excess of $70 million (escalated cost) or $61 million (2017 dollars). It has been recommended that these high priority repairs be implemented over the next five to ten years.

Two of the recommended priority projects at the AWTF, a new headworks screening facility and primary clarifier improvements and repairs, would provide two strategic functions:

- Protect the integrity of the existing treatment processes and ensure NPDES permit effluent limits are consistently met, and
- Provide the needed hydraulic capacity in the primary treatment processes.

The hydrologic and hydraulic (H&H) model used for the Program Plan to develop and evaluate alternative levels of wet weather control assumed a primary treatment capacity of 80 mgd would

[3] Whitman, Requardt & Associates, LLP, *Biosolids Facilities Existing Conditions Report*, February 2017.
[4] Whitman, Requardt & Associates, LLP, June 2017, *Biosolids Facilities Improvements Plan, Draft.*
[5] Whitman, Requardt & Associates, LLP, *Primary Clarifier 30% Design*.

be available to provide the needed quantity of wet weather treatment. Stress testing was performed to check the hydraulic capacity of the primary treatment facilities and the corresponding treatment effectiveness.

Table 4-1: Recommended High Priority Rehabilitation Projects at the AWTF

Rehabilitation Project Description	Wet Weather Benefit?
Headworks Screening Design/Construction	Yes
Anaerobic Digester Roof Repair/Primary Digester Facilities	No
WAS Thickening & Hauled Waste Improvements	No
Cogeneration (CHP) Improvements	No
Gravity Thickeners	No
Acid Phase Digester & Secondary Digester Conversion	No
Primary Clarifier Improvements and Repairs	Yes
Dewatering Improvements - Design Phase	No
Trucked-In Waste Receiving Station	No

The 2017 Biosolids Facilities Improvement Plan also recommended replacement of other aging equipment and implementation of process changes to reduce operating costs and improve digester gas production and utilization via cogeneration (combined heating and power) upgrades. Trucked-in waste receiving station improvements were also recommended to increase high-strength waste receiving capability and obtain the benefits of increased digester gas production for operating cost paybacks from digester gas to energy facilities and hauling revenues.

4.2.1.3 Assessment of Advanced Wastewater Treatment Facility Capacity

One component of CRW's strategy for compliance with the Environmental Protection Agency (US-EPA) National CSO Policy is through maximizing use of available capacity at the existing AWTF. This section summarizes an assessment of the AWTF treatment processes to handle the proposed peak wet weather flow.

4.2.1.3.1 Preliminary Treatment

The current AWTF preliminary treatment process consists of grit removal only. Screenings removal is performed at the Front Street pump station. CRW is constructing new screening facilities at the AWTF. Construction is scheduled for completion in 2018. The new screening facilities will mitigate historical problems with rags, wrappers, and other solids clogging and causing equipment failure in the grit removal system, primary clarifiers, and anaerobic digesters. The Screening Facility will consist of two mechanically-cleaned bar screens with ¼-inch bar spacing. Each fine screen has a capacity of 80 mgd which will provide 100-percent redundancy for peak wet weather flow. A washer/compactor unit on each screen will clean and reduce the volume of screenings for landfill disposal. The inlet chambers to the new Screening Facility will have an overflow arrangement in the event of an emergency to bypass the screens and direct flows to the grit removal system, or to bypass both the screens and grit removal systems.

The grit removal process consists of four vortex grit chambers. Each chamber is 16 feet in diameter with a maximum water depth of 7 feet. These have a rated capacity of 20 mgd per unit. The plant Operators normally operate with one or two units in service, and bring a third unit in service as plant flows reach 40 mgd and the fourth unit at 60 mgd to achieve the total 80 mgd capacity.

It is concluded that the preliminary treatment facilities, upon completion of the new Screening Facility, will have a wet weather screening and grit removal treatment capacity of 80 mgd.

4.2.1.3.2 Primary Treatment:

The AWTF includes a battery of four primary clarifiers that have the design criteria shown in **Table 4-2.** The clarifiers were modified in the mid-1980s to convert the first 51.5 feet of each unit, which was originally a flocculation tank, to remove the flocculation equipment and install a second sludge collector. Both sludge collectors convey settled sludge to a common cross collector that feeds a sludge sump. The sludge sump in each tank is connected to one of two sludge inspection wells by an 8-inch diameter pipe. Primary Clarifiers 1 and 2 share a common sludge inspection well, as do Primary Clarifiers 3 and 4. Primary sludge pumps that feed gravity thickeners draw suction from the sludge inspection wells.

Table 4-2: Primary Clarifier Design Criteria

Parameter	Criteria*
No. of Clarifiers	4
Original Clarifier Unit Dimensions, feet	
Length	220
Width	35
Depth at Average Water Level (AWL) = 315	7.5 – 8.82
Section Surface Area, square feet	7,700
Weir Length	359
Modified Flocculation Tank Unit Dimension, feet	
Length	51.5
Width	30.5
Depth at AWL = 315 Tanks 1 & 4	8.21
Depth at AWL = 315 Tanks 2 & 3	7.71
Section Surface Area, square feet	1,540
Total Unit Surface Area, square feet	9,240

*Design criteria for the primary clarifiers were obtained from City of Harrisburg 1957 Sewage Treatment Plant design drawings and Harrisburg Sewage Authority 1987 record drawings for the Grit Removal and Other Modifications to the Harrisburg Advanced Wastewater Treatment Facilities.

One way to maximize flow to the AWTF is by utilizing additional capacity in the primary treatment process beyond the secondary treatment process capacity. The wet weather flow that bypasses secondary treatment also undergoes disinfection prior to discharge. The current CRW wet weather flow routing practice is that influent flows above the secondary treatment capacity of 45 mgd are diverted after primary treatment to disinfection (up to 35 mgd) for a total of 80 mgd peak weather treatment capacity. CRW performed full-scale stress testing of the primary treatment process to assess treatment capacity.

4.2.1.3.3 Primary Stress Testing

The objectives of primary stress testing were to (1) confirm the peak flow-through hydraulic capacity of the primary clarifiers is 80 mgd, or more, and (2) evaluate the performance of the primary treatment process under proposed wet weather operating conditions. The testing was performed under full-scale operating conditions by isolating plant flow through two of the four primary clarifiers. Plant flow of 40 mgd through two tanks would simulate the flow conditions of operating at 80 mgd through four tanks.

The PA-DEP Domestic Wastewater Facilities Manual guidelines for primary clarifier design recommends a maximum surface overflow rate (SOR) of 1,000 gallons per day per square foot (gpd/ft^2) at maximum monthly average flow and 2,500 gpd/ft^2 at design peak hourly flow, including recirculation flows. **Table 4-3** shows the surface overflow rates under various flow conditions with all four primary clarifiers in service, three clarifiers in service, and under the stress testing conditions with two primary clarifiers in service.

Table 4-3: AWTF Flow and Primary Clarifier Surface Overflow Rates

Parameter	Flow mgd*	Surface Overflow Rates, gpd/ft^2		
		4 Clarifiers	3 Clarifiers	2 Clarifiers
Current annual average flow (AAF)	21.1	570	760	1140
Current maximum monthly flow (MMF)	28.2	760	1020	1525
Current peak daily flow (PDF)	50.6	2030	1825	2740
Design annual average flow	37.7	1020	1360	2040
Design peak hourly flow	45	1220	1620	2435
Peak instantaneous flow	80	2160	2890	2890

* Flow data obtain from Design Engineer's Report for WQM Permit Application. AWTF Headworks Screening Project. February 26, 2016.

The hydraulic stress test demonstrated a capacity to pass up to 94.4 mgd with four primary clarifiers in service. However, some submergence of the top floatables collecting flights was observed and would require the top rails of the collector mechanisms to be raised to prevent the pass-through of floatable materials.

Performance of the primary treatment process under the stress testing conditions was monitored using daily composite samples and laboratory analyses of primary influent and primary effluent. Process performance was measured based on percent removals of total suspended solids (TSS) and biochemical oxygen demand (BOD). A concurrent sampling program obtained grab samples of the primary influent and effluent to monitor process performance in "real-time" during storm events. A total of four storm events were sampled over the stress testing period.

In general, the plant flows encountered during the stress testing program were lower than the targeted flow of 40 mgd. One storm resulted in a peak plant flow of 39 mgd, however, the performance of the primary treatment process during this event was inconsistent with limited TSS and BOD removals. The testing program demonstrated the primary clarifiers will achieve satisfactory removals for SORs up to approximately 1,600 gpd/ft^2 which is equivalent to 59 mgd with all four clarifiers in service. Above that SOR, clarifier performance was inconsistent depending upon the nature of the storm event.

CRW will investigate performance enhancements to the existing primary clarifiers including, testing the chemically-enhanced primary treatment (CEPT) facilities during wet weather and evaluating hydraulic improvements such as baffling and inlet modifications. Hydraulic (baffling, etc.) improvements to the primary clarifiers may be included in the upcoming primary clarifiers rehabilitation project currently scheduled for construction in 2019-20. Once rehabilitation is complete, additional stress testing is recommended to determine the effectiveness of these enhancements and to support adaptive management decision making to determine the nature, priority, and timing of further enhancements within CRW affordability limits.

4.2.1.3.4 Secondary Treatment

In 2016, CRW completed construction and startup of improvements to the secondary treatment portion of the facility. The primary objective of this project was to achieve compliance with the PA-DEP Chesapeake Bay Tributary Strategy (CBTS) nutrient removal limits and significantly reduce the need to purchase nutrient credits. PA-DEP established annual nitrogen and phosphorus discharge loading limits for the AWTF that were unachievable with the prior secondary facilities. The 1980's secondary treatment biological process was a high rate pure oxygen activated sludge facility that could only perform limited nitrification during warm weather and could not denitrify. This presented a challenge to CRW due to limited space for expansion of treatment facilities on the plant site. An innovative approach utilizing sidestream treatment and bioaugmentation was selected to limit the additional space necessary to achieve nutrient removal goals.

The process improvements constructed between 2014 and 2016 included the addition of a Return Activated Sludge Reaeration Sidestream Treatment process that receives the high ammonia belt press filtrate; conversion of the first cells of the High Purity Oxygenation Activated Sludge (HPOAS) tanks to anoxic selectors; addition of new post-anoxic, oxic and swing bioreactors after the HPOAS tanks with supplemental carbon addition. Aerobic, anoxic and swing zones were created in the new facilities to enable optimization of the biological nutrient removal processes. Other improvements included replacement of final clarifier mechanisms and addition of energy dissipating internal baffles, and modifications to the Chemically Enhanced Secondary Treatment (CEST) process.

The advanced wastewater treatment improvements design and PA-DEP construction permit were based on a secondary treatment process flow of 45 mgd to achieve the nutrient removal requirements. Thus, it is concluded that additional wet weather advanced treatment capacity is not available at the facility due to the risk of discharge permit violation.

4.2.1.3.5 Disinfection

Prior to discharge to the Susquehanna River, treated wastewater is disinfected in the chlorine contact tanks (CCT). There are four CCTs at the AWTF, which are each 100 feet long and 24 feet wide. The tank width is split into three passes by concrete divider walls. At a total plant flow of 80 mgd, the depth of water in the tanks is 11.3 feet, which provides a total water volume in the CCTs of approximately 761,000 gallons with all four tanks in service. Under these conditions the resulting detention time in the CCTs is 14 minutes, which is slightly below PA-DEP wastewater treatment guidelines for chlorine disinfection detention time at peak flow of 15 minutes. However, considering the volume in the CCT Effluent Channel and Outfall pipe, there is additional 132,000 gallons of chlorine contact volume prior to discharge in the river. This results in over two minutes additional contact time which totals over 16 minutes contact time at a plant flow of 80 mgd, thereby, exceeding the PA-DEP recommended criteria.

In the recently completed AWTF improvements project the divider walls in CCT Nos. 3 and 4 were raised to the match the top of tank walls. This additional height prevents flow from overtopping the interior walls in each tank under river flood conditions. CCT Nos. 1 and 2 were originally constructed with higher divider walls.

4.2.1.3.6 Solids Handling

CRW recently completed a conditions evaluation of the existing solids handling facilities and is in the process of developing a biosolids facilities improvement plan. The proposed plan will recommend improvements to rehabilitate failing processes and re-establish or increase overall solids handling capacity. The plan will also provide recommendations to enhance digester gas production for additional heat and energy generation. The existing biosolids handling facilities include:

- Gravity thickening of combined primary and waste activated sludges.
- Anaerobic digestion of thickened sludge.
- Mechanical dewatering of digested sludge using belt filter presses.
- Digester gas storage and usage for two engine driven electrical power generators, three heat exchangers, and two hot water boilers.
- Covered dewatered sludge storage area.
- Dewatered sludge is hauled and land applied on agricultural sites.

The draft biosolids facility plan proposes the following solids handling improvements:

- Replacement of equipment that is beyond its service life.
- Digester cover and mixing improvements.
- Improve digester gas production and energy recovery.
- Add capacity for high-strength hauled waste from outside sources.
- Separation of primary and waste activated sludge thickening. Primary sludge will remain gravity thickened with separate mechanical thickening of waste activated sludge.

4.2.1.3.7 Susquehanna River Stage Evaluation

The outfall for the AWTF is a 60-inch diameter pipe that is buried in the river bed. There are three, 24-inch diameter discharge nozzles extending from the outfall pipe in the river. The plant discharge is by gravity, so the water elevation in the river has a direct impact on the plant hydraulic profile. The PA-DEP guidelines indicate the treatment facilities should remain fully operational up to the 25-year flood elevation. A hydraulic model was developed for the AWTF to analyze the hydraulic profile through the gravity flow portions of the plant to assess the capacity of the facilities and the impact of river flood elevations.

The Susquehanna River flood elevations shown in **Table 4-4** were obtained from Federal Emergency Management Administration (FEMA) maps.

Table 4-4: Susquehanna River Flood Elevations at AWTF

Flood Recurrence Interval	FEMA River Elevation (NAV29)	River Level (Plant Datum)
10-year	306	305.5
25-year	308.8*	308.3
50-year	311	310.5
100-year	313.5	313.0

* Flood elevation interpolated

The hydraulic model was used to assess the plant hydraulic profile at the 10-year and 25-year flood recurrence intervals at a peak wastewater flow of 80 mgd. It was concluded that the AWTF can pass 80 mgd peak flow during the 10-year river flood elevation without submerging any weirs in the plant. The hydraulic analysis indicates the weirs in the chlorine contact tanks will begin to submerge at a river flood elevation of 305.9 feet (plant datum) which is 0.4 feet above the 10-year flood.

At the 25-year river flood elevation the chlorine contact tanks weirs will be submerged by approximately 2.5 feet, however, the weirs in the primary clarifiers are not submerged. The submergence of the weirs in the chlorine contact tank does not adversely affect the disinfection process. The interior divider walls have been raised to a top elevation of 316.0 feet. This means the flow will remain within the channels and continue to provide chlorine contact time for disinfection. The weirs at the final settling tanks are high enough so that no submergence occurs at the 10-year and 25-year river flood elevations.

4.2.2 Conveyance System

CRW's wastewater conveyance system consists of 59 CSO regulators, 58 outfalls, six interceptor sewers (i.e., Front Street, Paxton Creek, Paxton Creek Relief, Asylum Run, Spring Creek, and Hemlock Street), the Front Street and Spring Creek wastewater pumping stations, the Market Street stormwater pumping station, and associated force mains. Most components of the collection system are original, subject to years of deferred maintenance, and in need of rehabilitation/repair. The following projects have been designed to fully rehabilitate these assets to address years of deferred maintenance, as well as implement hydraulic enhancements intended to increase the hydraulic capacity of the conveyance system to 80 mgd, equivalent to the enhanced hydraulic capacity of the primary treatment processes at the AWTF.

- ***CSO Regulators*** were inspected in 2013[6] and found to be largely equipped with original Brown and Brown regulators, in good structural and mechanical condition, but set at levels that restrict flows to current pumping / treatment capacity. Subsequent evaluation of the CSO outfall pipes and river intrusion potential in 2016[7] found 15 CSO outfall pipes in fair to critical condition in need of repair, as well as the 40 CSOs subject to potential river intrusion during a 2-year flood event or less. Early action repairs for outfalls with extreme structural deficiencies and/or frequent river intrusion are proposed for 2018, with remaining repairs to be scheduled under this Program Plan for consistency with long-term CSO control objectives. The engineer's opinion of probable cost for these rehabilitation and hydraulic/operational enhancement measures is $2,188,000 (2017 dollars).

- ***Interceptor Sewers*** were inspected in 2014[8]. In 2016, CRW cleaned 33,534 linear feet of its interceptor system and re-inspected the reaches to confirm cleaning effectiveness and confirm previous structural condition assessment[9]. Approximately, 1,500 tons of debris were removed from the interceptors in 2016, and a 5-year cycle of interceptor re-inspection and cleaning was recommended to verify maintenance of the structural integrity and hydraulic capacity of the interceptor system. **Table 4-5** lists the current scope and schedule for rehabilitation of CRW's interceptors to address critical structural conditions. The engineer's opinion of probable cost for these rehabilitation measures is $22 million (escalated cost and 2017 dollars).

- ***Front Street Wastewater Pump Station*** appears to be in fair to poor overall physical condition based on the available documents and inspections, with many of the pump station components near the end of their useful life, including the screens, pumps, HVAC system, and electrical and control systems. Planned pump station upgrades include replacement of pumps, bar screens, screenings conveyance equipment, controls and associated improvements to electrical, HVAC and building systems to meet current code requirements[10]. ***Spring Creek Wastewater Pump Station*** appears to be in fair overall physical condition based on the available documents and inspections.[11] Many of the pump station components are near the end of their useful life, including the screens, pumps, HVAC system, and electrical and control systems. The estimated cost for the rehabilitation measures at both pumping stations is $19 million (escalated cost), $17 million (2017 dollars).

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[6] CDM Smith, *Long-Term Control Plan Development: Regulator Infrastructure Inspection*, October 2013.

[7] CDM Smith, Technical Memorandum, *CSO Outfall Repair Early Action Project Schedule*, February 2016.

[8] Capital Region Water, *High Priority Combined Sewer Interceptor Improvements*, Letter to U.S. Department of Justice, February 26, 2015.

[9] CDM Smith, Technical Memorandum, *Capital Region Water Interceptor Cleaning and Rehab Improvements Update,* May 2017.

[10] Johnson, Mirmiran and Thompson, *Draft Preliminary Engineering Report, Front Street Sewage Pump Station.*

[11] Hazen and Sawyer, *Engineering Report*, April 21, 2015.

Table 4-5: Recommended Rehabilitation of CRW's Interceptor System

Interceptor Name	Pipe Shape and Size (inches)	Rehabilitation Length (linear feet)	Scheduled Implementation
Paxton Creek	48 (H) x 59 (W) Parabolic 60 (H) x 72 (W) Parabolic 42 (H) x 60 (W) Rectangular Dual 30-inch Siphons*	7,556 5,068 387 488*	2017-2018
Asylum Run	24-inch Circular	2,504	2017-2018
Front Street	30-inch, Circular 30 to 40-inch, Non-Circular 36 (H) x 30 (W) Rectangular	1,933 8,248 2,400	2017-2018 2019-2020 2019-2020
Spring Creek	24 to 36-inch, Circular	5,117	2022-2023
Hemlock Street	No Rehabilitation Scheduled		
Paxton Creek Relief	No Rehabilitation Scheduled		

* Extent of siphon rehabilitation and related costs are not yet defined.

4.2.3 Collection System Problems

CRW's collection system includes approximately 33 miles of sanitary sewers, 40 miles of stormwater sewers, and 87 miles of combined sanitary and stormwater sewers. Approximately 80 percent of the collection system was installed prior to 1940.

Rapid Assessment Inspection Results: CRW retained a contractor to perform the collection system Rapid Assessment Inspection Program in 2015 and 2016. The inspection observations were divided between operations and maintenance (O&M) findings and structural findings. O&M findings consist of defects related to the operation of the sewer system. Defects such as root intrusions and debris and grease deposits are examples of O&M defects. Structural defects pertain to any issue that may jeopardize the structural integrity of the pipe or manhole. Cracks, fractures, holes, exposed rebar, and missing bricks are examples of structural defects. The rapid assessment inspections are being followed by comprehensive, prioritized closed circuit television (CCTV) inspections of the entire collection system. This information is being integrated into CRW's asset management program.

CRW analyzed the rapid assessment data, and assigned each manhole a priority level, which reflects the number and severity of defects that were identified. Scores were given on a scale of one through five, with one being the lowest priority level and five being the highest. CRW also analyzed pipe assessments of the zoom camera inspection findings applying a modified NASSCO PACP[12] protocol. The results indicated that 17 percent of the pipes that were inspected 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

[12] National Association of Sewer Service Companies, Pipeline Assessment and Certification Program

information provided, so subsequently, CRW developed and is implementing a prioritized CCTV inspection program to fill in the information gaps at a pace within its financial capabilities.

CCTV Inspection Program: CRW is in the process of conducting a prioritized remedial CCTV inspection of the entire collection system within the next five years to eliminate risk associated with unknown defects, especially for critical sewers which have a high consequence of failure. CRW is utilizing its Cityworks Asset Management System to document completed CCTV inspections, prioritize future CCTV inspections, and manage the pace at which inspections are conducted.

Using this condition information (where CCTV data supersedes Rapid Assessment findings as it becomes available), and using the pipe's age or work order history where rapid assessment / CCTV data is not available, 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 (POF) and consequence of failure (COF) to determine the core risk, placing each asset in risk management zones, which in turn are used to develop priority levels. Additional details on the methodology to determine priority levels can be found in the technical memorandum, CRW Sewer and Stormwater Prioritization[13].

The current estimated total cost of needed collection system repairs is over $100 million (2017 dollars), based upon the completed rapid inspections and CCTV inspections to date. However, there is remaining uncertainty in the potential risk and costs associated with significant collection system defects until the CCTV inspections are completed system-wide. CRW will reassess the appropriate level of long-term investment when the CCTV inspections and condition analysis are completed.

Catch Basin and Inlet Inspection Findings: The CRW collection system includes approximately 4,300 inlets and catch basins. CRW is conducting a comprehensive program of inspection, cleaning and repair of its inlets and catch basins. Based on the most recent data, 2,007 inlets have been cleaned to date (approximately 47 percent of the system), and 655 inlets have been repaired (approximately 31 percent of structurally deficient inlets, assumed to be half of the system) through the end of December 2017. CRW plans to complete all the inlet cleaning and repair by the end of 2021. CRW plans to clean and, where necessary, repair the remaining catch basins and storm inlets over the next four to five years.

4.3 Wet Weather Discharges at CSOs and MS4 Outfalls

CRW applied its calibrated H&H model (extended into the selected trunk sewers) to evaluate the existing hydraulic performance of its combined sewer system. The response of the current combined sewer collection system to wet weather events is characterized in terms of the average annual volume of wet weather flow captured and treated, and the volume overflowed to receiving waters. Percent capture, defined as the fraction of wet weather combined sewer flow that is captured and treated, is also commonly used to characterize the performance of the combined sewer collection system.

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[13] GHD, Technical Memorandum, *CRW Sewer and Stormwater Prioritization*, January 2018.

4.3.1 Systemwide CSO Discharge Frequency, Duration and Volume

The hydrologic parameters in the calibrated model account for existing land cover conditions as well as the effect on measured/modeled flows of the significant deferred maintenance within CRW's collection and conveyance systems (e.g., over 50 percent of the catch basins clogged with debris, and over 350,000 feet of trunk sewers requiring light to heavy cleaning). In addition, the hydraulics of CRW's regulators are complex, particularly the operation of the Brown and Brown regulators within most regulator chambers, set to divert most wet weather flow away from the interceptor and discharged as CSOs during moderate rainfall events.

Table 4-6 presents the estimated systemwide wet weather performance measures, based on H&H model simulations for a typical year precipitation record, for a range of scenarios typifying system improvements that are currently in process to address these uncertainties. Since the CRW system is in a continual state of being cleaned, critical rehabilitation measures are already designed and scheduled, and operational rules of Brown and Brown regulator structure mechanisms (B&Bs) are uncertain, the following conditions were used to set the operational range presented in **Table 4-6**.

- **Scenario 1:** Existing conditions with an interceptor system and catch basin network partially obstructed by accumulations of debris and solids, prior to the cleaning of the interceptors and the continuing efforts to clean and rebuild catch basins. The existing hydraulic restrictions of the B&B regulator mechanisms and the existing Front Street Pump Station during wet weather are retained.

- **Scenario 2:** Existing conditions with the completed cleaning of the interceptor system, but prior to completing the scheduled and continuing efforts to clean and rebuild catch basins. The existing hydraulic restrictions of the B&B regulators and the existing Front Street Pump Station during wet weather are retained. The H&H model simulations showed that cleaning the interceptors, even though the accumulated sediment depths and volumes were significant in places, provided a virtually undetectable improvement on system performance and systemwide CSO capture without providing other system improvements.

Figures 4-1 and 4-2 further illustrate how these scenarios affect the hydraulic grade line within the Front Street and Paxton Creek interceptors.

Table 4-6: Combined Sewer System Wet Weather Characterization of Current Conditions

Scenario	Captured Volume (MG)	Overflow Volume (MG)	Percent Capture	CSO Regulator Average Annual Number of Hours Overflow	CSO Regulator Average Annual Number of Overflows
1- Previous Existing Conditions prior to Interceptor Cleaning	861	798	53%	175	54
2- Existing Conditions after Cleaning of Interceptor	863	796	53%	175	54

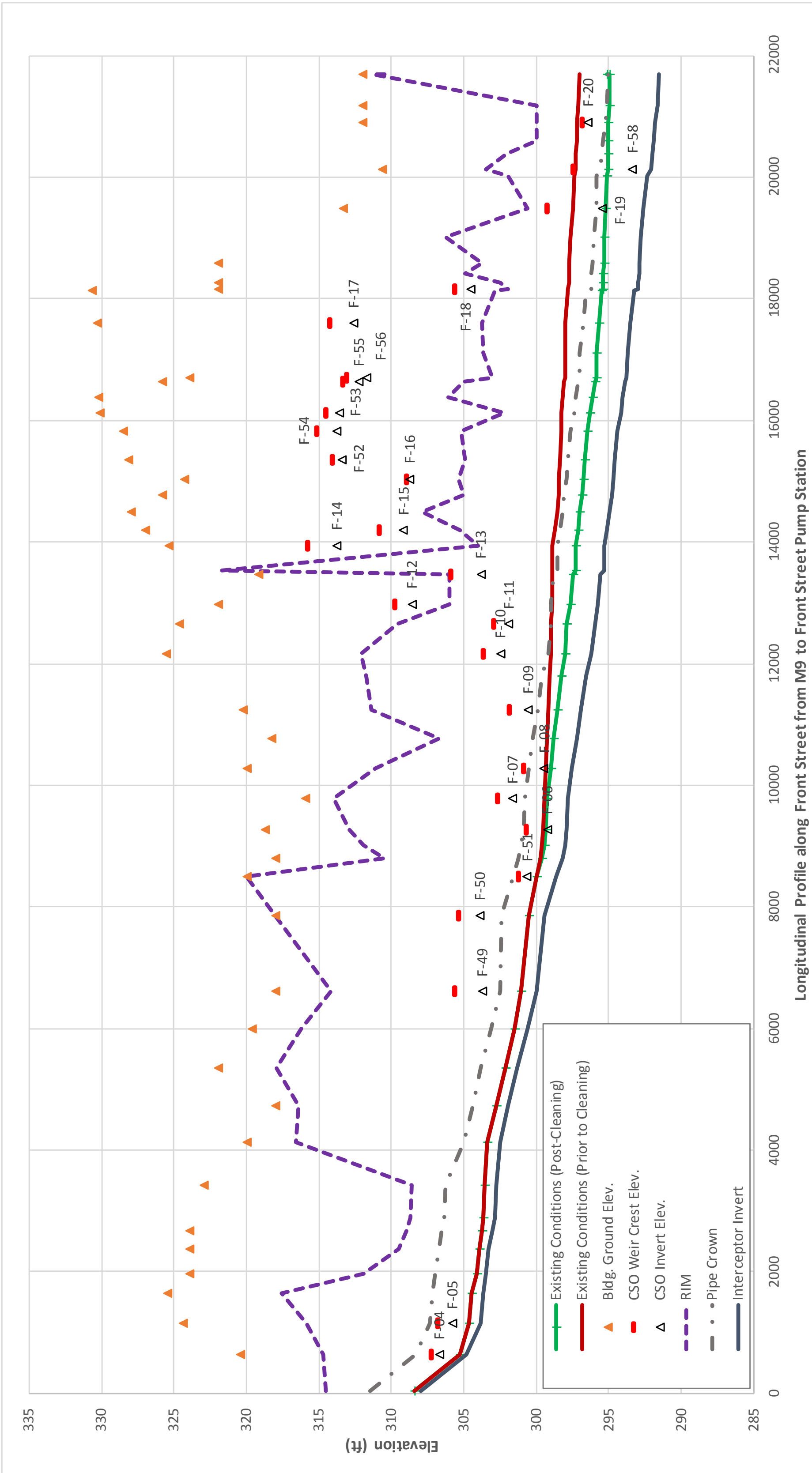


Figure 4-1: Peak HGL along the Front Street Interceptor during Typical Year

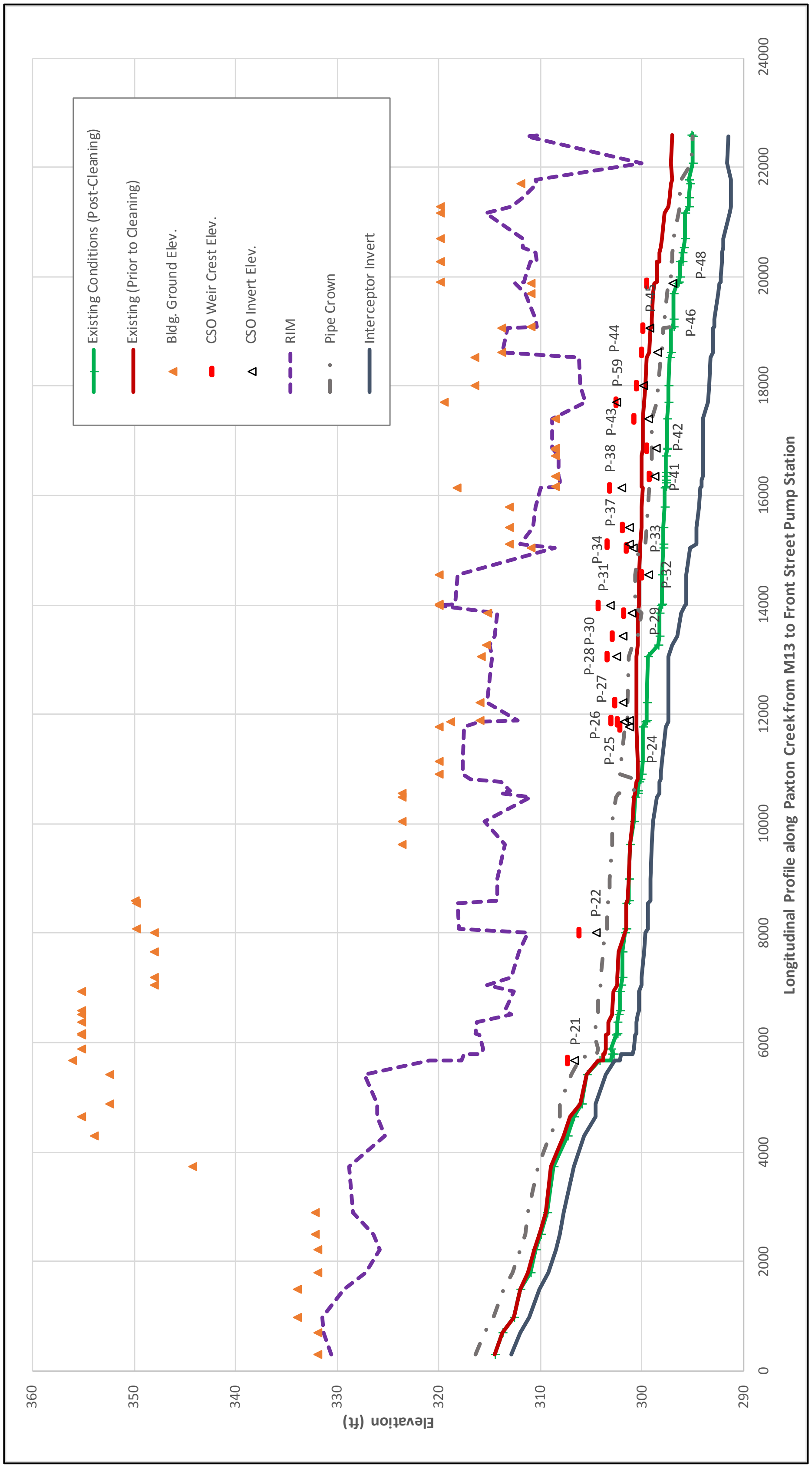


Figure 4-2: Peak HGL along the Paxton Creek Interceptor during Typical Year

4.3.2 Existing Performance Statistics for Individual CSO Regulators

The response of the combined sewer collection system to wet weather events is characterized in terms of the average annual volume of wet weather flow captured and treated, and the volume overflowed to receiving waters. While the previous section provided system-wide CSO statistics, this section provides CSO statistics for each individual regulator structure within the CRW system. Individual regulator statistics are based upon system-wide hydrologic and hydraulic model simulations for the typical year precipitation record. **Table 4-7** presents wet weather performance measures for each CSO regulator structure in the CRW combined system.

The volumes of combined sewer overflows at each CRW regulator structure location are presented in **Figure 4-3**. The outfall circles are color coded to more easily see the distribution of CSO discharge volumes along the Susquehanna River and Paxton Creek. The frequencies of CSOs at each CRW regulator structure location are provided in **Figure 4-4**. Again, the outfall circles are color coded to more easily see the distribution of CSO discharge frequencies along the receiving waters.

The frequency of combined sewer overflows is also a measure of system wet weather performance and is presented in **Figure 4-5** as box and whisker plots depicting the cumulative overflow frequency for each interceptor. The plot shows the range of overflow frequencies for the combined sewer regulators along the Front Street, Paxton Creek and Hemlock Street interceptors. The average annual overflow frequency for each outfall is based on model simulations for the typical year precipitation record. The model results indicate that the annual number of overflows varies greatly between regulators along each interceptor and within the system.

Table 4-7: Existing Combined Sewer System Wet Weather Characterization by CSO Regulator

Interceptor	CSO	Captured Volume (MG)	Overflow Volume (MG)	Capture %	Annual Overflow Duration (hours)	Annual Number of Overflows	Drainage Area (acres)
Front Street Interceptor	CSO-004	6.05	11.3	35%	284	68	34
	CSO-005	11.9	15.3	44%	227	61	74
	CSO-006	8.15	3.86	68%	74	39	19
	CSO-007	8.16	4.72	63%	103	52	16
	CSO-008	13.0	24.1	37%	300	70	40
	CSO-009	19.3	32.9	37%	252	58	67
	CSO-010	15.9	30.4	34%	696	89	42
	CSO-011	11.5	12.4	48%	107	47	31
	CSO-012	6.96	7.36	49%	139	55	25
	CSO-013	6.91	2.82	71%	36	33	16
	CSO-014	16.8	17.4	49%	392	84	30
	CSO-015	10.1	5.94	63%	111	36	20
	CSO-016	2.10	1.89	53%	49	37	8
	CSO-017	3.29	0.66	83%	12	21	6
	CSO-018	12.5	10.6	54%	186	59	31
	CSO-019	6.54	6.67	50%	194	63	41
	CSO-020	0.13	0.77	14%	159	90	16
	CSO-049	14.4	7.36	66%	125	48	28
	CSO-050	19.2	24.5	44%	353	84	42
	CSO-051	44.4	25.0	64%	407	83	79
	CSO-052	10.2	9.79	51%	232	69	22
	CSO-053	4.47	2.87	61%	94	46	10
	CSO-054	3.07	3.80	45%	176	69	8
	CSO-055	7.92	3.56	69%	45	33	14
	CSO-056	4.20	4.54	48%	164	64	10
	CSO-057	2.71	4.48	38%	95	49	16
	CSO-058	2.84	0.60	82%	21	26	22
	Total	**273**	**276**	**50%**			**766**
Hemlock Creek Interceptor	CSO-060	5.29	1.46	78%	31	36	16
	CSO-061	12.2	16.5	43%	305	84	56
	CSO-062	8.07	3.46	70%	142	74	10
	CSO-063	10.7	5.78	65%	154	66	40
	CSO-064	3.66	0.70	84%	24	37	11
	Total	**39.9**	**27.9**	**59%**			**133**

Table 4-7: Existing Combined Sewer System Wet Weather Characterization by CSO Regulator

Interceptor	CSO	Captured Volume (MG)	Overflow Volume (MG)	Capture %	Annual Overflow Duration (hours)	Annual Number of Overflows	Drainage Area (acres)
Paxton Creek Interceptor	CSO-021	65.4	11.3	85%	160	65	149
	CSO-022	6.02	0.69	90%	7	13	20
	CSO-023	3.75	0.69	84%	21	25	16
	CSO-024	28.7	21.3	57%	263	69	158
	CSO-025	5.48	0.27	95%	8	18	10
	CSO-026	11.2	5.89	66%	29	24	51
	CSO-027	7.35	1.59	82%	48	41	8
	CSO-028	23.1	10.5	69%	135	49	54
	CSO-029	8.26	13.21	38%	667	95	43
	CSO-030	16.7	1.23	93%	26	30	40
	CSO-031	95	49.5	66%	503	79	220
	CSO-032	5.14	7.01	42%	289	76	14
	CSO-033	7.14	5.14	58%	80	49	20
	CSO-034	29.7	19.5	60%	190	60	62
	CSO-037	26.4	26.4	50%	265	76	77
	CSO-038	9.46	5.34	64%	78	47	19
	CSO-039	6.2	5.3	54%	88	49	21
	CSO-040	3.07	2.03	60%	44	31	12
	CSO-041	5.2	2.63	66%	164	65	12
	CSO-042	31.4	37.6	31%	752	92	6
	CSO-043	4.02	1.02	80%	25	32	6
	CSO-044	23.5	6.82	78%	60	40	47
	CSO-045	4.69	0.59	89%	2	8	10
	CSO-046	5.95	0.66	90%	4	12	9
	CSO-048	117	225	34%	309	58	766
	CSO-059	see 042	30.9	31%	256	61	154
	Total	**550**	**492**	**53%**			**2,001**
System Total		**863**	**796**	**53%**			**2,900**

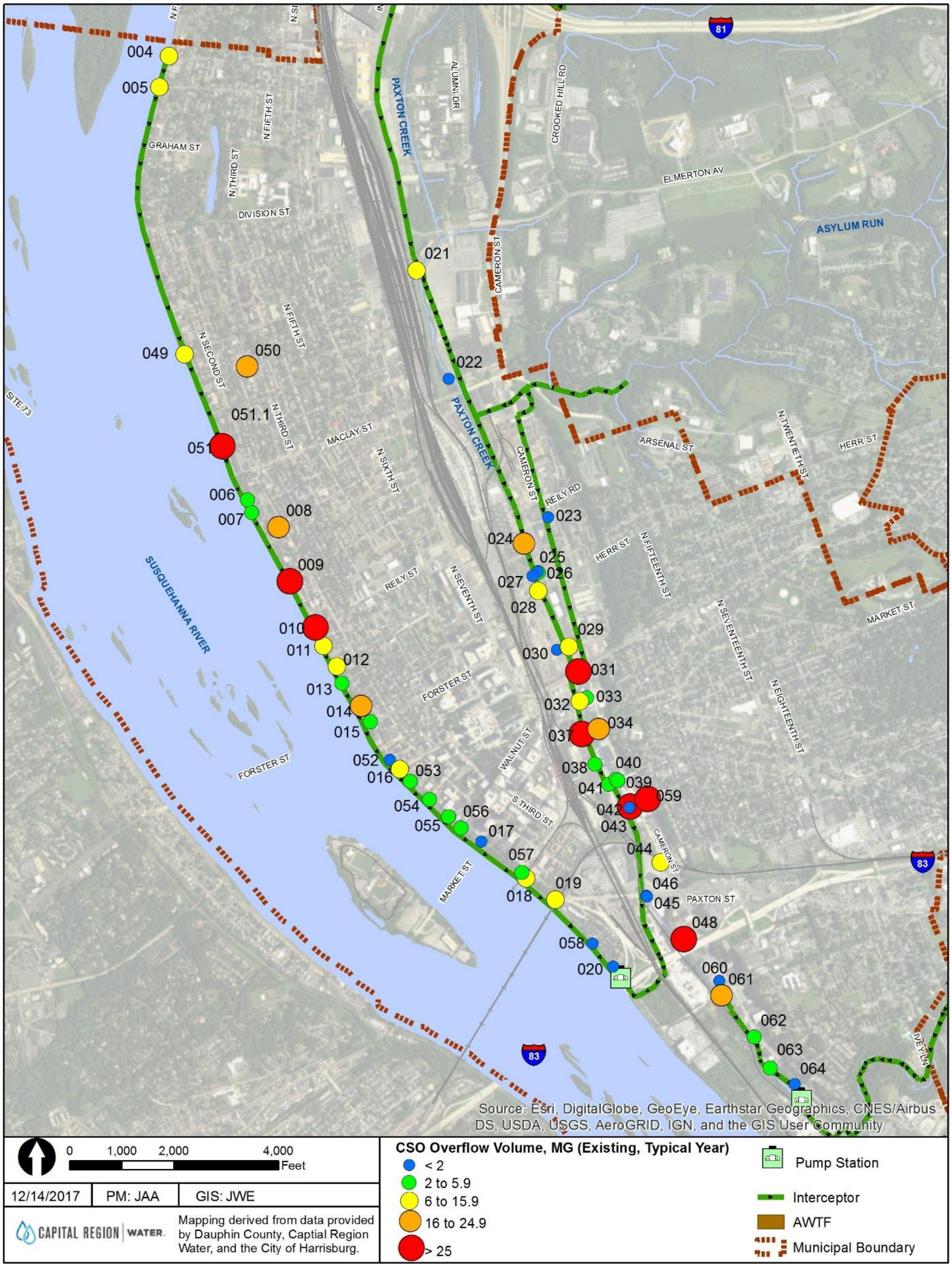


Figure 4-3: Distribution of Existing Condition CSO Discharge Volumes

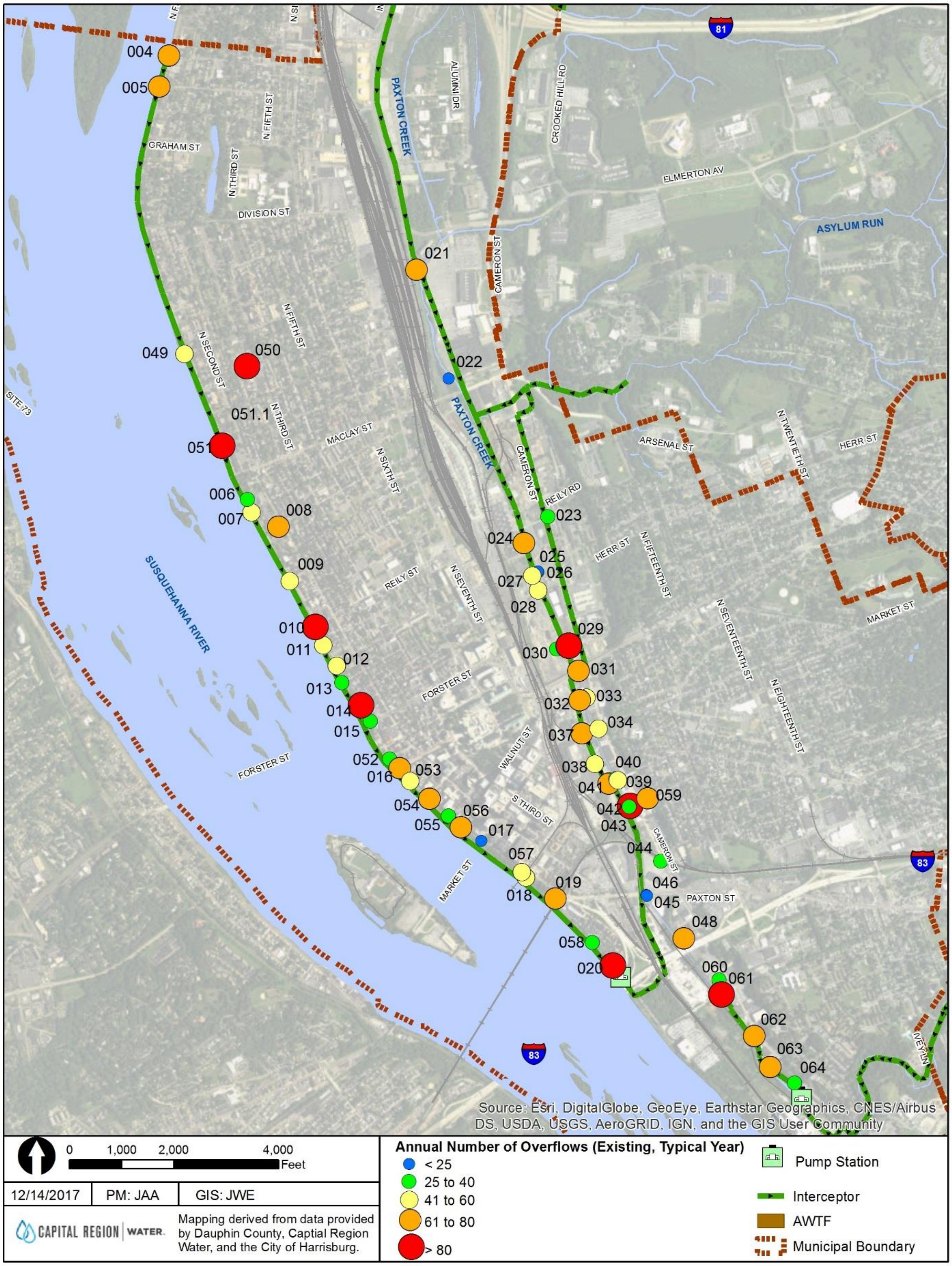


Figure 4-4: Distribution of Existing Condition CSO Discharge Frequencies

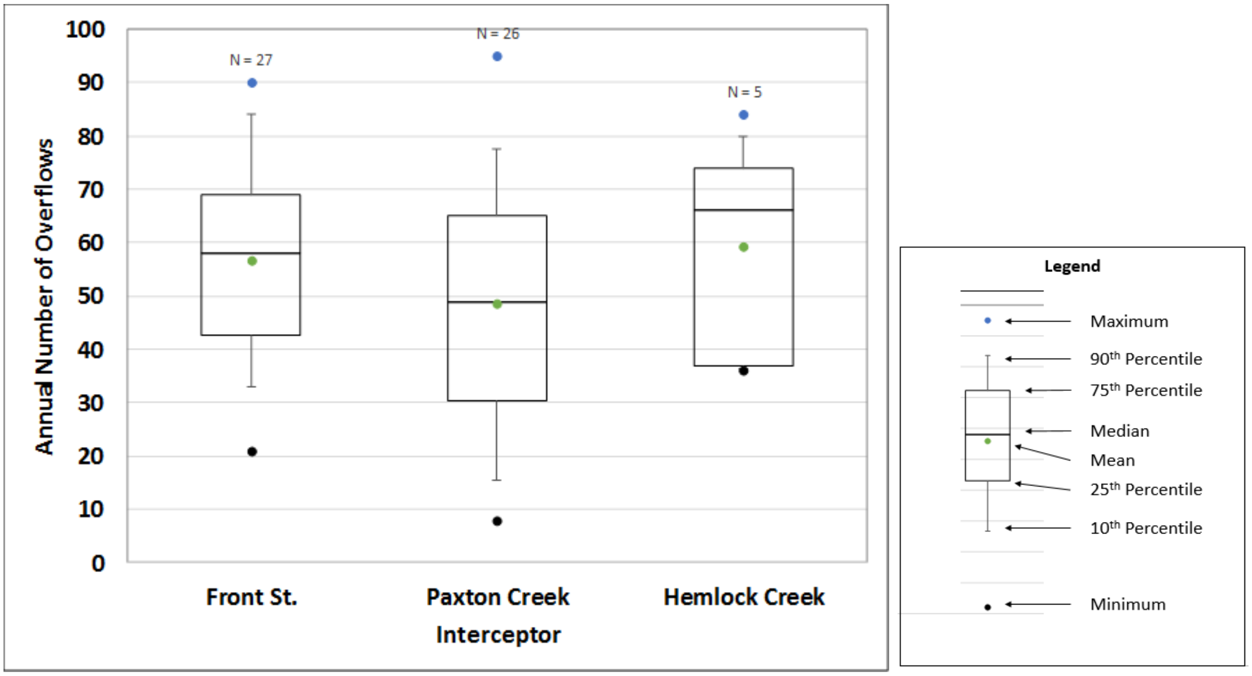
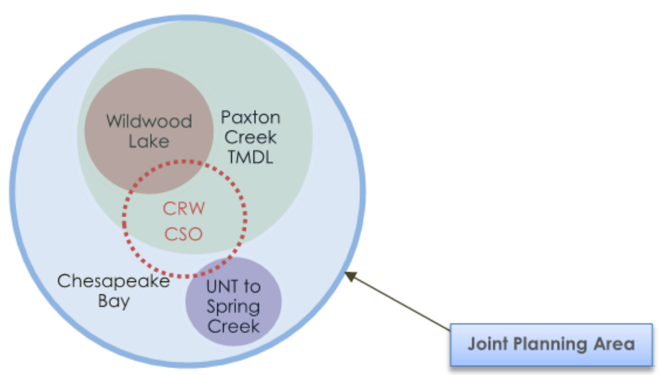


Figure 4-5: Average Annual Regulator Overflow Frequency by Interceptor

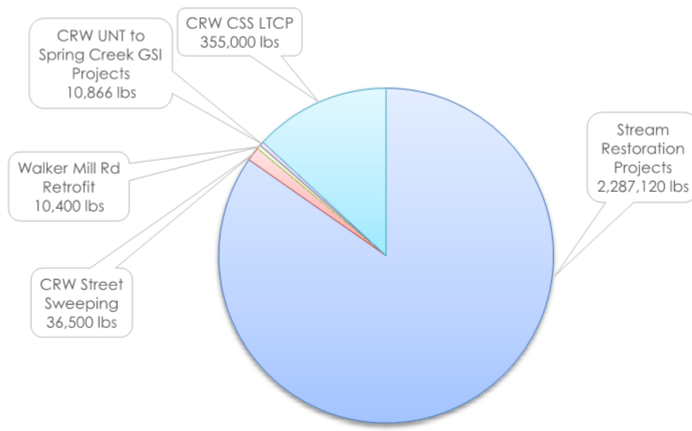
4.3.3 Stormwater Discharges at MS4 Outfalls

Paragraph V.D of CRW's partial Consent Decree requires CRW to "*develop and submit for review and approval an MS4 Individual Permit application for operation of the MS4, in accordance with applicable Federal and State regulations*". This was accomplished per PA-DEP regulations on September 15, 2017 through submission of PA-DEP's permit application. Key elements of CRW's MS4 program, many of which were included in the application, are outlined below:

- ***General Information*** describing the MS4 permittee and the location of the MS4.
- ***Stormwater Discharge Information***, including a map/inventory of the MS4 outfalls and identification of the surface waters receiving discharges from these outfalls.
- A ***Stormwater Management Program (SWMP) Plan***, defining how CRW intends to comply with the six minimum control measures (MCMs) identified in DEP regulations. CRW's Nine Minimum Controls (NMC) Plan is intended to also serve as its SWMP.
- A commitment to implement a ***Stormwater Management Ordinance*** compatible with the 2022 DEP Model Ordinance For consistency, CRW intends to also address CSO control requirements in its stormwater management ordinance.



- ***Pollutant Reduction Plans*** for impaired water bodies identified by PA-DEP. Capital Region Water, Lower Paxton Township, and Susquehanna Township prepared a Joint Pollutant Reduction Plan (Joint Plan)[14] to meet the pollutant load reductions requirements of DEP's September 2017 MS4 permit renewal process. The Joint Plan commits the three jurisdictions to implement the following projects over the next five years:
  - Thirteen streambank stabilization projects, addressing approximately 17,890 linear feet of streambank stabilization within the Paxton Creek watershed.
  - A green stormwater infrastructure (GSI) project controlling impervious area contributing to an unnamed tributary (UNT) to Spring Creek.
  - Bi-weekly (25 times/year) street sweeping within the City of Harrisburg.
  - Rehabilitation and optimization of CRW's AWTF, major pumping stations, and CSO regulators.



Total Proposed Joint Planning Area Sediment Load Reduction =
2,287,120 lbs. + 36,500 lbs. + 10,400 lbs. + 10,886 lbs. + 355,000 lbs. = 2,699,906 lbs.

Successful implementation of the Joint Plan is projected to reduce sediment loads by nearly 2.7 million pounds per year, achieving the following objectives:

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

The engineer's opinion of probable cost to implement these improvements is $8 million (2017 dollars), with CRW contributing approximately $2 million (2017 dollars). As of this writing, CRW is awaiting a response from PA-DEP on this application and the draft terms of the individual MS4 permit.

[14] Capital Region Water, Lower Paxton Township and Susquehanna Township, Joint Pollution Reduction Plan, September 2017.

4.3.4 Summary Conclusions on Wet Weather Control Needs

The National CSO Control Policy considers CSOs to be point sources subject to NPDES permit requirements including both technology-based and water quality based requirements of the Clean Water Act (CWA). NPDES permitting requirements for CRW's MS4 outfalls are also subject to CWA requirements. In addition, numerous hydraulic capacity constraints existing in both the combined collection system and the MS4, increasing risks of flooding and basement backups (see Sections 4.4 and 4.5). CRW must balance its efforts to address these systemwide wet weather control needs and significant system renewal priorities attributed to decades of deferred maintenance:

- The ongoing inspection of CRW's conveyance and collection systems is revealing numerous structurally deficient sewers, catch basins, and inlets requiring cleaning, rehabilitation and renewal;
- The Front Street and Spring Creek Pump Stations are over 50 years old and require major renovations to ensure reliable service, prevent potential system failure, and increase the available hydraulic capacity to convey peak wet weather flow;
- Critical equipment at the AWTF is at or near the end of its expected design life and needs to be replaced or repaired to ensure reliability and where possible expand the hydraulic and treatment capacity for peak wet weather flow.

This Program Plan seeks to allocate CRW's limited financial resources among competing priorities for comprehensive system renewal and systemwide wet weather control. Maintaining a healthy balance between these critical needs will be essential to developing a successful Program Plan.

4.4 Hydraulic Capacity of Combined Trunk Sewers

Paragraph H(34) of CRW's partial Consent Decree states that "*all Unauthorized Releases from the Combined Sewer System are prohibited,*" while Paragraph E(15)(g) requires CRW's H&H model to represent portions of the collection system ". . . *that hydraulically impact known chronic Unauthorized Releases*." CRW applied its H&H model to evaluate the hydraulic capacity of its collection system trunk sewers to identify and characterize chronic unauthorized release locations and incorporate their control into the Program Plan. This section summarizes the findings of this characterization.

Synthetic design storm rainfall (described previously in Section 3.3.4) was applied to the H&H model to estimate peak wastewater flows and water surface elevations within the existing combined sewer systems during the 1-year, 2-year, 5-year, and 10-year 24-hour design storm events. The modeling results are summarized in **Tables 4-8** and **4-9**.

Table 4-8: Summary of Hydraulic Conditions along Combined Trunk Sewer Pipes

Scenario	Trunk Sewer Length (linear ft.) at Percent of Full Pipe Depth of:				
	0% to 30%	30% to 60%	60% to 90%	>= 90%	Total
1-Year Design Storm	5,675	25,998	45,165	91,404	168,243
2-Year Design Storm	3,583	14,634	37,282	112,743	168,243
5-Year Design Storm	1,852	8,684	25,077	132,631	168,243
10-Year Design Storm	1,308	4,464	20,704	141,767	168,243

Table 4-9: Summary of Hydraulic Conditions at Combined Trunk Sewer Manholes

Scenario	Number of Trunk Sewer Manholes with Peak Depth Below Rim Elevation of:					
	> 8 ft	6 to 8 ft	4 to 6 ft	0 to 4 ft	< 0 ft	Total
1-Year Design Storm	313	78	56	235	96	682
2-Year Design Storm	209	78	55	339	171	682
5-Year Design Storm	139	47	61	435	245	682
10-Year Design Storm	84	46	52	500	290	682

The modeling results for each of the synthetic design storm precipitations are depicted in **Figures 4-6** through **4-9**. Because of the large format size of the maps, they are provided in **Appendix A**. The percent of full pipe depths and the wastewater depths within the manholes are color coded for easy identification. Sewer segments coded as red, are flowing full or surcharged during design storm conditions. The maps also identify specific locations where the design storm flows exceed the capacity of the combined collection system and surface flooding occurs. The approximate volume of surface flooding is indicated by the color coding. Orange dots indicate minor street flooding by surcharged sewers, while red dots indicate more significant street flooding.

4.5 Hydraulic Capacity of Separate Sanitary Sewers

CRW is required to perform a Separate Sanitary Sewer System Capacity Assessment under section V-F Paragraph 30-a of the PCD. Paragraph 30-b requires CRW to address a specific list of assessment activities in the Plan. Paragraph 30-c of the partial Consent Decree defines what the Separate Sanitary Sewer Capacity Assessment Report (SSSCAR) should include. In March of 2017 CRW submitted a SSSCAR to the regulatory agencies that met the PCD requirements. [15].

Monitored wastewater flow data from the suburban community separate sanitary sewer systems and the selected separate sanitary sewer catchment areas within the City of Harrisburg were analyzed to quantify and characterize flow under dry and wet weather conditions and validate the H&H model. 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 typical peak dry weather flow conditions, and the 2-year, 5-year, and 10-year 24-hour design storm events. The objective of this evaluation was to define the projected probability and locations of potential SSO discharges, including water in basements, within the CRW separate

[15] *Separate Sanitary Sewer Capacity Assessment Report, Version 1.0*, March 2017, available at **https://capitalregionwater.com/cbh2o/**.

sanitary sewer system. Detailed descriptions of the analyses and a series of maps depicting the results are found in Sections 3 and 5 and Appendix A of the SSSCAR.

4.5.1 System Performance during Design Storm Flows

The PCD committed CRW to apply the calibrated H&H model of its conveyance and collection systems and the synthetic design storm rainfalls to estimate peak wastewater flows and water surface elevations within the existing separate sanitary sewer system during peak dry weather flow and the 2-year, 5-year and 10-year design storms. The objective of this evaluation was to define the projected probability and locations of potential SSO discharges, including water in basements, within the CRW separate sanitary sewer system. The model simulations produced a series of hydraulic profiles along each of the modeled interceptor sewers and separate sanitary trunk sewers. The water surface elevations from each of the hydraulic profiles were applied to the Geographic Information System (GIS) database of the CRW collection system to produce a series of color-coded maps[16].

The hydraulic capacity evaluation results under each flow scenario are summarized in **Tables 4-10** and **4-11**. Model simulations confirmed that under peak dry weather flow conditions there are no hydraulic limitations anywhere within the CRW separate sanitary trunk sewer system that would cause SSO discharges or basement backups. Under 2-year design storm flow conditions, 37 percent of the pipe lengths were flowing full or under surcharge conditions and 18 structures have basements potentially subject to backwater flooding. Under 5-year design storm flow conditions, 51 percent of the pipe lengths were flowing full or under surcharge conditions and 24 structures have basements potentially subject to backwater flooding. Under 10-year design storm flow conditions, 63 percent of the pipe lengths were flowing full or under surcharge conditions and 49 structures have basements potentially subject to backwater flooding.

Table 4-10: Summary of Hydraulic Conditions along Separate Sanitary Sewer Pipes

Scenario	Sewer Length (linear ft.) at Percent of Full Pipe Depth of:*				Total
	0% to 30%	30% to 60%	60% to 90%	>= 90%	
Peak Dry Weather Flow	38,284	8,035	759	69	47,147
2-Year Design Storm	2,706	15,126	11,888	17,426	47,147
5-Year Design Storm	2,101	10,772	10,432	23,842	47,147
10-Year Design Storm	1,616	7,419	8,594	29,517	47,147

*Includes Asylum Run and Spring Creek Interceptors

[16] *Separate Sanitary Sewer Capacity Assessment Report, Version 1.0, Appendix A,* March 2017, available at **https://capitalregionwater.com/cbh2o/**.

Table 4-11: Summary of Hydraulic Conditions at Separate Sanitary Manholes

Scenario	Number of Manholes with Peak Depth Below Rim Elevation of:*					Potential for Water in Basement
	> 8 ft.	6 to 8 ft.	4 to 6 ft.	0 to 4 ft.	< 0 ft.	
Peak Dry Weather Flow	144	43	15	0	0	0 structures
2-Year Design Storm	119	17	11	47	8	18 structures
5-Year Design Storm	109	24	13	47	9	24 structures
10-Year Design Storm	86	20	19	67	10	49 structures

*Includes Asylum Run and Spring Creek Interceptors

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 assessment also yielded the following findings about the portion of the Spring Creek Interceptor operated by CRW.

- Evaluation of flow and precipitation data with US-EPA's Sanitary Sewer Overflow Analysis Program (SSOAP) found the amounts of non-wastewater flow entering the Spring Creek Interceptor summarized in **Table 4-12**.
- A comparison with similar evaluations of non-wastewater flows from other communities reveals that:
  - RDII rates from separate sanitary areas in the City of Harrisburg are near the median RDII value (considered to be average, not excessive RDII).
  - RDII rates from the suburban communities are less than median RDII value (considered to be low RDII).
  - Other communities have found that it is typically not cost-effective to achieve significant reductions in RDII at such rates of RDII.
- While measured RDII and GWI rates are considered low to average, H&H model simulations reveal significant limitations in the hydraulic capacity of the Spring Creek Interceptor during the 2- to 10-year, 24-hour design storms:
  - Flow monitoring and H&H model projections indicate that over 90 percent of the flow in the Spring Creek interceptor is generated by the suburban communities discharging into CRW's system.
  - Peak flows during the 2-year design storm exceed the existing hydraulic capacity of the Spring Creek Pump Station, and surcharge the entire length of the Spring Creek interceptor owned and operated by CRW. Most of the interceptor manholes have less than four feet of freeboard below the rim elevations.
  - Six manholes exhibit hydraulic grade line profiles above the manhole rims during the 2-year and 5-year design storms, increasing to six manholes during the 10-year design storm.

- There are no adjacent buildings near these manholes, located along a deep valley, so no basement backup would occur.
- CRW has sealed many of the manholes along its section of the Spring Creek interceptor to withstand pressure flow conditions and reduce the risk of SSOs. In June 2017, CRW Field Operations began inspecting each manhole along the Spring Creek Interceptor every month and following significant storm events. While the hydraulic model suggests the possibility for SSOs, CRW field staff have not observed SSOs along Spring Creek since the "problem lids" were bolted down, believed to be in 2009.

Table 4-12: Ground Water Infiltration along the Spring Creek Interceptor

Service Area	Contributing Area (square miles)	Average Groundwater Infiltration (GWI) as a Percent of Average Daily Flow	Average Rainfall Dependent Infiltration/Inflow (RDII) Volume as a Percent of Precipitation Volume
Suburban Communities	10.5	69	1.4
City of Harrisburg	0.9	64	3.8 to 4.2
Total:	**11.4**	-	-

Section 8 describes alternatives for addressing capacity constraints along the Spring Creek Interceptor.

4.6 Characterization of Receiving Water Conditions

The Partial Consent Decree, in Section V-E, Paragraph 21-c, requires CRW to "*. . . provide a characterization of current water quality conditions in its Receiving Waters, based upon available data, the use of a Water Quality Model*(s) *in Receiving Waters in which the Demonstration Approach is being utilized, and its efforts to identify pollutants of concern . . .*". The following Waters of the Commonwealth directly receive discharges from CRW's separate and combined sewer systems.

- The east shore of the Susquehanna River.
- The main stem of Paxton Creek from its confluence with the Susquehanna River upstream to Wildwood Lake.

CRW's service area also lies within the Chesapeake Bay watershed, and is subject to the objectives of the Pennsylvania Chesapeake Watershed Implementation Plan. As part of its individual MS4 NPDES Permit Application to PA-DEP, CRW participated in preparation of a Joint Pollution Reduction Plan with Lower Paxton Township and Susquehanna Township, recommending specific controls to meet current requirements of the Chesapeake Watershed Implementation Plan, the Paxton Creek TMDL, and an unnamed tributary of Spring Creek.

To characterize receiving water depth, CRW obtained monitored depth data and conducted a flood frequency analysis. To characterize receiving water quality, CRW identified, collected, and analyzed available water quality sampling study data. Pollutants of concern were identified, along with their geographic extent.

4.6.1 Regulatory Context, Water Quality Objectives, and Use Designations

Under the Clean Water Act (CWA), the PA-DEP Bureau of Point and Non-Point Source Management is responsible for establishing designated uses of each receiving water, establishing criteria for measuring if these designated uses are attained, assessing the attainment status of each receiving water, and where necessary, defining requirements for achieving future attainment. The current attainment status of the waters receiving discharges from CRW's combined sewer system, according to the PA-DEP 2016 *Pennsylvania Integrated Water Quality Monitoring and Assessment Report* is summarized in **Table 4-13**. There were no changes in attainment status of the receiving waters from 2014 to 2016, as indicated in Appendix F of the draft 2016 Integrated Report.

Table 4-13: Attainment Status of Waters Receiving CRW Combined Sewer System Discharges

Receiving Water	Designated Use	Cause / Constituent(s)	Source	Related to CSOs?	TMDL Date
Susquehanna	Fish Consumption	PCBs	Unknown	No	2027
	Potable Water	N/A	N/A	N/A	Attained
	Aquatic Life	N/A	N/A	N/A	Unassessed
	Recreation	N/A	N/A	N/A	Unassessed
Paxton Creek	Aquatic Life	DO/BOD	CSOs	Yes	None Required
		Siltation / TSS	Urban/Storm Sewers, Stream Erosion	Potential	2008
		Flow Variability	Urban / Storm Sewers	Potential	None Required
		Habitat Alteration	Urban / Storm Sewers	Potential	None Required
	Recreation	Pathogens	Unknown	Potential	2025

Existing Regulated Industrial Users: In accordance with US-EPA's CSO guidance, a preliminary assessment was performed as part of the development of CRW's *Nine Minimum Control Plan* to ascertain whether industrial discharges are concentrated in certain areas, thereby having the potential to impact specific CSO discharge points. As discussed in Section 3 of the NMC report, only one of the regulated industrial users is located within a CSO catchment area: CSO-043. However, the other eight industrial users discharge wastewater to interceptors that flow to the Front Street and Spring Creek pump stations. There are permitted emergency bypass CSOs at both pump stations (CSOs 002 and 003); therefore, these regulated industrial users are upstream of permitted CSOs. H&H modeling, however, reveals that neither of these two pump station bypasses activate during the typical year. The assessment indicated there is not a concentration of non-domestic discharges within the combined sewer system.

4.6.2 Receiving Water Depth Characterization and Flood Frequency Analysis

A network of four water surface elevation monitors was installed along Paxton Creek. Three of the monitors were installed over the creek along roadway bridge beams, and the ultrasonic sensors focused downward to the water surface. The fourth water surface elevation monitor was installed within a CSO outfall pipe and the pressure transducer sensors measured the depth up to the water surface. A summary of the site locations and data collection are provided in **Table 4-14** and illustrated on **Figure 4-10**. The elevation of the monitoring equipment at each site was surveyed and the sensor elevations were tied to the elevations of the sewer system structures in CRW's GIS database. The data provided the necessary boundary conditions in the H&H model during historical storm events at each CSO along Paxton Creek. A flood frequency analysis was also performed for estimating the frequency of potential river intrusion into CSO regulators along Paxton Creek.

Table 4-14: Paxton Creek Water Surface Elevation Monitoring Summary

Site Number	Gauge Location	Installation Date	Data Collection Status	Data Analysis Status
Paxton Creek 1	CSO-021 Outfall Pipe	Nov 3, 2014	Ongoing	Ongoing
Paxton Creek 2	Calder Street Bridge	Nov 3, 2014	Ongoing	Ongoing
Paxton Creek 3	Market Street Bridge	Nov 3, 2014	Ongoing	Ongoing
Paxton Creek 4	Shanois Street Bridge	Nov 4, 2014	Ongoing	Ongoing

For the Susquehanna River, CRW obtained monitoring data from United States Geological Survey (USGS) gauge 01570500. The gauge location on City Island is shown on **Figure 4-10**. The USGS river monitor records river stage elevation data in 30-minute increments. The slope of the river shoreline from the upstream to the downstream limits of the CRW service area was used to extrapolate the monitored river stage elevations to each of the CRW CSO outfall locations along the river. The data provided the necessary boundary conditions in the H&H model during historical storm events at each CSO along the Susquehanna River.

Historical water surface elevation data for the Susquehanna River is available for a 117-year period of record. The historical dataset was obtained and a Log-Pearson flood frequency analysis was conducted to determine river elevations associated with the 2-year, 5-year, 10-year, and 25-year flood frequency events. These flood events have a 50 percent, 20 percent, 10 percent, and 4 percent chance of being equaled or exceeded within a given year, respectively.

The 10-year flood level was obtained from the water surface profiles published in the FEMA Flood Insurance Study for the greater Harrisburg region. For the more frequent flood frequencies, the FEMA and Log-Pearson analyses were supplemented with data obtained from the USACE Silver Jackets program, which provides water surface elevation data for each flood stage in 1-foot increments. River stages during flood frequency events were used for estimating the frequency of potential river intrusion into CSO regulators along the Susquehanna River.

4.6.3 Water Quality Information Sources

Information on historic sampling locations within the Susquehanna River and Paxton Creek, the specific water quality parameters that were sampled, and the results of the completed water quality analyses are provided within the reference documents listed below.

- *Results of the Nationwide Urban Runoff Program*. Volume 1 – Final Report. U.S. Environmental Protection Agency. December 1983.
- *Water Quality Monitoring Data Analysis Report.* 2005 LTCP Attachment H. The Harrisburg Authority. August 2005.
- *2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report*. DEP.
- *LTCP Approach.* Partial CD Deliverable. Submitted to PA-DEP December 23, 2014.

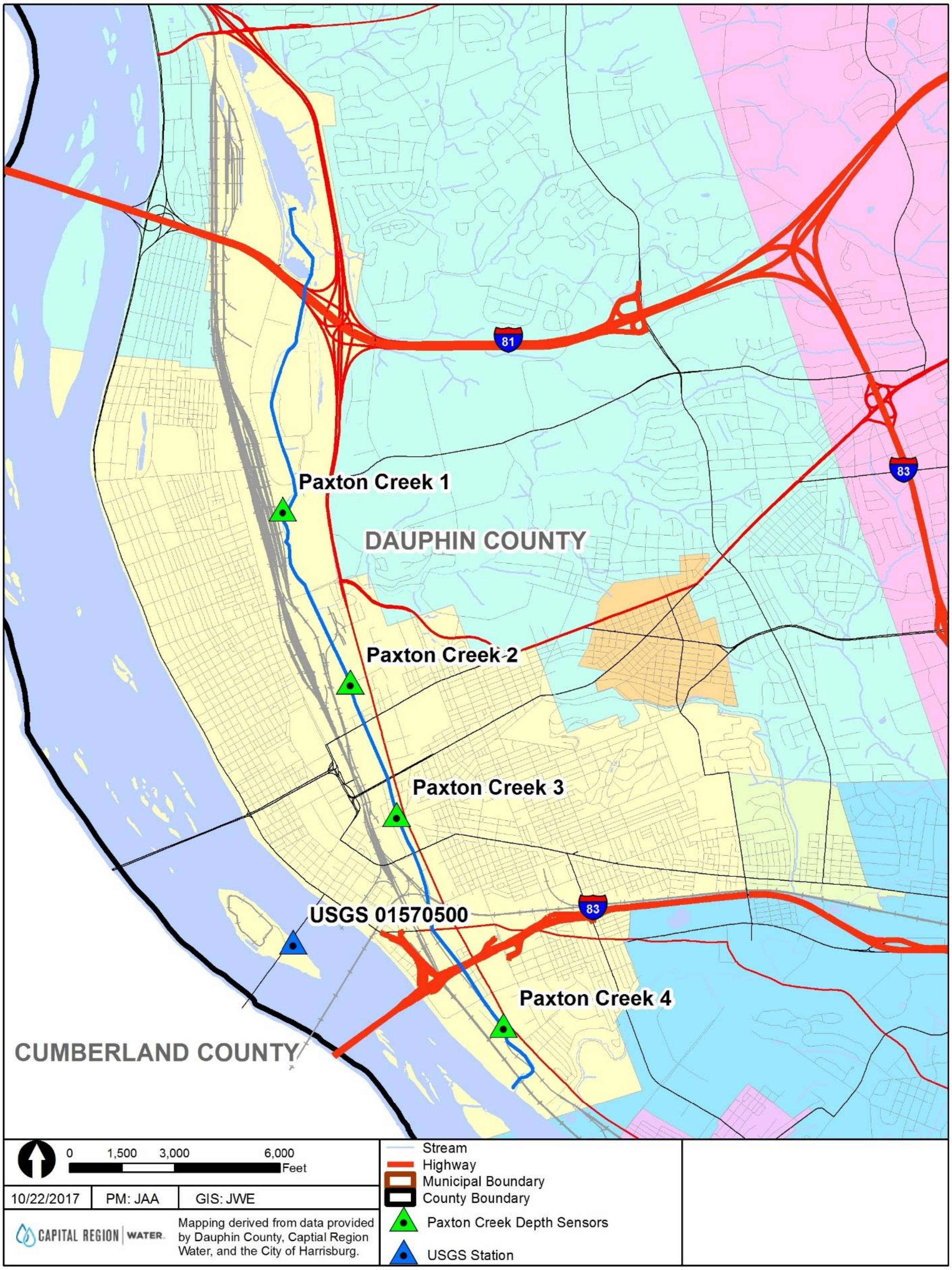


Figure 4-10: Paxton Creek and Susquehanna River Elevation Monitoring

- *Water Quality Modeling Plan.* Partial Consent Decree Deliverable. Submitted to PA-DEP July 27, 2015.
- *Sensitive Areas/Priority Areas in the Harrisburg Receiving Waters.* Partial Consent Decree Deliverable. Submitted to PA-DEP April 1, 2016.
- *PADEP Susquehanna River Bacteria Sampling Report*. Sent to Capital Region Water August 1, 2016.
- *2016 Draft Pennsylvania Integrated Water Quality Monitoring and Assessment Report*. DEP

4.6.4 Receiving Water Quality Studies and Characteristics

Over the past 10 years, periodic water quality monitoring and analysis has been conducted on the two waterbodies receiving direct discharges from CRW's CSOs, the Susquehanna River and Paxton Creek. This data has been collected by CRW (for preparation of the 2005 LTCP), US-EPA (for preparation of the 2008 Paxton Creek TMDL), and by PA-DEP / Susquehanna River Basin Commission (via the relatively long-term Water Quality Network and over the past three years as part of the Susquehanna River Study).

A review of existing water quality data is documented in the PCD deliverable *LTCP Approach* submitted to PA-DEP on December 23, 2014. The review presents data from monitoring, over the past decade or more, within the reaches of the Susquehanna River and Paxton Creek receiving discharges from CRW's combined sewer system. The document summarizes pertinent available data and published conclusions drawn from these data regarding CSO discharge characteristics, water quality, physical stream assessments, and biomonitoring for the Susquehanna River and Paxton Creek. Further documentation of completed water quality sampling activities, and the data that were obtained, was documented in Section 4 of the March 2017 *Combined Sewer System Characterization Report.* [17]

4.6.4.1 Susquehanna River Sampling and Studies

As part of the development of the 2005 LTCP, CSO discharges were monitored in 2003. Samples of CSO discharges were collected throughout overflow events to determine the combined sewer wastewater characteristics. Three CSO events between June and November 2003 were sampled at eight discharge locations selected based on estimated overflow volume and spatial distribution. The water quality parameters that were measured include total settleable solids, total suspended solids, BOD_5, total nitrogen, total phosphorus, and fecal coliform bacteria. The system-wide average event mean concentrations (EMCs) for all storm events were calculated by determining the arithmetic average EMC for each parameter.

Water quality monitoring was also conducted at sample sites along the east, west, and center tracts of the Susquehanna River during three wet weather events in 2004 to determine the effect of CSO discharges on water quality. The water quality parameters that were measured include fecal coliform, dissolved oxygen, pH, temperature and turbidity.

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[17] Capital Region Water, Combined Sewer System Characterization Report, Version 2.0, March 2017, available at **https://capitalregionwater.com/cbh2o/**.

Additional sampling data to measure fecal coliform along the Susquehanna River was collected by PA-DEP between July and September 2014. Sampling locations included sites that were upstream and downstream of Harrisburg mostly adjacent to developed suburban neighborhoods, as well as six locations along the reach impacted by CRW's CSO discharges. The system-wide average event mean concentrations for all storm events were calculated by determining the arithmetic average EMC for each sampling parameter.

The results from the receiving water sampling events, and the subsequent water quality analyses, are summarized in a series of tables provided in Section 4.2.3 of the March 2017, *Combined Sewer System Characterization Report.* The results include sampling dates, the number of samples taken, fecal coliform concentrations, and calculated EMCs for selected water quality parameters.

A 2016 PA-DEP assessment of the Susquehanna River concluded that due to the shallow and wide physical characteristics of the river, tributary waters have limited opportunity to mix with the volume of river water that originates upriver. In the vicinity of Harrisburg, the PA-DEP study concluded that the river is divided into five distinct flow streams with water quality differences across the total river transect. **Figure 4-11** shows the five flow streams at Rockville, PA, located approximately one mile above Harrisburg. The 2016 PA-DEP integrated report indicates that CSO discharges from CRW regulators would tend to be shore-hugging plumes.

Figure 4-11: Susquehanna River Flow Streams in the Vicinity of Rockville, PA

4.6.4.2 Paxton Creek Sampling and Studies

Similar to CSO monitoring for locations along the Susquehanna River, four CSO outfalls discharging into Paxton Creek were monitored as part of CRW's 2005 Long Term Control Plan flow monitoring program. Sampling along Paxton Creek was conducted concurrently with sampling along the Susquehanna River, for CSO discharges during the same wet weather events between June and November 2003. The sampling analysis results were used to determine the combined sewer wastewater characteristics. The parameters measured include total settleable solids, total suspended solids, BOD_5, total nitrogen, total phosphorus, and fecal coliform bacteria. The system-wide average EMCs for each sampling parameter for all storm events were calculated.

4.6.5 Pollutants of Concern

Table 4-15 identifies the pollutants of concern associated with discharges from CRW's sewer systems to the Susquehanna River, Spring Creek, and Paxton Creek. These pollutants were identified based on the various water quality/stream attainability studies by PA-DEP and others, and from prior available water quality monitoring and modeling information. Further information is provided in the December 23, 2014 memorandum *LTCP Approach*.[18]

Sediment is identified as a pollutant of concern in Paxton Creek, Chesapeake Bay, and an unnamed Tributary of Spring Creek, but not the Susquehanna River. The 2008 Paxton Creek TMDL Report indicates that about 86 percent of the sediment concentration is attributed to stream erosion and the rest to wet weather discharges.

Table 4-15: Pollutants of Concern Discharging from CRW's Combined Sewer System

Pollutant of Concern	Susquehanna River	Paxton Creek	Unnamed Trib., Spring Creek	Chesapeake Bay
Sediment		✓	✓	✓
Bacteria	✓	✓		
Dissolved Oxygen / BOD		✓		
Nitrogen / Phosphorus			✓	✓

Bacteria is a pollutant of concern in Paxton Creek and the Susquehanna due to potential human health risks from pathogens during in-stream recreational activities. Elevated levels of bacteria are associated with CSO discharges and present a potential threat in areas of the Susquehanna used for recreation. No recreation occurs in Paxton Creek at this time.

Oxygen-demanding substances (e.g., BOD, COD) that cause dissolved oxygen concentrations to fall below limits necessary to sustain aquatic life are considered a pollutant of concern in Paxton Creek. Per PADEP's 2012 Susquehanna River Study, which included water quality monitoring between June and August 2012, dissolved oxygen concentrations along the east transect of the Susquehanna were less variable. This would indicate lower discharges of oxygen-demanding substances and/or higher aeration rates, and/or greater assimilation capacity of the receiving water, resulting in few observed in-stream DO depletion events. The Paxton Creek TMDL states, however, that DO depletion is an issue in Paxton Creek related to discharge of oxygen demanding substances in CRW's CSOs.

Nitrogen and phosphorus loads must be reduced under the Pennsylvania Chesapeake Watershed Implementation Plan, and to meet PA-DEP's pollution reduction requirements for an unnamed

[18] CDM Smith, Technical Memorandum, *LTCP Approach*, December 2014.

tributary to Spring Creek. As a result, nutrients should be considered pollutants of concern for wet weather discharges to each receiving water body. Existing levels of wet weather treatment achieved by CRW's combined sewer system, coupled with additional treatment achieved under the LTCP, will help achieve the targeted nitrogen load reduction of approximately 50 percent and the targeted phosphorus load reduction of approximately 40 percent. PADEP's May 2016 NDPES General Permit for Stormwater Discharges from small MS4s establishes minimum loading reductions of Chesapeake Bay pollutants of concern–10 percent for sediment, 5 percent for total nitrogen, and 3 percent for total phosphorus.

4.6.6 Priority and Sensitive Areas

Due to the distribution of the 58 CRW outfalls (2 CSO regulators share a common outfall) along the receiving waters and the relatively uniform characteristics of the receiving waters, there are not any Sensitive Areas as defined in the National CSO Policy in the receiving waters that would directly require more attention than others in evaluating LTCP options. Portions of the Susquehanna River are used for recreation, including fishing, boating, and swimming/wading. However, it should be noted that the primary points of direct contact (swimming and wading) within the Susquehanna River are located on City Island at the public beach, which is not susceptible to discharges from CRW's CSO outfalls due to the Susquehanna River's flow regime. Near-shore discharges to the Susquehanna do not migrate or disperse from the shore, as noted in the *2016 Pennsylvania Integrated Water Quality and Assessment Report, "…this results in five distinct water columns from the east to west shores in the Susquehanna River around Harrisburg, PA. These waters do not mix due to the Susquehanna River being relatively low and shallow."* Additional information is documented in the April 1, 2016 memorandum *Sensitive Areas/Priority Areas in the Harrisburg Receiving Waters*.

4.7 Regulatory Compliance Framework

This section summarizes the various regulatory obligations applicable to entities discharging to receiving waters of the Commonwealth, providing a framework for either demonstrating that the Program Plan is able to achieve compliance with these obligations or supporting a re-assessment of water quality objectives.

4.7.1 Framework for Structural/Operational Deficiencies and Debris Buildup

CRW's partial Consent Decree recognizes the significant remedial measures necessary to restore the operational integrity of the existing AWTF, conveyance system, and collection system after years of deferred maintenance. Paragraph 11(a)(iv) requires "*a program to evaluate the structural integrity and maintenance needs of the Conveyance and Collection Systems through internal inspections utilizing state of the industry technology.* Paragraph 11(a)(vii) further requires "*a program to identify and prioritize remedial work determined based on the findings of internal and visual inspections",* while Paragraph 11(a)(viii) requires "*a list that identifies and prioritizes equipment purchases for critical equipment".* This requirement supports CRW recommendations of priority remedial repairs and equipment upgrades for its AWTF and its two major pumping stations. The failure of any of these systems presents a heightened risk of major failures at this critical infrastructure, potentially leading to significant water quality and public health risks. The PCD considered these remedial cleaning and repair needs of such high priority that Paragraph 31 identified certain projects as early action projects:

- High priority combined sewer interceptor improvements for the Paxton Creek, Asylum Run, and Front Street Interceptors.
- Repair of known sinkholes.
- Priority remedial repairs of CSO Outfalls.

A second major element of the framework for prioritizing structural/operational deficiencies and debris buildup is found in the *Government Accounting Standards Board (GASB) Statement 34.* This requires state and local governments to report the value of their infrastructure assets in annual financial reports, including a reporting of the value of infrastructure assets, the remaining useful value of these assets, and the cost of deferred maintenance (i.e., unmade repairs that result in equipment or facility deterioration). These GASB 34 requirements are based on asset management, which is defined in US-EPA's Reference Guides for Asset Management Tools as "… the practice of managing infrastructure capital assets to minimize the total cost of owning and operating them, while delivering the service level customers desire. Asset management is a framework widely adopted by the water sector as a means to pursue and achieve sustainable infrastructure." Failure to routinely address remedial repair and operational needs created by deferred maintenance affects the value of infrastructure assets and, consequently the financial position of their owner. As a result, re-investment in existing infrastructure has become a priority element of CRW's capital improvement and maintenance programs, resulting in an improved financial position.

4.7.2 Framework for Addressing Water Quality Degradation

Paragraph E(14) of CRW's partial Consent Decree requires CRW to "*complete and submit a revised and updated Long Term Control Plan ("LTCP") . . .* that . . . *shall conform to the requirements of the EPA's CSO Policy and EPA's "Guidance for Long-Term Control Plan, EPA 832-B-95-002, September 1995, and consider EPA's Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control, EPA 832-R-14-001, March 2014, and EPA's Integrated Municipal Stormwater and Wastewater Planning Approach Framework Memorandum, dated June 5, 2012*". This paragraph goes on to state that *"The updated LTCP shall include schedules, deadlines and timetables for remedial measures designed to meet the following goals:*

- *Bring all CSO discharge points into full compliance with the technology-based and water quality-based requirements of the CWA; and*
- *Minimize the impacts of CSOs on water quality, aquatic biota, and human health".*

4.7.2.1 Technology-Based Requirements of the CWA

Paragraph II(B) of US-EPA's CSO Control Policy[19] states *"Because the CWA requires immediate compliance with technology-based controls (section 301(b)), which on a Best Professional Judgment basis should include the nine minimum controls, a compliance schedule for implementing the nine minimum controls, if necessary, should be included in an appropriate enforceable mechanism".* Paragraph C of CRW's PCD provides the compliance schedule for implementing the nine

[19] Federal Register, *Environmental Protection Agency, Combined Sewer Overflow (CSO) Control Policy,* Vol. 59, No. 75, Tuesday April 19, 1994, Pages 18688 through 18698.

minimum controls, stating that CRW is to prepare and annually update a Nine Minimum Control (NMC) Plan which *". . . shall evaluate and document the current level of implementation of the NMCs within the Combined Sewer System, and shall identify and include an implementation schedule for actions necessary for achieving compliance with the CSO Policy for all NMCs . . .".* CRW's latest NMC Plan was submitted to US-EPA on August 10, 2017[20]., documenting CRW's current level of compliance with the NMCs accompanied by an implementation schedule for remaining actions necessary to achieve compliance with remaining NMCs. Certain actions required to achieve compliance with the NMCs are to be reported in this Program Plan.

4.7.2.2 Water Quality-Based Requirements of the CWA

US-EPA's Combined Sewer Overflows, Guidance for Long-Term Control Plan[21] states that Permittees should develop LTCPs using one of two approaches:

1. *Demonstrate that its plan is adequate to meet the water quality-based requirements of the CWA ("demonstration approach"), or*
2. *Implement a minimum level of treatment (e.g., primary clarification of at least 85 percent of the collected combined sewage flows) that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise ("presumption approach").*

The guidance also defines two additional considerations for establishing water quality-based requirements for CSO control:

- *WQS authorities should review and revise, as appropriate, State WQS during the CSO long-term planning process.*
- *NPDES permitting authorities should consider the financial capability of permittees when reviewing CSO control plans.*

Further, the principles articulated by US-EPA's Integrated Municipal Stormwater and Wastewater Planning Approach Framework[22] will be applied, namely:

- *Reflect State requirements and planning efforts and incorporate State input on priority setting and other key implementation issues.*
- *Provide for meeting water quality standards and other CWA obligations by utilizing existing flexibilities in the CWA and its implementing regulations, policies and guidance.*
- *Maximize the effectiveness of funds through analysis of alternatives and the selection and sequencing of actions needed to address human health and water quality related challenges and non-compliance.*

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[20] Capital Region Water, *Nine Minimum Control Plan, Version 3.0*, August 2017, available at **https://capitalregionwater.com/cbh2o/**.

[21] US-EPA, Office of Water, *Combined Sewer Overflows, Guidance for Long-Term Control Plan*, EPA 832-B-95-002, September 1995.

[22] US-EPA, Memorandum, "*Integrated Municipal Stormwater and Wastewater Planning Approach Framework",* June 5, 2012.

- *Evaluate and incorporate, where appropriate, effective sustainable technologies, approaches and practices, particularly including green infrastructure measures, in integrated plans where they provide more sustainable solutions for municipal wet weather control.*
- *Evaluate and address community impacts and consider disproportionate burdens resulting from current approaches as well as proposed options.*
- *Ensure that existing requirements to comply with technology-based and core requirements are not delayed.*
- *Ensure that a financial strategy is in place, including appropriate fee structures.*
- *Provide appropriate opportunity for meaningful stakeholder input throughout the development of the plan.*

This Program Plan is intended to serve as CRW's Integrated Municipal Stormwater and Wastewater Plan, and as such is designed to evaluate and establish priorities among a range of water quality and public health issues, including CSOs, SSOs, MS4 discharges, AWTF discharges, unauthorized releases from combined sewers, and non-point sources within CRW's service area.

Chapter 93 of the Pennsylvania Code defines designated uses of the Waters of the Commonwealth and the Water Quality Standards (WQS) for each use. Both the segments of the Susquehanna River and Paxton Creek receiving discharges from CRW's combined sewer system have been assigned the same designated uses:

- ***Aquatic Life***: Warm Water Fishery (WWF), Migratory Fishes (MF)
- ***Water Supply***: Potable (PWS), Industrial (IWS), Livestock, Wildlife, Irrigation
- ***Recreation***: Boating, Fishing, Water Contact Sports (WC), Aesthetics

The following water quality criteria apply to these designated uses:

- ***General Criteria***: Control floating materials, oil, grease, scum and substances that produce color, tastes, odors, turbidity or settle to form deposits.
- ***Specific Criteria***: The constituent concentration listed in Chapter 93 should not be exceeded. **Table 4-16** provides a partial list of constituents most applicable to CSO control.

In applying these water quality criteria, Pennsylvania Code Chapter 96 states that water quality criteria ". . . *shall be achieved in all surface waters at least 99% of the time, unless otherwise specified in this title",* and that general water quality criteria ". . . *shall be achieved in surface waters at all times at design conditions*". This criterion applies to the development of Total Maximum Daily Loads (TMDLs) and Water Quality-Based Effluent Limitations (WQBEL), along with the following criteria:

- Consider relevant design factors, including, but not limited to: water quality criteria duration, flow duration and frequency, natural seasonal variability in water temperature, the natural variability of pH and hardness, the physical characteristics of a watershed, reserve factors, factors of safety, and pollutant contributions from other sources.

- Treat all pollutants as conservative unless it finds based on scientifically valid information that the substance is not conservative and adequate information is available to characterize the substance's fate or transformation, or both.

Pennsylvania Code Section 96 is relevant to episodic wet weather discharges, which occur at varying magnitudes, durations, and frequencies. Under this criterion, excursions from water quality criteria up to 1 percent of the time are allowed. In other words, excursions of water quality criteria are allowed up to a total of 3.65 days (87.6 hours) over a typical year. Compliance with water quality criteria for fecal coliform is evaluated based upon a geometric mean of five consecutive samples during a 30-day period.

Table 4-16: Numeric Water Quality Criteria for Designated Uses of Pennsylvania Waters

Constituent	Ambient Water Quality Standard	Use
Alkalinity	20 mg/l as CaCO3 (or natural alkalinity, if less)	WWF, MF
Ammonia Nitrogen	Varies, per pH of water	WWF, MF
Fecal Coliform	5/1 to 9/30: 200 per 100 ml (30-day geometric mean) 400 per 100 ml (<10% of monthly samples) 10/1 to 4/30: 2,000 per 100 ml (30-day geometric mean) Year Round: 5,000 per 100 ml (max monthly average) 20,000 per 100 ml (<5% of samples)	WC WC WC PWS
Chloride	250 mg/l	PWS
Color	75 units (platinum-cobalt scale)	PWS
Dissolved Oxygen	7-day average: 5.5 mg/l Minimum: 5.0 mg/l	WWF WWF
Fluoride	Daily Average: 2.0 mg/l	PWS
Iron	30-day average: 2.0 mg/l	WWF, MF
Manganese	1.0 mg/l	PWS
Nitrite plus Nitrate	10 mg/l as nitrogen	PWS
Osmotic Pressure	50 milliosmoles/kg	WWF, MF
pH	Between 6.0 and 9.0	WWF, MF
Phenolics	0.005 mg/l	PWS
Sulfate	250 mg/l	PWS
Temperature	Varies throughout year	WWF
Total Dissolved Solids	Monthly Average: 500 mg/l Maximum: 750 mg/l	PWS PWS
Total Residual Chlorine	4-day average: 0.011 mg/l 1-hour average: 0.019 mg/l	WWF, MF
Toxic Substances	Develop per Chapter 16	WWF, MF
Metals	Chronic, Acute Values	WWF, MF

Based on the preceding discussion, CRW's Program Plan will evaluate four distinct levels of control:

- ***Baseline Level of Control***, involves multi-objective projects that provide priority remedial repairs to CRW's AWTF and conveyance system, coupled with other low cost, high performance projects that can improve the capacity, efficiency, and performance of the existing sewer system in the near term.
- ***Affordable Level of Control*** that represents the highest level of water quality control that can be achieved based on the financial capabilities of CRW's rate payers, balanced appropriately between the expenditures needed to address system rehabilitation needs and SSOs / unauthorized releases caused by hydraulic capacity limits.
- ***Cost-effective level of Control,*** defined as the wet weather controls at the "knee of the curve" of the cost-effectiveness analysis, where the inflection point in each cost curve indicates an optimal level of CSO control from a cost-to-benefit perspective.
- ***Presumptive Level of Control***, defined as the controls necessary to capture and treat 85 percent of the systemwide combined sewage during typical year precipitation.

4.7.2.3 Water Quality Requirements for Bacteria

The State of Pennsylvania water quality criteria for bacteria are based on fecal coliform and state:

> *(Fecal coliforms/100 ml) – During the swimming season (May 1 through September 30), the maximum fecal coliform level shall be a geometric mean of 200 per 100 milliliters (ml) based on a minimum of five consecutive samples each sample collected on different days during a 30-day period. No more than 10% of the total samples taken during a 30-day period may exceed 400 per 100 ml. For the remainder of the year, the maximum fecal coliform level shall be a geometric mean of 2,000 per 100 milliliters (ml) based on a minimum of five consecutive samples collected on different days during a 30-day period.*

These criteria are based on the use of in-stream water quality sampling data for assessing water quality attainment. Generally, the cost of sample collection and analysis limits water quality sampling programs in terms of the frequency of sample collection, the duration of the sampling program, and the number of sampling locations that can be cost effectively assessed.

4.7.3 Framework for Addressing SSOs and Unauthorized Releases

CRW's PCD is clear on the priority that should be given to sanitary sewer overflows (SSOs) and unauthorized releases from the combined sewer system. PCD Paragraph 27 is clear: "*All SSOs are prohibited*"*.* Since the PCD defines SSOs to include "*(i) discharges to waters of the Commonwealth or United States from the Separate Sanitary Sewer System and (ii) any release of wastewater from the Separate Sanitary Sewer System to public or private property that does not reach waters of the United States or the Commonwealth of Pennsylvania, including but not limited to Building/Private Property Backups*"*,* it is clear that this Program Plan must prioritize mitigation of hydraulic capacity constraints within the separate sanitary collection system, and their heightened risk to public health and safety equivalent to the water quality impacts caused by discharges to receiving waters.

Similarly, PCD Paragraph 34 states that "*All Unauthorized Releases from the Combined Sewer System are prohibited*" and defines an unauthorized release as "*any release of wastewater from the Combined Sewer System to public or private property that does not reach waters of the Commonwealth or United States, including Building/Private Property Backups*". As such, this Program Plan must prioritize mitigation of hydraulic capacity constraints within the combined collection system, and their heightened risk to public health and safety equivalent to the water quality impacts caused by CSOs. Clearly, traditional, end-of-pipe CSO controls focused on improvements to the conveyance system and AWTF do not address unauthorized releases, while more decentralized controls placed within the collection system could provide multiple benefits.

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