

Capital Region Water

**CONSULTING ENGINEER'S ANNUAL
REPORT**

Wastewater System

September 30, 2019





Anthony J. Dill, PE BCEE

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Prepared for:

David Stewart, P.E., BCEE

Director of Engineering

Capital Region Water

212 Locust Street, Suite 302

Harrisburg, PA 17101

Prepared by:

Arcadis U.S., Inc.

1128 Walnut St.

Suite 400

Philadelphia

Pennsylvania 19107

Tel 215 625 0850

Our Ref.:

30003502

Date:

September 30, 2019

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ACRONYMS AND ABBREVIATIONS

AWTF	Advanced Wastewater Treatment Facility
BOD	Biochemical Oxygen Demand
CAMP	CSO Activation Monitoring Pilot
CEAR	Consulting Engineer's Annual Report
CIP	Capital Improvement Plan
CRW	Capital Region Water
CSO	Combined Sewer Overflow
FY	Fiscal Year
MGD	Million Gallons per Day
Mg/L	Milligrams per Liter
NMC	Nine Minimum Controls
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
OMM	Operation & Maintenance Manual
PADEP	Pennsylvania Department of Environmental Protection
PPC	Preparedness, Prevention, and Contingency
PRP	Pollution Reduction Plan
SSO	Sanitary Sewer Overflow
TMDL	Total Maximum Daily Load
VFD	Variable Frequency Drive

1 INTRODUCTION

Arcadis U.S., Inc. (Arcadis) prepared this Wastewater System Consulting Engineer's Annual Report (CEAR) for Capital Region Water (CRW) as required by Section 7.11 of the Trust Indenture between CRW and The Bank of New York Mellon Trust Company, N.A. originally dated May 1, 2017. This CEAR is being submitted to comply with the following requirements for Fiscal Year (FY) 2019, as outlined in the Indenture:

Section 7.11:

"It shall be the duty of the Consulting Engineers, in addition to the other duties prescribed elsewhere in this Indenture, to prepare and file with the Authority and with the Trustee on or before 90 days prior to the beginning of each Fiscal Year hereafter, a report setting forth the following:

- a. Their advice and recommendations as to the proper maintenance and repair of the operating and wastewater delivery infrastructure of the Sewer System during the next Fiscal Year;*
- b. Their advice and recommendations as to the Capital Additions that should be made during the next Fiscal Year and their estimate of the amounts of money necessary for such purpose; and*
- c. Their finding whether the operating and wastewater delivery infrastructure of the Sewer System have been maintained in good repair and sound operating condition and their estimate of the amount, if any, required to place such operating and wastewater delivery infrastructure in such condition and the details of such expenditures and the approximate time required therefor."*

CRW's fiscal year runs from January 1 through December 31. The wastewater system is owned and operated by CRW and includes an Advanced Wastewater Treatment Facility (AWTF), a conveyance system, and wastewater and stormwater collection systems located within the City of Harrisburg (City) limits. Overall, the wastewater system includes approximately 36 miles of sanitary sewers, 40 miles of stormwater sewers, and 101 miles of combined sanitary and stormwater sewers.

The wastewater collection system services customers located within the City. The conveyance and treatment systems provide wastewater conveyance and treatment services to the City and Suburban wholesale customers. Suburban wholesale customers are located in Susquehanna Township, Lower Paxton Township, Swatara Township, Paxtang Borough, Penbrook Borough, and Steelton Borough.

1.1 Report Methodology and Limitations

In preparing this CEAR, Arcadis reviewed existing records and documents prepared by or on behalf of CRW to understand, assess, and report on the technical information contained therein as it relates to the CEAR. The major relevant documents provided by CRW and reviewed as part of the CEAR include, but are not necessarily limited to the following:

- Chapter 94 Municipal Wasteload Management Report and Semi-Annual Report on Consent Decree Implementation, March 2019.
- 2019 Operation and Maintenance Manual (Version 3.0).
- Nine Minimum Control Plan, August 2017.

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- City Beautiful H₂O Program Plan, March 2018.
- The Harrisburg Authority 2005 Long-Term Control Plan.
- Monthly Treatment Plant Operating Data (2018, and January 2019 through May 2019).
- Historic Wastewater System Expenses (FY 2018)
- Budgeted FY 2019 Wastewater System Expenses.
- Correspondence to/from the Pennsylvania Department of Environmental Protection (PADEP), as related to inspection reports, bypass events, unauthorized discharges (UD), and sanitary sewer overflow (SSO) events.
- Biosolids Facilities Improvement Plan Existing Conditions Report, March 2018.
- Biosolids Facilities Improvement Plan Draft, prepared by WRA, June 2017.
- CAMP Study Evaluation Report, prepared by CDM Smith, December 2016.
- Combined Sewer System Characterization Report, prepared by CDM Smith, March 2017.
- Separate Sanitary Sewer Capacity Assessment Report, prepared by CDM Smith, March 2017.
- Collection System Rapid Assessment Findings and Recommendations, prepared by CDM Smith, April 2017.
- Primary Digester Facilities Rehabilitation, Basis of Design Report, prepared by WRA, May 2017.
- Technical Memorandums provided by Arcadis, relating to Digester Gas Evaluations, April 2019.
- Sewer Replacement Project Study Phase – Report of Findings, prepared by HRG, June 13, 2017.
- Memorandum from Gannett Fleming to CRW entitled “PENNVEST Second Opinion Review - Front Street Sewage Pumping Station Improvements Project”, dated May 4, 2018.
- Primary Clarifiers Cost Evaluation – 2nd Opinion Review Report, prepared by Gannett Fleming, July 2018.
- Memorandum from CDM Smith to CRW entitled “Capital Region Water Interceptor Cleaning and Rehab Improvements Update”, dated May 3, 2017.
- Memorandum from HRG to CRW entitled “2019 Sewer Replacement Project Study Phase – Report of Findings”, dated October 11, 2018.
- Memorandum from WRA to CRW entitled “Front Street Interceptor Rehabilitation Phase 2”, dated October 11, 2018.
- Memorandum from JMT to CRW entitled “Paxton Creek Interceptor Rehabilitation Phase 2 Technology Evaluation”, dated December 27, 2018.
- Pipeline Inspections and Investigations Phase II Draft Recommendations Report, prepared by WRA, April 2019.
- Memorandum from JMT to CRW entitled “Front Street Rehabilitation Technologies Review”, dated April 29, 2019.
- Memorandum from CDM Smith to CRW entitled “Front Street Interceptor Lining Hydraulic Performance Evaluation”, dated March 15, 2019.
- Paxton Creek Interceptor and Front Street Interceptor Hydraulic Evaluation of Rehabilitation Alternatives Report, prepared by CDM Smith, April 2019.

In addition, on August 22, 2019, Arcadis conducted limited visual site inspections of the following components of the Wastewater System:

- Advanced Wastewater Treatment Facility
- Front Street Pump Station

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- Spring Creek Pump Station
- City Island North Pump Station
- City Island South Pump Station
- Market Street Pump Station

The review also included discussions with representatives of CRW and performance comparisons to other comparable wastewater systems and related industries.

This CEAR summarizes the findings of the visual inspections at the time they were conducted, and the findings of the data reviewed and discussions with CRW up to the date of the issuance of the CEAR. Changed conditions occurring or becoming known after such date could affect the material presented and the conclusions reached herein to the extent of such changes.

Arcadis has not independently verified the accuracy of the information provided by CRW and others. However, it is believed such sources are reliable and the information obtained to be appropriate for the analysis undertaken and the conclusions reached herein. In addition, the scope of review did not include any pending or threatened litigation against CRW. CRW has stated that there is pending litigation (two claims related to termination of sewer construction contracts totaling \$2.8M and one claim of unspecified damages alleging CRW's failure to properly maintain water and sewer lines causing personal injury) which could have a material impact on its wastewater operations.

In completing this CEAR for CRW, Arcadis is not serving in the role of a "municipal advisor" under the regulations of the Securities and Exchange Commission. As such, Arcadis is not recommending any action regarding municipal financial products or the issuance of municipal securities; and is not acting as a registered municipal advisor to CRW and does not owe a fiduciary duty to CRW pursuant to Section 15B of the Securities Exchange Act of 1934, as amended by the Dodd-Frank Wall Street Reform and Consumer Protection Act, with respect to the information and material prepared in connection with this CEAR. CRW should discuss any information and material prepared in connection with this CEAR with any and all internal and external financial and other advisors that they may deem appropriate before acting on this information and material.

2 WASTEWATER SYSTEM MANAGEMENT

2.1 Overview of the Wastewater System

CRW is a municipal authority that owns and operates an Advanced Wastewater Treatment Facility (AWTF), a conveyance system, and wastewater and stormwater collection system within City limits. The AWTF is one of the largest publicly owned treatment facilities in the Commonwealth and currently the largest in Pennsylvania within the Chesapeake Bay Watershed. The AWTF employs biological nutrient removal technology in an activated sludge plant to achieve nitrogen and ammonia requirements. Overall, the wastewater system includes approximately 33 miles of sanitary sewers, 40 miles of stormwater sewers, and 87 miles of combined sanitary and stormwater sewers. A summary of the major wastewater system facilities is provided in Table 2-1. The wastewater collection system provides service to customers located within the City. The conveyance and treatment systems provide wastewater conveyance and treatment services to City and Suburban wholesale customers. Suburban wholesale customers are located in Susquehanna Township, Lower Paxton Township, Swatara Township, Paxtang Borough, Penbrook Borough, and Steelton Borough. The Suburban wholesale customers account for approximately 50% of the revenues of the wastewater system.

Table 2-1: Summary of Major Wastewater and Stormwater System Facilities

Facility	Description	Design Peak Capacity	2018 Average Flow	2018 Peak Flow
Advanced Wastewater Treatment Facility	High Purity Oxygen Activated Sludge Plant	45.0 MGD	28.8 MGD	39.8 MGD ¹
Front Street Pump Station	Pump Station	43.2 MGD	19.4 MGD	52.2 MGD ²
Spring Creek Pump Station	Pump Station	28.9 MGD	7.53 MGD	26.3 MGD ³
City Island North Pump Station	Pump Station	0.432 MGD	0.006 MGD	0.014 MGD ² Total
City Island South Pump Station	Pump Station	0.432 MGD		
Market Street Pump Station	Pump Station	Unavailable	Unavailable	Unavailable

¹Maximum monthly flow, which occurred in November 2018.

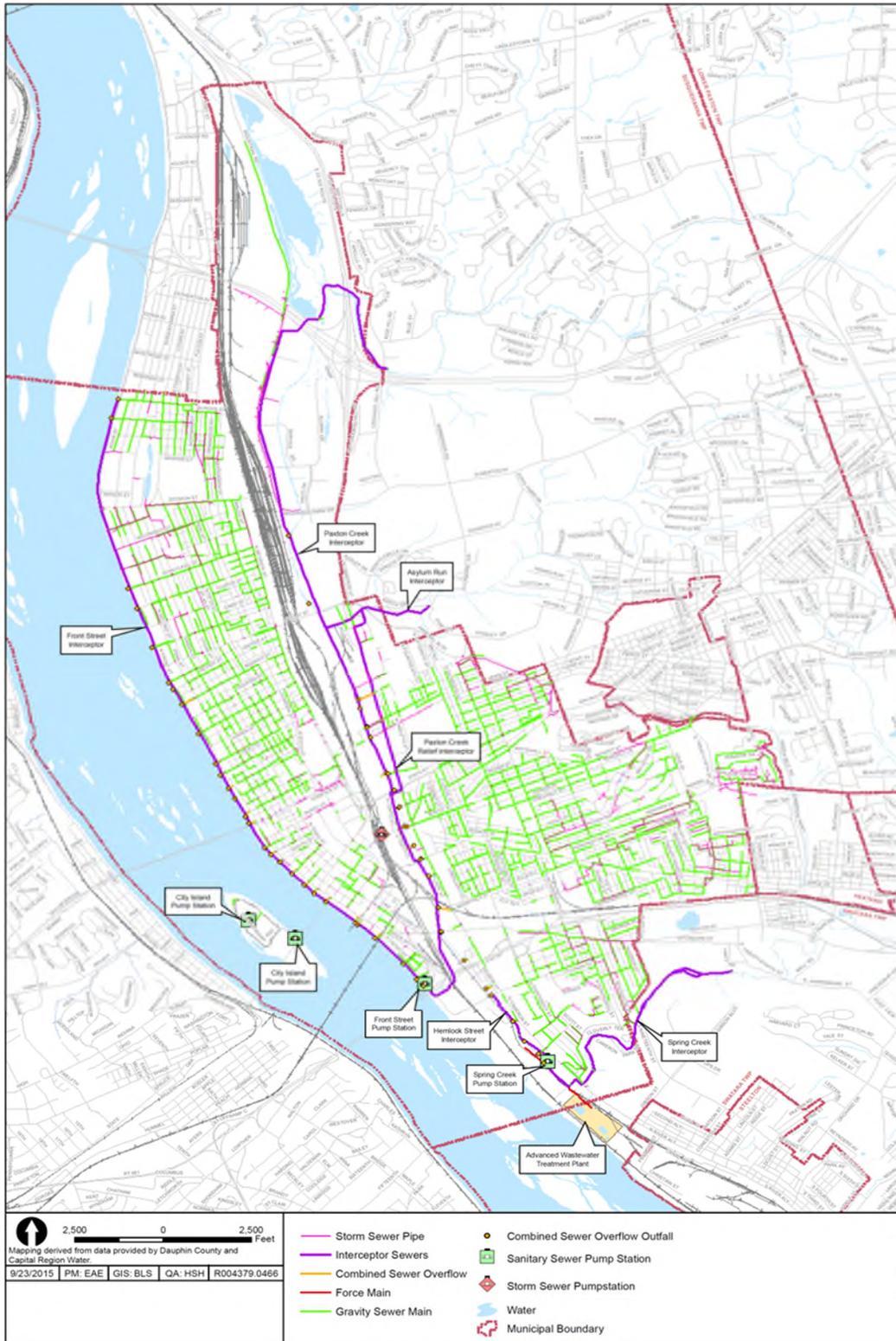
²Peak day flow.

³Peak instantaneous flow.

Source: Chapter 94 Municipal Wasteload Management Report for Calendar Year 2018, and Semi-Annual Report on Consent Decree Implementation for July 1, 2018 to December 31, 2018, dated March 2019.

A map of the wastewater system's infrastructure, including stormwater pipe, interceptor sewers, force mains, gravity sewer mains, and pump stations, is shown in Figure 2-1.

Figure 2-1: Wastewater System Infrastructure Map



2.2 Wastewater System Description

2.2.1 Wastewater Treatment

The AWTF is a 45 million gallon per day (MGD) capacity, high purity, oxygen activated sludge plant. The plant consists of preliminary treatment, including vortex grit removal, followed by primary clarifiers, high purity oxygen secondary treatment, secondary clarifiers, and chlorine disinfection. In 2016 the plant was upgraded to implement biological nutrient removal. This upgrade consisted of new side-stream treatment, 4.5-million-gallon biological reactor tankage and numerous associated appurtenances to upgrade treatment capabilities for nitrogen removal.

2.2.2 Wastewater Pump Stations

The Front Street Sewage Pump Station, located at 830 South Front Street, receives combined sewage flows from the 42-inch by 42-inch Front Street interceptor and 60-inch diameter Paxton Creek interceptor. The Pump Station was constructed in the late 1950s. Annual average daily flow ranges between 14 and 20 MGD with peak daily flows exceeding the station design capacity of 43.2 MGD in 2018 with a peak daily flow of 52.2 MGD being recorded. The Pump Station conveys flow approximately 6,100-feet to the AWTF through a 48-inch diameter cast iron force main joined by the contribution of Spring Creek Pump Station into the force main approximately 2,000-feet upstream of the AWTF. The Front Street Pump Station is currently undergoing a rehabilitation project to replacing the aging infrastructure at the station and increase peak capacity to 60 MGD. The rehabilitation project was awarded in September 2018 with a total cost of \$12.5M.

The Spring Creek Pump Station was originally constructed in 1959, and it currently conveys average daily flows of 7.53 MGD to the AWTF with a peak design capacity of 28.9 MGD. The pump station is located just south west of the intersection of South Cameron Street and Magnolia Street and serves the southern portions of the wastewater collection system. Wastewater enters the station through a 24-inch diameter cast iron interceptor on the east side of the station and a 27-inch diameter reinforced concrete pipe interceptor on the south side. The station is equipped with three sewage pumps that discharge through a 24-inch diameter cast iron line, which ultimately connects to the 48-inch diameter force main from the Front Street Pump Station. The Spring Creek Pump Station also has a permitted combined sewer overflow (CSO) chamber that relieves the system during high flow events. The Spring Creek Pump Station is nearing the end of its useful life, and CRW has begun evaluating potential improvement options for how to implements improvements to the station. However, CRW has elected to wait until Front Street PS Upgrade Project is completed to determine capacity and screening requirements for upgrading or replacement/relocation of the Spring Creek Pump.

There are also two small pump stations (City Island North Pump Station and City Island South Pump Station) that convey wastewater flow from City Island to the Front Street Interceptor and eventually to the Front Street Pump Station. CRW also operates the Market Street Pump Station, which conveys stormwater from a railroad underpass to Paxton Creek.

2.2.3 Wastewater Conveyance

CRW operates and maintains 59 CSO regulator structures located along the Front Street, Paxton Creek, and Hemlock Street interceptor sewers, which ultimately direct combined wastewater (sanitary wastewater and stormwater) to the AWTF. During dry weather conditions, the CSO regulator structures divert all of the combined wastewater from the trunk sewer lines to the interceptor sewers. During wet weather, the rate and volume of the sanitary and stormwater flow from the system of collector sewers increases significantly and can exceed the capacity of the downstream interceptor sewers and the AWTF. When this occurs, the CSO regulator structures (oftentimes called diversion structures) divert a controlled volume of flow to the interceptor, while untreated excess combined wastewater is discharged to receiving waters. The receiving waters are the Susquehanna River for regulator structures along the Front Street interceptor and Paxton Creek (a tributary of the Susquehanna) for regulators along the Paxton Creek and Hemlock Street interceptors.

There are also CSO outfalls at the Front Street Pump Station and the Spring Creek Pump Station. These are permitted emergency outfalls (CSO-002 and CSO-003) that only activate during a mechanical failure of the pump stations or if the station capacities are exceeded during large storms. Each regulator has a dedicated outfall, except in one case where two regulators serve a common outfall. Therefore, there are a total of 60 outfalls (including those from the pump stations) in the system.

In addition, the wastewater conveyance system also includes approximately 33 miles of sanitary sewers, 40 miles of stormwater sewers, and 87 miles of combined sanitary and stormwater sewers.

2.3 Management and Staffing

The Wastewater System was originally managed, owned, and operated by the City of Harrisburg. The wastewater conveyance system was acquired by, and the Advanced Wastewater Treatment Facility was constructed by The Harrisburg Authority and a Conveyance and Treatment System Lease provided for the City's operation of those assets. While the City continued to own and operate the sewer collection system, both the City of Harrisburg and The Harrisburg Authority were party to a Collection System Lease providing for leasing of assets related to the collection system.

In 2011, a fiscal emergency was declared for the City of Harrisburg due to severe financial distress and a state receiver was appointed. Financial distress resulted in operational challenges for the Wastewater System, including a loss in access to capital markets. As a result, the Commonwealth's Office of Receiver, the City, and The Harrisburg Authority agreed to transfer the sewer collection system to The Harrisburg Authority and the Conveyance and Treatment System Lease was terminated. With this termination, codified by the Transition Agreement dated November 4, 2013, The Harrisburg Authority (later renamed Capital Region Water) accepted full ownership and operation of the Wastewater System.

CRW is governed by a five-member Board of Directors. A management team headed by the Chief Executive Officer is responsible for technical and administrative operations of CRW, as well as the implementation of programs, policies, and procedures, and the execution of contracts upon approval by the Board. In addition to providing drinking water services, CRW also provides wastewater services. CRW operates as one entity; however, CRW separately tracks and records the provision of services associated with each of the utilities that it manages and operates.

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CRW's organizational chart is made up of five departments as well as an Executive Team. The five departments are as follows: Drinking Water Operations, Wastewater Operations, Administration, Engineering, and Finance. An overview of the current organization structure of CRW is shown in Figure 2-2.

Figure 2-2: CRW Management Level Organizational Chart



Organizational Structure

2.3.1 Administration, Engineering, Finance, and Operations Departments

The Drinking Water Operations and Wastewater Operations Departments are responsible for operation and maintenance (O&M) of facilities, permit compliance, tracking and reporting, energy management, monitoring, long-term planning, repair and construction, and assistance in budget preparation and tracking. The Wastewater Operations Department includes plans for 48 positions, with 48 positions filled as of August 2019. The Wastewater Operations organizational chart is provided in Figure 2-3.

The Administrative Department provides office management, information technology, human resources, insurance, risk management and safety programs, and administrative support services. The Engineering Department provides engineering support, project coordination, GIS coordination, wet weather coordination, and asset management services. The services currently provided by the Finance Department include accounting, billing and collections, customer service, and payroll. An Executive Team provides sustainability and strategic planning as well as community outreach and communications.

It is understood that CRW plans to staff the Administrative Department, Engineering Department, Finance Department, an Executive Team with a total of 48 positions (12 for Administration, 9 for Engineering, 22 for Finance, and 5 for Executive), and as of July 2019, 40 of the 48 positions have been filled. Personnel expenses associated with these departments are allocated to each of the utilities based on budgeted time allocated to each of the services.

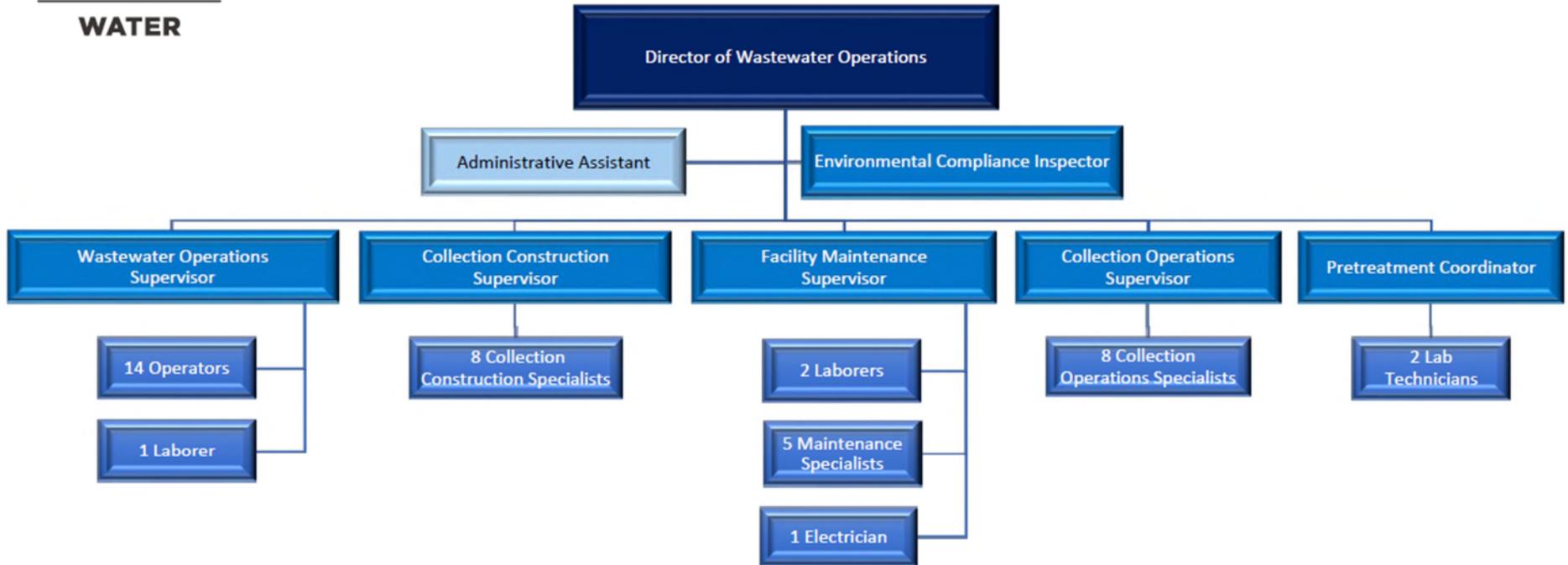
In summary, CRW's FY 2019 Wastewater System budget includes estimated costs associated with the current and planned employees dedicated to the Wastewater System and the Water System's share of costs associated with the planned positions under the Administrative, Engineering, and Finance Departments as well as the Executive Team, which all provide support to CRW's water and wastewater utilities. These employees are all employees of CRW, with the majority belonging to a collective bargaining unit.

The organizational structure of CRW provides strong opportunities for economies of scale through the sharing of administrative, engineering, finance, and executive services between the water and wastewater utilities. The structure is generally consistent with similar-sized, combined utilities and it appears that all required Wastewater System functions of CRW are adequately staffed.

Figure 2-3: Wastewater Operations Division Organizational Chart



Wastewater



3 WASTEWATER SYSTEM PERFORMANCE

3.1 Service Area

The wastewater system provides service to City retail customers and suburban community wholesale customers. The suburban communities account for approximately half of the revenues of the conveyance and treatment systems and include Susquehanna Township, Lower Paxton Township, Swatara Township, Paxtang Borough, Penbrook Borough, and Steelton Borough, all of which are located in Dauphin County. A map of the wastewater system's service area is included in Appendix A.

3.2 Customer Base

CRW maintains approximately 17,000 active connections within the City. Suburban communities are billed on a wholesale basis with their allocation based on an estimate of individual account data for customers located in these communities. Some suburban customers are billed based on metered water consumption, while others are billed based on the estimated number of equivalent dwelling units within their customer base. For 2018 billing purposes, one equivalent dwelling unit has been assumed to equal 45,000 gallons of annual water consumption. During FY 2018, suburban communities were billed for approximately 2.1 billion gallons of wastewater flow.

The number of customers and billed wastewater flow by class for customers located within the City are down in Table 3-1. The total billed wastewater flow for Suburban communities is also shown in the table.

Table 3-1: Customer Information

Description	Accounts	Billed Wastewater Flow (1,000 gal.)
City of Harrisburg:		
Residential	14,862	774,927
Commercial	1,704	537,299
Industrial	18	61,870
Public / Institutional	<u>72</u>	<u>79,388</u>
Total	16,656	1,453,484
Suburban Communities ¹ :		
Penbrook Borough	n/a	68,582
Paxtang Borough	n/a	35,483
Swatara Township	n/a	454,622
Lower Paxton Township	n/a	766,412
Susquehanna Township	n/a	652,025
Steelton Borough	<u>n/a</u>	<u>132,202</u>
Total	n/a	2,109,326
Combined Total	n/a	3,562,810

Source: FY 2018 customer and billing data provided by CRW.

¹EDU basis for residential portion of Suburban Communities reduced from 65,000 gallons/yr to 45,000 gallons/yr in 2018

3.3 Regulation and Compliance

CRW's AWTF is permitted to discharge to the Susquehanna River under National Pollutant Discharge Elimination System (NPDES) Permit No. PA0027197. CRW's permit renewal application was submitted in July 2014 and is currently under review.

3.3.1 Operational Performance

In FY 2018, the average annual wastewater flow received at the AWTF was 28.8 MGD, with the highest month being November with an average flow of 39.8 MGD, and the maximum 3-month average of 31.9 MGD during September through November. The permitted design hydraulic capacity flow for the AWTF is 45.0 MGD. No hydraulic overloads were recorded in 2018, as the monthly average flow at the AWTF did not exceed the design capacity of 45.0 MGD in any month during the year. In addition, the average flow at the AWTF in FY 2019 (through May), was approximately 30.84 MGD and the highest average flow on a per month basis occurred in February and was 32.3 MGD. Based on flow projections for the City, and contributing municipalities, no hydraulic overload conditions are projected through FY 2023, as the annual average flow in that year is projected to be 23.6 MGD.¹ Given that 2018 flows were significantly above 23.6 MGD, we recommend that CRW revisit its future flow projections.

In FY 2018, annual average biochemical oxygen demand (BOD) loading was 25,294 pounds per day with a maximum month loading of 30,358 pounds per day. The permitted average daily organic loading for the AWTF is 68,257 pounds BOD per day. No organic overloads were recorded in 2018 and no overload conditions are expected through 2023, as the annual average organic loading is projected to be 24,654 pounds per day over the period from 2018 to 2023. Over the past five years, the average organic waste strength of the sewerage received at the AWTF has averaged at 137 milligrams per liter (mg/L). The organic waste strength of the sewerage is not expected to increase significantly over the next five years.²

With the completion of the AWTF Nutrient Removal Upgrade (BNR) project in 2016, CRW has realized a significant decrease in the concentration of nitrogen in the effluent from the AWTF. For example, in 2015, the average concentration of nitrogen as sampled from effluent was 22.4 mg/L; in FY 2017 the average concentration of nitrogen in the effluent was 5.6 mg/L and in FY 2018 the average concentration of nitrogen in the effluent was 7.0 mg/L and in FY 2019 (January to May) the average concentration of nitrogen in the effluent was 9.0 mg/L.

3.3.2 Permit Exceedances

CRW did not exceed any of its NPDES permit requirements in 2018 which was attributed to having the upgraded AWTF facilities in operation.³

¹Chapter 94 Municipal Wasteload Management Report for Calendar Year 2018, and Semi-Annual Report on Consent Decree Implementation for July 1, 2018 to December 31, 2018, dated March 2019.

² Ibid, p.1-2.

³ Chapter 94 Municipal Wasteload Management Report for Calendar Year 2018, and Semi-Annual Report on Consent Decree Implementation for July 1, 2018 to December 31, 2018, dated March 2019.

3.3.3 Sewer Overflows and Bypass Events

There were 57 secondary bypass events during 2018. A secondary bypass event is where there is excess wastewater flow received at the secondary treatment train above 45.0 MGD, causing the wastewater flow to bypass secondary treatment. This includes one unanticipated bypass on August 05, 2018 due to a 26-minute failure of a settled sewage pump. Nineteen of the bypass events exceeded 12 hours in duration, with the longest bypass event lasting longer than 23 hours.

CRW has a combined sanitary and stormwater system, which conveys wastewater and stormwater runoff during wet weather periods. Regulators and diversion chambers divert excess flow to Paxton Creek or Susquehanna River during wet weather events. Wet weather events occur when the combined flow exceeds the dry weather peak flow capacity. CRW's discharge permit authorizes discharges from regulators and diversion chambers, however, it does not authorize overflows from sanitary sewers or discharges from other than identified combined sewer regulators and diversion chambers. A summary of the SSO events and combined sewer unauthorized discharges during the 2018 reporting period are listed in Table 3-2.

Table 3-2: Sewer Overflows and Unauthorized Discharges (2018)

Date	Location	Issue
1/6/18	2121 Kensington St	Blockage in main
1/6/18	2103 Kensington St	Blockage in main
1/20/18	1613 Derry St	Sewer collapse
3/4/18	2121 Kensington St	Debris blockage in main
3/28/18	334 Rumson Dr	Blockage from partial pipe collapse at end of lateral
4/2/18	2543 Fourth St	Blockage in main
4/9/18	2749 Fourth St	Grease blockage in main
4/25/18	385 Rumson Dr	Root and grease blockage
7/11/18	Cameron St & Wildwood Park	Sewer main punctured by boring equipment (inaccurate mapping)
7/24/18	1839 Spencer St	Grease buildup in main and poor condition of main
7/25/18	Spring Creek Interceptor (SSMH-000391, SSMH-000392)	Excessive rain (10-inches) for five days, flash flooding.
11/12/18	Wilson Taylor Park & Capital Area Greenbelt	Debris in main (previously not in CRW GIS)

3.3.4 Partial Consent Decree

In August 2015, CRW entered into a partial Consent Decree with the Department of Justice, the U.S. Environmental Protection Agency, and PADEP concerning the operation of its collection system, pump stations, and AWTF. The Consent Decree requires CRW to complete a Long-Term Control Plan for its combined sewer system, update the Combined Sewer System Operations and Maintenance Manual and Nine Minimum controls, obtain a MS4 permit and establish a Stormwater Management Program, and implement early action projects. In 2018, CRW fulfilled its partial Consent Decree requirements for deadlines due during this reporting period, including the following:

- Completion of its Annual Update of the Nine Minimum Controls plan
- Completion of its Semi-Annual Report on Consent Decree Implementation
- Completion of a Chapter 94 Annual Wasteload Management Report
- Completion of its updated Long-Term Control Plan (City Beautiful H₂O Program Plan) in March 2018 and provided responses to regulatory agencies with initial responses in August and November 2018.
- Completed remedial work on the Asylum Run Interceptor

CRW has met compliance dates for the reporting period January 1, 2019 to June 30, 2019 corresponding to Semi-Annual Report on Consent Decree Implementation and Chapter 94 Annual Wasteload Management Report.

CRW completed upgrades to its AWTF in 2016 with biological nutrient removal in order to comply with the Chesapeake Bay Tributary Strategy and meet new NPDES permit discharge requirements. This \$50 million project at the AWTF consisted of adding biological nutrient removal technology to the existing processes to achieve nitrogen and ammonia removal requirements associated with the new NPDES discharge permit. With the project now complete, CRW has the ability to generate nutrient credits. However, as reported by CRW, based upon the current market value of the credits, it is not cost-effective to generate credits at this time.

3.3.5 Wet Weather Program Accomplishments

CRW's progress during FY 2018 and FY 2019 under its Wet Weather Program included the following accomplishments:

- Submitted the Nine Minimum Controls Plan Update on August 10, 2018.
- CRW began updating a CSO hotline with the status of CSO events and continued to conduct numerous public outreach activities including: monthly litter clean-ups; monthly community ambassador meetings; public outreach via bill inserts, door to door, local media coverage, website, email, and social media to engage the public; and CRW hosted two green infrastructure block parties.
- Continued to expand the development of the sewer maintenance management system, including the GIS and Cityworks systems, including development of training protocol for all Cityworks users and is incorporating additional reporting related to maintenance and regulatory activities within the sewer system from the Cityworks data.

- Continues to monitor 8 precipitation gauging sites as well as gauge adjusted radar rainfall, 4 flow meters monitoring flow from the satellite communities, and 8 combined sewer interceptor flow meters.
- Continued to develop and implement Green Stormwater Infrastructure Projects, including existing projects at the following sites: Cloverly Heights, Penn & Sayford, Royal Terrace, and Summit Terrace. A new project is being constructed as part of a larger multimodal transportation project along 3rd Street in Harrisburg which consists of 29 rain gardens, 14 stormwater trees, and 1 tree trench stormwater control measure.
- A Green Stormwater Infrastructure Operation and Maintenance Manual was developed to provide guidance on vegetative care as well as the long-term maintenance of piping and underdrain systems.

3.3.6 Nine Minimum Controls Plan

CRW developed a detailed approach to achieve future compliance with each of the Nine Minimum Controls (NMCs), which was submitted in the August 2015 NMC Plan and has been updated annually. In many cases, the compliance measures have already been implemented, such as daily CSO regulator inspections. In other areas, additional information is required to implement some of the NMCs, and CRW has undertaken efforts necessary to collect the data. Efforts related to the NMC Plan that have been completed include the following:

- Prepared the 2018 NMC Plan Update to address EPA comments
- Identified critical trunk sewers and completed manhole inspection data review
- Refined the sewershed and catchment delineations using the manhole investigation data
- Updated the GIS system with collection system manhole investigation and rapid assessment data
- Completed the majority of the interceptor cleaning by December 31, 2016
- Completed an internal force main inspection and found no critical deficiencies
- Continued to implement and optimize Cityworks for the management of complaints and service requests and operations and maintenance of AWTF and pumping stations
- Purchased a new vector truck
- Purchased a second CCTV camera and a replacement pickup truck
- Continued to perform daily regulator inspections at each regulator
- Development of an asset investment prioritization process to organize assets into five priority levels for future capital improvement projects
- Stakeholder Engagement and External Affairs Strategy Report, which included developing a public engagement strategy

The following efforts are ongoing by CRW related to its NMC Plan:

Conduct proper operation and regulator maintenance of the conveyance and collection system:

- Initiation of a comprehensive systemwide CCTV inspection and assessment of the collection system
- Identification of key equipment purchases
- Allocating funds to address Priority 1 projects within the next five years

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- Continued to provide training to staff
- Continued to perform daily regulator inspections
- Will consider CSO activation monitoring capabilities as the baseline regulator improvement projects identified during the City Beautiful H₂O Program Plan (CBH2OPP) are implemented
- Continued to implement practices outlined in the Operations and Maintenance Manual (OMM)
- Continued with an ongoing inlet cleaning and inspection program
- Continued to inspect and maintain pump stations as outlined in the OMM
- Continued to optimize Cityworks for data management and maintenance problems
- Continued to investigate and repair sinkholes in accordance with the OMM

Maximize use of storage in the collection systems:

- Continuing to prioritize areas of the collection system for remedial repair based on an overall schedule for cleaning, rehabilitation, and replacement as part of the core risk analysis in the asset management program and LTCP plan implementation.
- Continuing to clean interceptors
- Intention to use a decentralized green grey local control strategy during the implementation of the LTCP to provide storage to reduce CSOs and unauthorized releases (e.g., basement backups) within the collection system

Maximize flow to the AWTF:

- Continued to operate the system in accordance with the OMM
- Continued flow monitoring work within the sanitary sewer system to quantify inflow and infiltration
- Comprehensive CSO regulator/outfall enhancements recommended as a baseline control under the LTCP
- Inspected the MS4 and sanitary/combined sewer systems
- Evaluated the AWTF flows for the preparation of the Chapter 94 Report
- Construction upgrades to the Front Street Pumping Station

Eliminate dry weather overflows:

- Reported dry weather overflows in accordance with regulatory guidelines
- Implement weir height adjustments for the Baseline Level of Control
- Removed blockages and modified hydrant flushing operations to correct dry weather overflows.
- Conducted daily inspections as detailed in the OMM
- Removed waste material that accumulated on the stream banks.

Operate and maintain the combined sewer system to control solid and floatable materials:

- Removed waste material that accumulated on the stream banks

Implement public notification procedures set forth in the NMC plan:

- Installed temporary signs at each CSO outfall and public stream access point that notify and alert the public.
- Continued to develop a public outreach and notification program as described in the NMC Plan

- Continued to increase public involvement activities, including monthly trash clean-ups, and presentations at community events.

Utilize a phased approach to characterize CSO impacts and control efficacy:

- Employed visual inspections of regulator and outfalls daily
- Continue to monitor rainfall at rain gauges

Evaluate the efficacy of the NMC Plan:

- Updated the NMC Plan

Submit MS4 Individual Permit Application with a Stormwater Management Plan:

- Continued implementing a TMDL Strategy in collaboration with two neighboring municipalities
- Continued with field investigations to identify outfalls and a map of the MS4 system
- Continued to conduct stormwater management plan reviews through coordination with the City of Harrisburg
- Developed draft rules and regulations for stormwater management
- Pursuing an MOU with Dauphin County Conservation District

3.3.7 Operations and Maintenance Manual

CRW reviewed ongoing maintenance and operation efforts and developed improved practices for compilation in the new Operations and Maintenance Manual (OMM). The OMM defines the critical equipment and facilities for the AWTF and collection/conveyance systems. The OMM also includes detailed procedures, complete with checklists, for the following system components: CSO regulators, outfalls and backflow prevention gates, pump stations, interceptors, force mains, collection system and manholes, and inlets and catch basins. The OMM also outlines emergency procedures, citizen complaint tracking, sinkhole remediation, and education programs. The OMM document was originally submitted on August 10, 2015, and the latest version (V3.0) was released in March 2019.

3.3.8 Data Management Systems

CRW has developed a Cityworks™ data management system for their sewer system. Cityworks was implemented in October 20, 2015. This software is the recordkeeping tool for maintenance activities and will assist in reporting requirements of the partial Consent Decree. From January to December 2018 the following items have been documented in Cityworks for sewer system maintenance and inspection activities:

- 1,701 inlets were cleaned, 65 were repaired and 3 were replaced
- 53 sinkholes were identified and addressed
- 3,485 work orders completed, including pipe flushing, cleaning out manholes and repairing manholes
- 96,426 linear feet of collection system sewer were cleaned and televised
- 2,220 hotspot inspections

- 21,170 daily CSO inspections

3.3.9 LTCP Development

In support of the LTCP development, CRW has completed several tasks, including the following:

- Started construction of four green stormwater infrastructure pilot projects.
- Completed the CSO/wet weather alternatives evaluation.
- Performed a Financial Capabilities Analysis according to U.S. EPA protocol.
- Conducted community stakeholder workshops.

CRW submitted the City Beautiful H2O Program (CBH20PP) on April 1, 2018, received comments on the CBH20PP on July 6, 2018, and met with EPA/DEP to review the comments on August 7, 2018. CRW provided an initial response on August 31, 2018 and a more detailed response on November 9, 2018.

3.3.10 Industrial Pre-Treatment

CRW maintains an Industrial Pre-Treatment Program to ensure that industrial users comply with federal state, and local pre-treatment program effluent discharge limitations and regulations. Industrial user compliance eliminates interference or possible damage to the conveyance and treatment system, untreated waste from passing through the AWTF to the receiving stream, the contamination of sludge which limits disposal and reuse options, and the exposure of personnel to chemical, explosion or fire hazards.

The total number of permitted industrial users in 2018 was eight. During FY 2018 no additional significant industrial users were permitted. Of the eight permitted industrial users, one is classified as categorical and seven as non-categorical industrial users. Inspection and sampling activities performed during the year included facility inspections, self-monitoring inspections, and compliance sampling. During 2018, no permitted industrial users were on a formal compliance schedule for non-compliance. However, during the 2018 calendar year, two violation notices were issued for noncompliance with effluent discharge limits. No notices of violation were issued for significant noncompliance in 2018.

4 WASTEWATER SYSTEM CONDITION

4.1 Overview

CRW staff aim to ensure the entire Wastewater System is properly operated and maintained. The cost to provide routine and preventative maintenance is included in CRW's annual operating budget. CRW uses a proactive preventative maintenance program and a systematic replacement policy for inventory parts to minimize downtime.

Additionally, CRW is developing a comprehensive asset management program for the wastewater system which will further enhance preventative maintenance and increase system reliability. KCI Technologies is supporting the asset management program development. Asset registries have been developed for all CRW treatment plants, pumping stations, storage facilities, and the DeHart Dam facility. CRW has developed a risk register for CRW's buried assets and established high-level replacement, rehabilitation, and condition assessment cost estimates.

Development of the Wastewater Collection System Asset Management Plan is underway with a targeted completion date in the Fall of 2019. The plan will provide CRW with strategies for operations, maintenance, capital investments, and funding. A parallel Asset Management Plan for the drinking water system will follow.

4.2 Condition Assessment

Arcadis conducted a limited condition assessment of the key components of CRW Wastewater System, which included a review of existing information provided by CRW, discussions with CRW staff, and visual observations during field visits held on August 22, 2019. Based on the type of facilities, available documents related to the facilities, and previous experience with similar facilities, a representative sample of facilities was inspected on a limited basis to visually confirm the information provided, identify any apparent capital improvement needs, and discuss reliability and O&M performance with the operation and maintenance staff. No field investigations were conducted for buried infrastructure.

The condition assessment of the facilities in the Wastewater System was based on numerical ratings for the following criteria:

- Appearance of mechanical, structural, and electrical components
- Reliability
- O&M performance
- Capacity
- Regulatory compliance

Based on the evaluations using the above categories, an overall risk rating was assigned to each of the major assets. The risk ratings for each of the five categories above are outlined in Table 4-1.

Table 4-1: Summary of the Rating System

Numerical Rating	Interpretation of Rating	Description
1	Little to no risk	Relatively new and in good physical and operating condition.
2	Some risk	Good condition, no known capital requirements.
3	Moderate risk	Aged or worn but generally in good operating condition may require capital investment within 5 years.
4	Significant risk	Operational but nearing end of life and / or requires investment to bring to full operating condition.
5	High risk	Should be on high priority for renewal and/or replacement.

The following presents a summary of the risk ranking for each of the major facilities based on a review of the available information and limited visual inspections.

Table 4-2: Major Assets Risk Rating

Major Asset	Risk Rating
AWTF	3.1
Front Street Pump Station	3.3
Spring Creek Pump Station	3.0
City Island North Pump Station	2.3
City Island South Pump Station	2.3
Market Street Stormwater Pump Station	2.2
Combined Sewer Overflow Regulators	2.0
Interceptor Sewers	
• Front Street Interceptor	4.1
• Paxton Creek Interceptor	4.8
• Hemlock Street Interceptor	3.0
• Spring Creek Interceptor	3.0
• Paxton Creek Relief Interceptor	3.0
• Asylum Run Interceptor	3.0
Collection System	3.0
Separate Stormwater Collection System	3.0
Overall System Rating	3.0

Overall the Wastewater System is in fair condition; however, some components are aged and will require investigation and capital investment to preserve the asset and maintain appropriate system performance and delivery of services.

An arc flash study is recommended for the wastewater system in order to be in compliance with current NFPA 70E and OSHA 1910 (Subpart S) regulations. However, due to the current state of electrical

equipment at the AWTF and collection system pump stations, it is anticipated that a sizeable portion will be replaced in the next 2 to 5-years given the current CIP. Therefore, CRW intends to evaluate the need, scope, and budget for arc flash studies after completion of the improvement projects currently in the CIP.

The following provides a summary of the current condition of the major components, the rationale for the risk scores assigned, and the improvements needed to address moderate, significant, and high risks.

4.2.1 AWTF

The AWTF, located on Elliot Street off South Cameron Street on the City of Harrisburg's border with the Borough of Steelton, treats wastewater conveyed from the Front Street Pump Station, the Spring Creek Pump Station, and the Trewick Street Pump Station (Borough of Steelton). It also treats trucked in wastewater. The site also contains the CRW collection system maintenance garage. The AWTF utilizes grit removal, primary clarification, oxic/anoxic biological treatment, chemical addition, final clarification, and disinfection to treat wastewater prior to discharge to the Susquehanna River. Additionally, AWTF thickens, anaerobically digests, and dewater residuals from the wastewater treatment processes prior to farmland application as Class B residuals. CRW completed major improvements to the biological treatment and final clarification processes at the AWTF in 2016 which were intended to achieve the effluent limits for nutrient removal contained in its discharge permit.

The AWTF appears to be in fair overall physical condition based on the available documents and an Arcadis inspection on August 22, 2019. However, some capital investments and minor additional O&M expenditures should be made within the next five years to ensure continued compliance with effluent limits and reduce operating costs. Table 4-3 identifies the anticipated additional capital and incremental O&M needs that have not been identified already in the previous CRW CIP.

Table 4-3: AWTF Improvements

Description	Classification
Repair Damaged Section of Handrail on Chlorine Contact Tank	Capital Maintenance

CRW has completed construction on their new influent screening facility at the AWTF and has yet to have one single issue with blockages since the facility was brought online. The influent screening facility improvements included two screening units, with a third bypass channel containing a manually-cleaned bar rack. Each channel has the ability to pass 40 MGD, providing a total of 120 MGD of capacity and 80 MGD (peak design flow) with one unit out of service.

An energy audit was performed for the AWTF in July 2017. The purpose of the audit was to provide a comprehensive list of energy efficiency improvements that CRW could perform to reduce overall energy consumption. Based on the results of the audit, CRW plans to implement various energy efficiency improvements at the AWTF. Already completed by CRW was the installation of a dissolved oxygen (DO) probe in the final effluent channel that measures the oxygen in the effluent and reduced the number of blowers in operation to maintain adequate DO without over aerating. CRW is currently evaluating alternatives for the implementation of waste activated sludge (WAS) improvements that would modify existing piping in the WAS pump station to allow for return activated sludge (RAS) to be wasted instead of

mixed liquor suspended solids (MLSS). By wasting RAS instead of MLSS, the pumping requirements are significantly reduced due to the increased solids concentration of the RAS compared to the MLSS.

Additionally, CRW is in the process of implementing improvements to the existing primary clarifiers. Whitman, Requardt & Associates, LLP (WRA) was retained to provide design services for primary clarifier improvements. The recommended improvements based on WRA's evaluation include the following:

- Structural repairs and rehabilitation of all clarifier tanks
- Primary clarifier mechanism replacement of all tanks (inclusive of main and cross collector drive units, chain and flight scrapers, influent gates, effluent weirs).
- Replacement of miscellaneous piping, valves, and actuators.
- Primary sludge pump replacement (2 units).
- Replacement of decant pump in the decant pump vault.

However, based on the engineering cost estimate prepared by WRA, the construction cost was too high and therefore CRW elected to perform the replacement of the primary clarifier mechanism and pumps in-house in an effort to reduce cost. Currently, CRW is planning to replace the pumps, drive mechanisms, chains and flights on the primary clarifiers in the second half of 2019 or early 2020. Additionally, in July 2018 CRW hired Gannett Fleming to review the WRA 60% submittal and construction cost estimate. Their findings included reducing the construction cost by approximately \$2,741,000 by having CRW's maintenance staff complete the sludge collection and pumping upgrades.

4.2.1.1 Biosolids Facility Review

In March 2017, a Biosolids Facilities Existing Conditions Report was completed by WRA. The purpose of this report was to provide an assessment of the current conditions of the solids treatment and handling systems at the AWTF. Based on the Biosolids Facilities Existing Conditions Report, WRA submitted in June 2017, a Preliminary Biosolids Facilities Improvement Plan for CRW, which included several recommendations as part of the improvement plan, including:

- Process modifications to separately thicken waste activated sludge and primary sludge
- Upgrade of the primary digesters
- Replacement of gravity thickener facilities
- Upgrade of the dewatering facilities
- Construction of a hauled waste facility
- Replacement of the boiler building
- Replacement of the combined heat and power (cogeneration) system equipment
- Replacement of the gas collection, storage and pretreatment systems

The opinion of probable construction costs for the biosolids facility improvements total \$52.3 million, with a low estimate of \$42.4 million and a high estimate of \$75.5 million. The report provides phased schedule for construction beginning in 2017 for the primary digester improvements and extending to 2024 for the dewatering facility improvements. CRW has proceeded with the primary digester improvements which is currently under construction. The Primary Digester Improvements project is based upon the May 2017 Basis of Design Report prepared by WRA for the Rehabilitation of the Primary Digester Facilities. The

improvements include the rehabilitation of the primary digester facilities equipment to replace old components with new, and upgrade the digester mixing system. In addition, the project includes an electrical building to help facilitate the replacement of old electrical gear and provide a central power distribution facility to serve the southern part of the AWTF. The engineer's opinion of probable construction cost was \$10.1M, however the awarded construction contract value is \$8.8M. Currently construction is under way, having started in the summer of 2018 with the first digester anticipated to be online by January 2020 and the second digester to be online mid-2020.

CRW is planning to move forward with replacement of the combined heat and power (CHP) system; the design phase will be performed in 2019 and followed with design implementation in 2020. CRW intends to prioritize work on the secondary digesters following completion of the primary digester improvements. Remaining biosolids facility projects will be evaluated for priority as the above projects are completed.

Additionally, from 2013 to present, nearly all of the biosolids generated by CRW have been land applied for beneficial use by agriculture. Biosolids hauling to the farms is provided by a contracted hauler. The 13,250 wet tons of biosolids produced by CRW requires approximately 623 acres of beneficial use. CRW has approximately 793 qualified acres, which provides a buffer of 170 acres. WRA recommended that an additional 140 acres of qualified acreage be added to the current land base over the next 1 to 5 years for beneficial biosolids disposal.

Recommendations from WRA's regulatory biosolids review include a recommendation that CRW should periodically have a phosphorous source coefficient test performed as part of routine monitoring, which can be used in the future in site index calculations of phosphorous management is implemented by PADEP. Further, WRA notes that there are several regulatory and non-regulatory drivers that could potentially affect biosolids land application programs, including limiting phosphorous application, odor considerations, and farmland availability. While there are no federal biosolids regulatory changes planned, PADEP indicated that the new General Permit would include new phosphorous management and hauled waste requirements. CRW may want to consider conducting an assessment of their current qualified acreage to determine the impact of phosphorous management.

4.2.2 Pump Stations

CRW maintains five wastewater or stormwater pump stations: Front Street, Spring Creek, City Island North, City Island South, and Market Street.

4.2.2.1 Front Street Pump Station

The Front Street Pump Station is located at 830 South Front Street in the City of Harrisburg and receives combined sewage flows from the 42-inch by 42-inch Front Street interceptor and 60-inch diameter Paxton Creek interceptor. The pump station is currently being upgraded, including replacement of pumps, bar screens, screenings conveyance equipment, controls, and associated improvements to electrical, HVAC, and building systems to meet current code requirements.

4.2.2.2 Spring Creek Pump Station

The Spring Creek Pump Station is located southwest of the intersection of South Cameron Street and Magnolia Street in the City. It conveys combined sewage from the Spring Creek Interceptor and the

Hemlock Street Interceptor to the AWTF. Hazen and Sawyer prepared an engineering report dated April 21, 2015 that assessed the condition of the station as part of an investigation into improving wastewater screen performance at all CRW's major wastewater facilities. The station appears to be in fair overall physical condition based on the available documents and an inspection by Arcadis on August 22, 2019. 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. Capital investments should be made within the next five years to ensure continued operation and to reduce operating costs.

Miscellaneous improvements were made since the previous site inspection. The variable frequency drives (VFDs) were sent to be cleaned and have since been returned and installed in the pump station. Pump No. 1 is still being rebuilt and the spare pump is currently installed. Bar screen is currently out of service and is not anticipated to be replaced until 2021; currently screening is being performed at the AWTF using the newly constructed influent screening facility.

In addition, the April 2015 Screening Study completed by Hazen and Sawyer evaluated the existing screening equipment at Spring Creek Pump Station and recommended replacement. The total project cost for screening improvements at the Spring Creek Pump Station was estimated to be \$7.5 million. It is anticipated that construction would not take place until 2023. However, it has yet to be determined if the improvements will be made to the existing Spring Creek Pump Station or if a new Pump Station will be constructed along with CSO storage until they finish the Front Street Pump Station and see how that is handling flows and grit removal.

4.2.2.3 City Island Pump Stations

The City Island North Pump Station is located at the north end of City Island in the City of Harrisburg. Sewage is conveyed from the City Island South Pump Station and elsewhere on City Island to the CRW collection system in Harrisburg proper. The station appears to be in good overall physical condition based on the available documents and an inspection by Arcadis on August 22, 2019. During the inspection, it was noted that a sewage pump and associated check valve, along with the dry well ventilation fan were replaced since the previous site inspection. However, it is recommended that CRW replace the following in the next 2-3 years at the pump station: the wood platform, due to warping and splitting, the electrical control box due to corrosion, and electrical gear due to its age. It is estimated that the cost to replace the platform and the electrical equipment would be approximately \$100,000. Currently CRW operates the pump station but has not accepted ownership of the pump station and therefore improvements are on hold pending resolution of ownership with the City. The improvements for the City Island North Pump Station are not currently included in the capital plan, but should be included once CRW accepts ownership.

The City Island South Pump Station is located near the center of City Island in the City. It conveys sewage from elsewhere on City Island to the CRW collection system in Harrisburg proper. The station appears to be in good overall physical condition based on the available documents and an inspection by Arcadis on August 22, 2019. It was noted during the inspection that the pump station has been bypassed for several months and flow is being directed to the City Island North Pump Station. This is due to the lack of pumping requirements out of both facilities as pumping is not required at both stations to accommodate service flow requirements. It is recommended that CRW replace the following in the next 2-3 years at the pump station: repair the broken weld on the railing of the pump station, the wooden

platform needs to be replaced due to warping and splitting, the electrical control box needs to be replaced due to corrosion, and electrical gear needs to be replaced due to its age. It is estimated that the cost to replace the platform and electrical gear would total approximately \$100,000. Currently CRW operates the pump station but has not accepted ownership of the pump station and therefore improvements are on hold pending resolution of ownership with the City. The improvements for the City Island South Pump Station are not currently included in the capital plan, but should be included once CRW accepts ownership.

4.2.2.4 Market Street Pump Station

The Market Street Pump Station conveys stormwater from a railroad underpass to Paxton Creek. The station appears to be in good to fair overall physical condition based on the available documents and an inspection by Arcadis on August 22, 2019. However, some additional O&M expenditures should be made within the next five years to ensure continued operation and to reduce operating costs. For example, concrete cracks were observed at the following locations: floor surfaces in the generator building, along the east side of the exterior of the building, and at the stairs leading to the entrance to the Pump Station. Additionally, 3rd pump is currently under repair and 4th pump to be repaired in 2020.

Table 4-4 identifies the anticipated additional capital and incremental O&M needs for the pump stations that have not been identified already in the previous CRW CIP.

Table 4-4: Pump Station Improvements

Description	Classification
Spring Creek PS – Perform Maintenance on the Bar Screen (replace drive chain)	O&M
Spring Creek PS - Replacing Missing Railing Section Between Screening Enclosure and Pump Station	O&M

4.2.3 Collection System

CRW wastewater system includes approximately 33 miles of sanitary sewers, 40 miles of stormwater sewers, and 87 miles of combined sanitary and stormwater sewers. Approximately 80% of the collection system was installed prior to 1940. Regulators and diversion chambers serve to divert excess flows to the Paxton Creek or the Susquehanna River during wet weather events.

While the collection system was not inspected by Arcadis during its August 2019 field visit, CRW has completed several inspection efforts associated with its collection system. In April 2017, CRW issued a Collection System Rapid Assessment Findings and Recommendations Report, where the findings of the assessments performed in 2012, 2015, and 2016 were summarized and recommendations were provided. The Report recommended that CRW complete the immediate sewer repairs that were identified and to continue to televise the collection system over the next 4 to 6 years. The remedies range from light to heavy cleaning to point repairs and pipe replacement. Remedial program costs were developed, which estimated the cost to address immediate priority issues at \$2.3 million, high priority issues at \$16 million, medium priority issues at \$32.2 million, and low priority issues at \$35.6 million. The report also provided a schedule for remedial repairs, cleaning and inspection on an annual basis, which consisted of

an annual cost of between \$4.0 million and \$4.9 million in years 1-5, and \$4.0 million per year thereafter through 2026.

In June 2018, WRA prepared "Pipeline Inspection and Investigations Phase I, Recommendations Report" for CRW following the review of CCTV inspection services performed by TFE Resources and a memorandum prepared by EBA Engineering, Inc. to recommend sewer rehabilitation projects within the City system. CCTV reports/videos were reviewed, sewer segments were scored for rehabilitation, recommendations were made, and projects were prioritized.

Phase 1 of this project includes inspection of approximately 15,143 LF of sewer. WRA prioritized repair and replacement projects for Phase I on the order of 22 projects for an approximate total cost of \$1.7 million. Prioritization was done to assist in the Long-Term Control Plan and identify the key components of the system. Prioritizing projects helps in identifying choke points in the system, where failure would impact the greater service area.

Of the 22 projects, 3 require excavated point repair, 6 require complete pipe replacement, 7 require heavy cleaning, and 6 require lining point repairs. Phase 1 recommends that for the 22 projects, approximately 4,112 LF of pipe is rehabilitated. Further recommendations for the system are summarized below:

- Locate and uncover manholes to permit inspection and condition assessment of 2,325 LF of sewers to determined rehabilitation requirements.
- Update the GIS database with CCTV conditions/comments recorded in the field. During the CCTV inspection, there were a significant number of defects noted. Having this knowledge readily available will assist future users.
- Continued investigation of remaining pipe segments in the system due to the poor conditions observed under this investigation.

Inspection efforts to date have focused on the sanitary and combined sewers. CRW should develop an inspection and rehabilitation program for the separate storm sewers. It is anticipated that inspection of the storm sewers will identify repair needs that should be included in a future CIP.

In April 2019, WRA prepared "Pipeline Inspection and Investigations Phase II, Recommendations Report" for CRW following the review of CCTV inspection services performed by TFE Resources and a memorandum prepared by EBA Engineering, Inc. to recommend sewer rehabilitation projects within the City system. CCTV reports/videos were reviewed, sewer segments were scored for rehabilitation, recommendations were made, and projects were prioritized. WRA developed a prioritization of recommended replacement and repair projects for the pipelines investigated under Phase II. This resulted in the development of 40 projects, with a total cost of approximately \$3.15 million.

In October 2019, Herbert, Rowland & Grubic, Inc. (HRG) prepared "Sewer Replacement Project Study Phase – Report of Findings" for CRW following the review of CCTV inspections of the sewer pipe sections completed by CRW. HRG recommends the repair/replacement of the identified sewer sections in their report. The construction cost estimate for the recommended improvements are \$2,070,000 and CRW has recently begun the design phase for these improvements.

4.2.3.1 Sewer Interceptors

CRW operates and maintains a total of six (6) interceptor sewers. Four of these interceptors convey combined wastewater, including the Front Street Interceptor, Paxton Creek Interceptor, Paxton Creek Relief Interceptor, and the Hemlock Street Interceptor. Each of these interceptor sewers receive combined wastewater from trunk lines, and each trunk line has an associated CSO regulator structure and outfall. Two of the interceptors convey sanitary wastewater, including the Spring Creek Relief Interceptor and the Asylum Run Interceptor.

A May 3, 2017 memorandum prepared by CDM Smith provided CRW with an update of the interceptor cleaning and rehabilitation improvements.⁴ As the interceptor cleaning was completed, additional inspections of the interceptors were conducted providing better detail and evaluation of the existing conditions than the initial inspections. In some cases, this resulted in expanding the scope of proposed improvements for sewer and manhole rehabilitation. Additional areas were recommended for rehabilitation within the Paxton Creek Interceptor and the Front Street Interceptor. The opinion of probable construction cost for the Paxton Creek Interceptor was estimated to be \$7.3 million, \$1.6 million for the Asylum Run Interceptor, \$9.4 million for the Front Street Interceptor, and \$2.5 million for the Spring Creek Interceptor. CRW completed rehabilitation and replacement of the Asylum Run Interceptor in 2018 (substantial completion was issued in January 2019). However, until the upgrades of the Spring Creek Pump Station are confirmed the schedule and design of the Spring Creek Interceptor improvements that feeds the pump station cannot be determined.

The design of the first phase of interceptor rehabilitation, which was scheduled for the Paxton Creek Interceptor commenced in 2016 and was completed and bid in 2017. The Paxton Creek Interceptor rehabilitation project is underway using spin-cast applied geopolymer due to the irregular sewer shape. During construction, the cost of the rehabilitation project has escalated because the pipe was in worse condition than anticipated and the efforts to prepare the pipe (including stopping active infiltration) for geopolymer application are beyond what was anticipated in the contract documents. CRW intends to terminate the current contract and is currently investigating alternative methods for pipe rehabilitation prior to bidding out rehabilitation of the remaining portion of the interceptor. In December 2018 JMT reviewed the existing approach to repair the Paxton Creek Interceptor using centrifugally cast concrete pipe lining technology and recommended CRW consider alternate technologies for structural restoration of the interceptor using either sliplining or open-cut parallel pipe replacement.

In March 2019 CDM Smith performed a two-phase evaluation of the rehabilitation/lining alternatives under consideration for the Front Street Interceptor. The conclusions were the circular CIPP liner and HOBAS slipliner decrease the peak hydraulic capacity of Front Street Interceptor by 6 and 14 percent, respectively. Additionally, it was recommended by JMT in the Front Street Rehabilitation Technologies Review Findings Memorandum dated April 29, 2019 that flow should be bypassed during dry weather and high groundwater for three or more separate segments of the interceptor to further understand the current infiltration conditions.

⁴ Memorandum from CDM Smith to CRW entitled "Capital Region Water Interceptor Cleaning and Rehab Improvements Update", dated May 3, 2017.

4.2.3.2 CSO Outfalls and Regulators

CRW operates and maintains 59 CSO regulator structures located along Front Street, Paxton Creek, and Hemlock Street Interceptors, which ultimately direct combined flows of wastewater and stormwater to the AWTF. During dry weather, the CSO regulators divert all of the combined flows from the trunk sewer lines to the interceptor sewers. During wet weather, the CSO regulator structures divert a controlled volume of flow to the interceptors, while untreated excess combined flow is discharged to receiving waters. In addition to the 59 CSO regulator structures and outfalls, there are two additional CSO outfalls at the Front Street pumping station and the Spring Creek pumping station that activate only during mechanical failure of the pump stations or if the pump station capacities are exceeded.

The regulators and diversion chambers are inspected by CRW on a daily basis to ensure proper operation. Furthermore, each of the 59 regulator structures are inspected once per day by CRW.

During the manhole inspections in the fall of 2015, zoom cameras were used to inspect each of the flood chambers, gates, and the outfall pipes. This information was analysed by CRW for structural integrity and operation and maintenance issues. CRW continues to develop recommendations for early action projects to address critical structural deterioration and river intrusion. Five CSO outfalls have been scheduled to be addressed in 2019 for critical structural deterioration.

5 CAPITAL IMPROVEMENT PLAN

5.1 Overview

CRW prepares a capital improvement plan (CIP) that identifies the major planned projects and initiatives for the Wastewater System. The CIP includes projects that are required to replace aging infrastructure, enhance or expand services to customers, provide resiliency and redundancy, and increase cost effectiveness and efficiency. Portions of the CIP are related to repair and replacement of assets that are beyond their useful life and other portions address requirements under the Consent Decree, the LTCP, and other regulatory driven projects.

CRW's CIP as of the date of this report is summarized in Table 5-1. Below is a brief discussion of the capital projects and a summary of the review findings.

5.2 AWTF Upgrades

In March 2016, CRW completed an upgrade to its AWTF, adding biological nutrient removal in order to comply with the Chesapeake Bay Tributary Strategy and meet new NPDES permit discharge requirements.

In addition, the following maintenance projects were completed at the AWTF in 2018⁵:

- Continued construction of AWTF Headworks Screening Facility.
- Replacement of a 4-inch Primary Sludge Pump in the Control Building basement.
- Replacement of a 6-inch Waste Activated Sludge Pump in the Final Clarifier pipe gallery.
- Replacement of a 4-inch sludge pump at the Gravity Thickeners.
- Replacement of 2 Stormwater Pumps at the Market Street Pump Station.
- Replacement of the Intercooler Bundles for Joy Compressor Number 2 at the Cryogenic Oxygen Distillation Facility.
- Replaced 2 Hot Water Recirculation Pumps at the Boiler Building.
- Replaced the Turbine for the Cryogenic Oxygen Distillation Facility.
- Installed four wash down hydrants for Final Clarifier maintenance.
- Rebuilt a Hoffman Blower for final aeration at the Settled Sewage Pump Station.
- Remove and rebuild 200hp pump No. 1 at Front St Pump Station.
- Remove and rebuild 200hp pump No. 2 at the Front St. Pump Station.
- Pista Grit pump replacement T-series Gurman Rupp at the grit removal system.
- Install new Velodyne Polymer system at the Chemical storage Building.
- Replace rooftop natural gas heating unit on the Chlorine Building.
- Install new T-Series pump at the Thickener Pump station.
- Install new T-Series pump for raw sludge in the Main Building.
- Work to secondary clarifier troughs to improve hydraulic capacity.

⁵ Chapter 94 Municipal Wasteload Management Report and Semi-Annual Report on Consent Decree Implementation, March 2019.

- Commenced construction of the Primary Digester Rehabilitation Project to fully rehabilitate the two (2) primary anaerobic digesters and associated equipment at the AWTF and construct a new electrical building. Construction is expected to be complete in 2020.

The following are anticipated projects at the AWTF for 2019:

- Complete construction of the AWTF Headworks Screening Facility to provide ¼" screening.
- Rehabilitate the existing engines at the Co-gen building.
- Replace the Dorr-Oliver Hydrogritter Unit.
- Primary Clarifier mechanical equipment replacement in tank Nos. 1 and 2.
- Ingersoll Rand gas compressor rehabilitation at AWTF.

5.3 Pump Station Capital Improvements

The Front Street Pumping Station is currently being upgraded. CRW plans to evaluate options for potential upgrades of the Spring Creek Pumping Station once the Front Street Pumping Station upgrades have been completed. Additionally, the City Island North and South Pump Stations require capital improvement but currently CRW only operates the facilities for the City and has not accepted ownership. As a result, the cost of the required improvements at City Island North and South Pump Stations have not been included in Table 5-1 but should be updated as necessary once CRW accepts ownership.

5.4 Conveyance Capital Improvements

CRW has included several conveyance capital improvements in its CIP for FY 2020 shown in Table 5-1. These include the Paxton Creek, Front Street, and the Arsenal Boulevard sewer improvements. Currently the Paxton Creek Interceptor rehabilitation is underway but experiencing unexcepted high costs due to difficult site conditions. The project may be reassessed and rebid and the budget for this project may need to be re-evaluated once the approach to rehabilitating the remaining portion of the pipe is determined. CRW will evaluate the schedule and design for Spring Creek Interceptor improvements after the upgrades of the Spring Creek Pump Station are confirmed.

In addition, collection system cleaning, rehabilitation, and replacement work is expected to be an ongoing annual capital need. In addition to the conveyance capital improvements, CRW plans to implement a number of Long-Term Control Plan related capital projects, including several green stormwater infrastructure projects, as shown in Table 5-1.

5.5 Discussion

CRW's capital plan is in general alignment with Arcadis' observed requirements for the Wastewater System. However, currently the capital plan does not include improvements to the City Island North Pump Station, City Island South Pump Station, or the Spring Creek Interceptor. Once CRW accepts ownership of the City Island North and South Pump Stations, and the improvements to the Spring Creek Pump Station that is fed by the Spring Creek Interceptor are finalized, the capital plan should be revised as necessary. CRW generally has a good understanding of capital project needs and should prioritize projects based on urgency and affordability. CRW may proceed to reschedule and reprioritize various

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projects to balance the capital needs over the next several years. It is recommended that CRW update its cost estimates and capital funding plans for these projects as additional information becomes available.

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Table 5-1: Capital Improvement Plan

Location	Description	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
AWTF	Anaerobic Digester Roof Repair	\$ 1,946,000				
AWTF	Cogeneration (CHP) Improvements	\$ 750,000	\$ 6,750,000	\$ 6,750,000		
AWTF	Primary Digester Insulation (ECM)		\$ 500,000			
AWTF	Primary Sludge Pipe Replacement	\$ 250,000				
AWTF	Primary Clarifier Improvements & Repairs		\$ 168,000	\$ 4,000,000	\$ 3,500,000	
AWTF	5-Ton Dump Truck for Dewatering	\$ 120,000				
AWTF	Plant Window/Door Replacements		\$ 500,000			
AWTF	Hoffman Blowers		\$ 200,000			
AWTF	Plant Ops Truck Replacement				\$ 35,000	
AWTF	Trmt Minor Capital Improvements	\$ 386,500	\$ 334,500	\$ 137,200	\$ 260,000	\$ 60,000
AWTF	Flood Barriers		\$ 130,000			
Pump	Settled Sewage PS Rebuilds & Diluent Replacement	\$ 107,000				
Pump	Spring Creek Pumping Station Screening	\$ 500,000				
Pump	Front Street Pump Station Improvements	\$ 10,301,000				
Convey	Paxton Creek Interceptor Repairs	\$ 610,000	\$ 10,000,000	\$ 10,000,000		
Convey	Front Street Interceptor Rehab Phase II	\$ 221,000	\$ 10,000,000	\$ 10,000,000		
Convey	Arsenal Boulevard Sewer Improvements - Phase I	\$ 1,238,000	\$ 2,280,000			
Convey	Other Multimodal CCTV Investigations	\$ 400,000	\$ 400,000			
Convey	Collection System Rehabilitation	\$ 5,887,000	\$ 5,000,000	\$ 5,000,000	\$ 5,000,000	\$ 5,000,000
Convey	2nd/7th St Multimodal	\$ 460,000				
Convey	Jet Truck Replacement	\$ 270,000				
Convey	Camera & Crawler	\$ 110,000				
Convey	Camera Truck			\$ 200,000		
Convey	Field Ops Truck Replacement	\$ 48,000		\$ 35,000	\$ 35,000	\$ 35,000
Convey	Gap Vax Units				\$ 425,000	\$ 425,000
Convey	Collection Minor Capital Improvement	\$ 172,720	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000
SW	SW Paxton Creek TMDL Joint PRP MS4	\$ 434,000	\$ 447,020	\$ 458,196	\$ 469,650	\$ 481,392
SW	SW Pond Retrofit - Bellevue Park	\$ 222,000	\$ 1,500,000			
SW	TLC Cornerstone GSI	\$ 363,000				
SW	2018 South Allison Hill GSI	\$ 1,019,000				
SW	2019 South Allison Hill GSI	\$ 160,000				
SW	4th & Dauphin GSI	\$ 329,000				
SW	Camp Curtin Big Green Block GSI	\$ 1,857,000				
SW	Future Stormwater CIP	\$ 375,000	\$ 2,250,000	\$ 4,000,000	\$ 3,000,000	\$ 1,301,000
Total		\$ 28,536,220	\$ 40,609,520	\$ 40,730,396	\$ 12,874,650	\$ 7,452,392

¹Project costs are presented in 2019 dollars.

²Collection System Rehab estimates subject to change based on ongoing asset management efforts, and do not include separate stormwater system rehab needs, which are not quantified.

6 OPERATIONS AND MAINTENANCE EXPENSES REVIEW

6.1 Overview

The Trust Indenture (Section 7.12) requires CRW to adopt a Wastewater System budget each year. CRW typically adopts a finalized budget in November, two months prior to the start of the new fiscal year. CRW utilizes the capital plan and O&M recommendations in this CEAR to assist in establishing the budget. However, it should be noted that this CEAR only serves to provide advice and recommendations regarding capital additions and amount of funds that should be expended to meet incremental O&M expenses. CRW must then establish a realistic funding and financing plan that serves to meet these goals, which may necessitate reprioritization of projects and programs.

6.2 Historical Wastewater System Expenses

A summary of CRW's historical actual O&M expenses for FY 2017 and FY 2018 and the budgeted O&M expenses for FY 2019 are shown in Table 6-1. These expenses were reviewed to and determined to be in general alignment with overall O&M needs of the Wastewater System.

Table 6-1: Historical Wastewater System Expenses

Description	Historical		Budget
	FY 2017	FY 2018	FY 2019
O&M Expenses:			
Salaries and Wages	2,418,384.00	2,653,143.65	2,846,587.00
Benefits and Taxes	1,582,918.00	1,285,208.62	1,497,700.00
Contracted and Professional Services	871,033.00	1,064,338.15	1,264,200.00
Repairs, Maintenance, and Supplies	589,997.00	400,588.43	396,480.00
Electricity	1,182,365.00	817,502.55	893,263.00
Chemicals	652,073.00	323,416.22	350,791.00
Water	104,800.00	200,070.11	195,740.00
Refuse	442,912.00	587,673.22	725,193.00
Nutrient Credits	-	-	-
Insurance	458,634.00	-	-
Administrative Fee	2,759,571.00	2,801,741.35	3,402,854.00
Shared Services	520,000.00	700,847.23	829,000.00
Other Operating Expenses	370,362.00	-	-
Total Annual O&M Expenses	\$ 11,953,049	\$ 10,834,530	\$ 12,401,808

Source: Historical actual expenses in FY 2017 and FY 2018 and budgeted expenses in FY 2019 provided by CRW.

6.3 Additional Operations, Maintenance, and Repair Costs

Based on visual inspection and review of the existing CIP for the Wastewater System, some additional O&M expenses were identified for the proper maintenance, repair, and operation of the Wastewater System. These items are summarized in Table 6-2. In addition, until CRW gains several years of

operating history associated with its new biological nutrient removal processes at the AWTF, operating costs associated with these facilities could differ from those included in CRW's budget.

Table 6-2: Additional O&M and Repair Costs

Category	Location	Description	Cost
Pump Station	Spring Creek	Replace drive chain on bar screen	\$ 4,000
Pump Station	Spring Creek	Replace missing railing section between screening enclosure and pump station	\$ 5,000
Estimated Total Additional O&M Expenditure			\$ 9,000

7 CONCLUSIONS

Set forth below are the principal conclusions that have been reached regarding our review of the Wastewater System and associated information provided by CRW:

1. In 2018, the AWTF has operated within its hydraulic capacity with no hydraulic or BOD overloads recorded.
2. There were 57 secondary bypass events during 2018, where there was excess wastewater flow received at the secondary treatment train of the AWTF causing wastewater flow to bypass secondary treatment. These were due to wet weather and one power outage.
3. Based on Arcadis' field inspection, the AWTF was given a risk rating of 3.1, indicating that it is aged but generally in good operating condition and requiring capital investment within 5 years. However, in order to keep the AWTF in compliance with effluent limits and to reduce operating costs, rehabilitation work related to onsite CHP facilities, anaerobic digesters, and primary clarifiers should be completed.
4. With the exception of the Front Street and Spring Creek Pump Stations, all the other pump stations and the CSO regulators were also given a risk rating ranging from 2.0 to 2.3. The Front Street and Spring Creek Pump Stations were given risk ratings of 3.3 and 3.0, respectively, indicating that these facilities were aged or worn. The Front Street Pump Station is currently under construction with construction anticipated to be completed by the end of 2020. CRW will continue to assess the Spring Creek Pump Station.
5. Overall the Wastewater System is in fair condition with a risk rating of 3.0. However, some components of the system are aged and will require capital investment to preserve the asset and maintain appropriate system performance.
6. CRW's capital plan is in general alignment with Arcadis' observed requirements for the Wastewater System. CRW generally has a good understanding of capital project needs and should prioritize projects based on urgency and affordability. Once CRW accepts ownership of the City Island North and South Pump Stations, and completes the evaluation of improvements to the Spring Creek Pump Station and Spring Creek Interceptor, the capital plan should be revised.
7. CRW should perform an evaluation of the adequacy of collection system rehabilitation (budgeted in the Rapid Assessment Report) as it advances its asset management program to assure that the level of service goals for the collection system are achieved.
8. An arc flash study is recommended for the wastewater system in order to be in compliance with current NFPA 70E and OSHA 1910 (Subpart S) regulations. CRW intends to evaluate the need, scope, and budget for arc flash studies after completion of the improvement projects currently in the CIP.

This CEAR summarizes the work completed up to the date of the issuance of this CEAR. Changed conditions occurring or becoming known after such date could affect the material presented to the extent of such changes. Arcadis has no responsibility for updating this CEAR for changes that occur after the date of this report.

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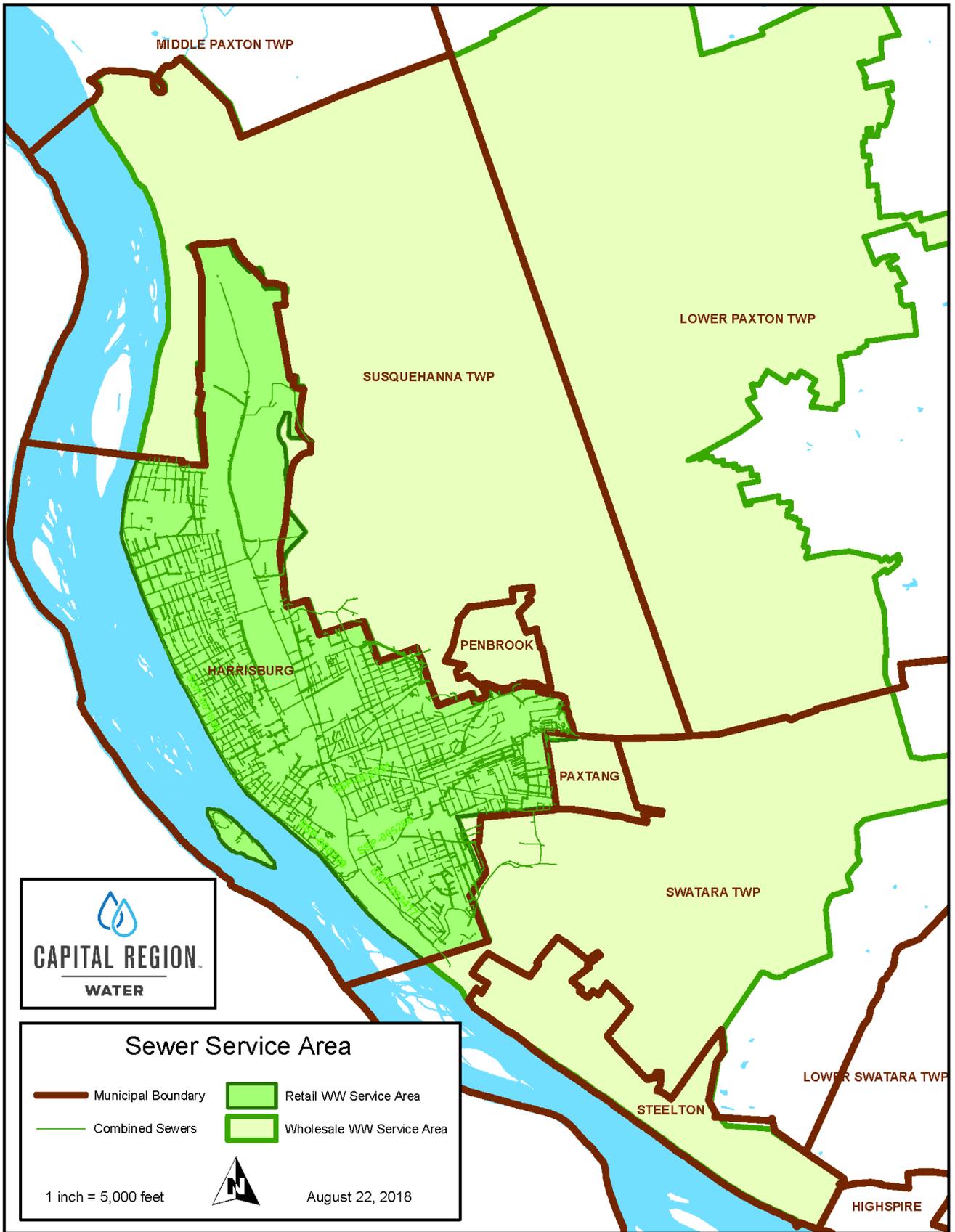
In preparation of this CEAR, Arcadis has relied upon financial, engineering and operational data, and assumptions prepared by and / or provided by CRW. In addition, information and projections have been provided by other entities working on behalf of CRW. We believe such sources are reliable and the information obtained to be appropriate for the review undertaken and the conclusions reached in this CEAR. To the best of our knowledge, information and belief, the information does not omit material facts necessary to make the statements herein. However, Arcadis has not independently verified the accuracy of the information provided by CRW and others. To the extent that the information is not accurate, the findings and recommendations contained in this CEAR may vary and are subject to change.

Arcadis devoted effort in making such opinions consistent with that degree of care and skill ordinarily exercised by members of the same profession currently practicing under same or similar circumstances and the time and budget available for its work in its efforts to endeavor to provide such opinions. The opinions are based on information provided by and consultations with CRW. No responsibility was assumed for inaccuracies in reporting by CRW or any third-party data source used in preparing such opinions. Arcadis' opinions represent its professional judgment. Neither Arcadis nor its parent corporation, or their respective subsidiaries and affiliates, makes any warranty, expressed or implied, with respect to such opinions.

APPENDIX A

Wastewater System Service Area





Arcadis U.S., Inc.

1128 Walnut St.

Suite 400

Philadelphia, Pennsylvania 19107

Tel 215 625 0850

Fax 215 625 0172

www.arcadis.com

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