Capital Region Water

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Harrisburg, PA 17101

Consulting Engineer's Annual Report

October 2, 2015

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ARCADIS Design & Consultancy for natural and built assets

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1. Introduction and Purpose

1.1. Introduction and Purpose

Arcadis U.S., Inc. ("Arcadis") prepared this Water 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 January 1, 1991 and Amended and Restated April 1, 2014. This CEAR is being submitted to comply with the following requirements for Fiscal Year 2016 (FY2016), as outlined in Section 7.11 of the Indenture:

> *"It shall be the duty of the Consulting Engineers, in addition to the other duties described elsewhere in this Indenture, to prepare and file with the Authority and with the Trustee on or before October 1, 1991, and on or before 90 days prior to the beginning of each Fiscal Year thereafter, a report setting forth the following:*
>
> *(a.) Their advice and recommendations as to the proper maintenance, repair and operation of the Water 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 that should be expended for Operating Expenses and their estimate of the amounts of money necessary for such purposes; and*
>
> *(c.) Their finding whether the properties of the Water System have been maintained in good repair and sound operating condition and their estimate of the amount, if any required to place such properties in such condition and the details of such expenditures and the approximate time required therefore."*

CRW's Fiscal Year runs from January 1st through December 31st. The Water System includes the Dr. Robert E. Young Water Services Center Water Treatment Facility, Susquehanna River Raw Water Intake, the DeHart Dam Reservoir, Finished Water Reservoirs (Upper Reservoir, Lower Reservoirs 1&2), pump stations, pumping equipment, transmission and distribution mains, and related equipment servicing the City of Harrisburg ("City") and portions of the Borough of Penbrook, Susquehanna Township and Lower Paxton Township all located in Dauphin County, Pennsylvania.

1.2. The Consulting Engineer

Arcadis has served the water and wastewater industry for over 100 years and began providing consulting engineering services to CRW in 2011. Arcadis is one of the largest consulting engineering firms in the United States and is recognized as a leader in providing services to the water and wastewater industry. Arcadis, with over 28,000 employees worldwide, is a global leader in all the markets for which it provides professional technical

and management support services. In 2014, Engineering News Record ("ENR") magazine ranked Arcadis #3 in the top 500 overall design firm category.

1.3. 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 FY2016 CEAR. The major relevant documents provided by CRW and reviewed as part of the CEAR include, but are not necessarily limited to the following:

- The Trust Indenture between Capital Region Water and the Bank of New York Mellon Trust Company dated April 1, 2014
- Capital Region Water (formerly the Harrisburg Authority) Public Water Supply Permit No. 7220049, dated February 11, 2004
- 2012 Filter Plan Performance Evaluation Report
- 2013 State Department of Environmental Protection (DEP) Inspection Report of the Dam
- 2014 Dehart Dam Inspection Report
- 2014 Consulting Engineer's Annual Report
- 2014 Water Allocation Permit Compliance Report
- 2015 Annual Water Supply Report
- 2015 Consumer Confidence Report
- 2015 Water and Sewer Rate Study Report, dated August 27, 2015
- 2015 State DEP Water Supply Inspection Report
- Latest (2015) Long-Term Capital Improvement Program
- Current and Historic Operating Performance Including:
    - Regulatory compliance records
    - Operations records and staff accounts including history of water main breaks
    - Capital improvement plans
- Historic Water System Revenues and Expenses

In addition to the above record and document reviews, on September 9, 2015 Arcadis conducted limited visual site inspections of the following components of the Water System:

- DeHart Dam, Reservoir Control Building and Chemical Feed Facility
- Susquehanna River Raw Water Pump Station
- Dr. Robert E. Young Water Services Center Treatment Facility
- Gate House Pump Station
- Union Square Industrial Park Booster Station
- Finished Water Reservoirs (Upper Reservoir and Lower Reservoirs 1 & 2).

The review also included discussions with representatives of CRW and performance comparisons to other comparable water 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, we believe 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 the Arcadis review did not include any pending or threatened litigation against CRW. CRW has stated that there is no significant litigation which they believe would have any material impact on CRW 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: (a) recommending any action regarding municipal financial products or the issuance of municipal securities; and (b) 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. Water System Management

2.1. Overview of the Water System

The primary source of drinking water is the William T. DeHart Dam and Reservoir located 20 miles northeast of the City in the pristine Clarks Valley Watershed. The Dam and Reservoir collects water from almost a 22 square mile watershed. The Susquehanna River provides CRW with a backup water supply and currently is only used in case of severe drought or emergency. The Susquehanna River had been used as a primary water source up until construction of the DeHart Dam in 1940.

Components of the Water System were first established in 1839 when the Commonwealth of Pennsylvania granted the City permission to withdraw water from the Susquehanna River to serve City residents in the central part of the City. Over the years, numerous upgrades and expansions were undertaken to meet new regulations and to expand services City-wide and to other municipalities (portions thereof) located in Dauphin County.

Currently, the Water System includes over 20 miles of forty-two inch diameter transmission mains, 250 miles of distribution piping ranging from four to forty-two inches in diameter, more than 1,600 fire hydrants and 5,340 valves, five hydrant interconnections with United Water, Inc., and the sources of supply, pumping and treatment facilities summarized in Table 2-1.

Table 2-1.
Summary of Major Water System Facilities

Facility	Item	Capacity
DeHart Dam and Reservoir	Full Storage Capacity Reservoir Yield Allocation	6 billion gallons 10.5 MGD 13.5 MGD
Susquehanna River Intake	Source Allocation Pumping Capacity	15 MGD (Secondary) 30 MGD
Dr. Robert E. Young Water Services Center Treatment Facility	Design Flow	20 MGD
Upper Reservoir	Storage Capacity	28 million gallons
Lower Reservoir #1	Storage Capacity	6 million gallons
Lower Reservoir #2	Storage Capacity	6 million gallons
Susquehanna River Pump Station	Pumping Capacity	14,000 GPM (with one out of service)
Gate House Pump Station	Pumping Capacity	8,700 GPM (with one out of service)

Union Square Industrial Park Booster Station	Pumping Capacity @ -Triplex Constant Pressure - Fire Pump	 750 GPM 1,000 GPM

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A more detailed description of the Water System is provided in Appendix B: Description of the Water System. In addition, an overview of the history of the Water System since its original creation in 1839 is provided in Appendix C: History of the Water System.

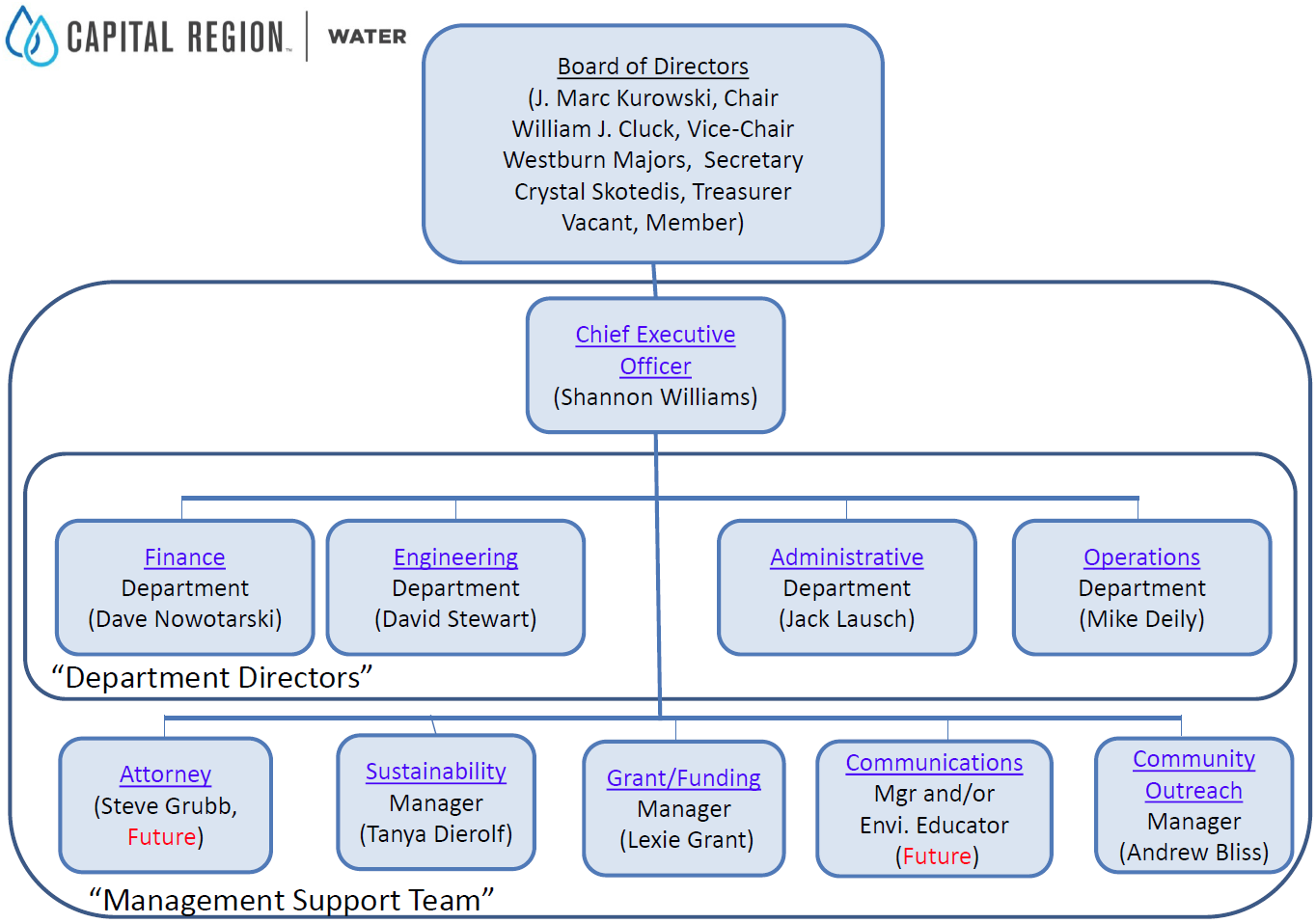
2.2. Management and Staffing

The Water System was originally managed, owned and operated by the City. In 1990, the Harrisburg Authority (now known as CRW) was created to purchase the Water System from the City and at the same time enter into a 1990 Management Agreement with the City for continued management and operation of the Water System.

In 2011, the City was placed under State of Pennsylvania Receivership due to severe financial stresses being incurred primarily resulting from insufficient funds to pay its solid waste system debt associated with the Harrisburg Resource Recovery Facility. These financial stresses were causing a shortage of experienced and qualified personnel needed to operate, manage and administer the Water System and a loss in access to capital markets. As a result, the Commonwealth's Office of the Receiver, the City, and CRW agreed to terminate the 1990 Management Agreement with the City on November 4, 2013. With the termination of this Agreement, CRW has taken back operational and management control of the Water System.

An overview of the current organization structure of CRW is shown on Figure 2-1.

Figure 2-1: CRW Management and Operations Organization Chart



Source: CRW Organizational Structure for a New Beginning for and Old System, dated August 13, 2015.
Note that the Operations Department manager position has been recently vacated.

CRW is governed by a five member Board of Directors and is headed by the Chief Executive Officer, who is responsible for all technical and administrative operations of CRW and 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 treatment services. CRW operates as one entity, however, CRW separately tracks and records provision of services associated with each of the utilities it manages and operates.

CRW's organization chart includes four departments: Finance, Engineering, Administrative, and Operations, all headed by their respective department directors, as shown in Figure 2-1. These departments provide services to support CRW's water utility as well as its wastewater utility. Note that only the Water System utility is the subject of this CEAR.

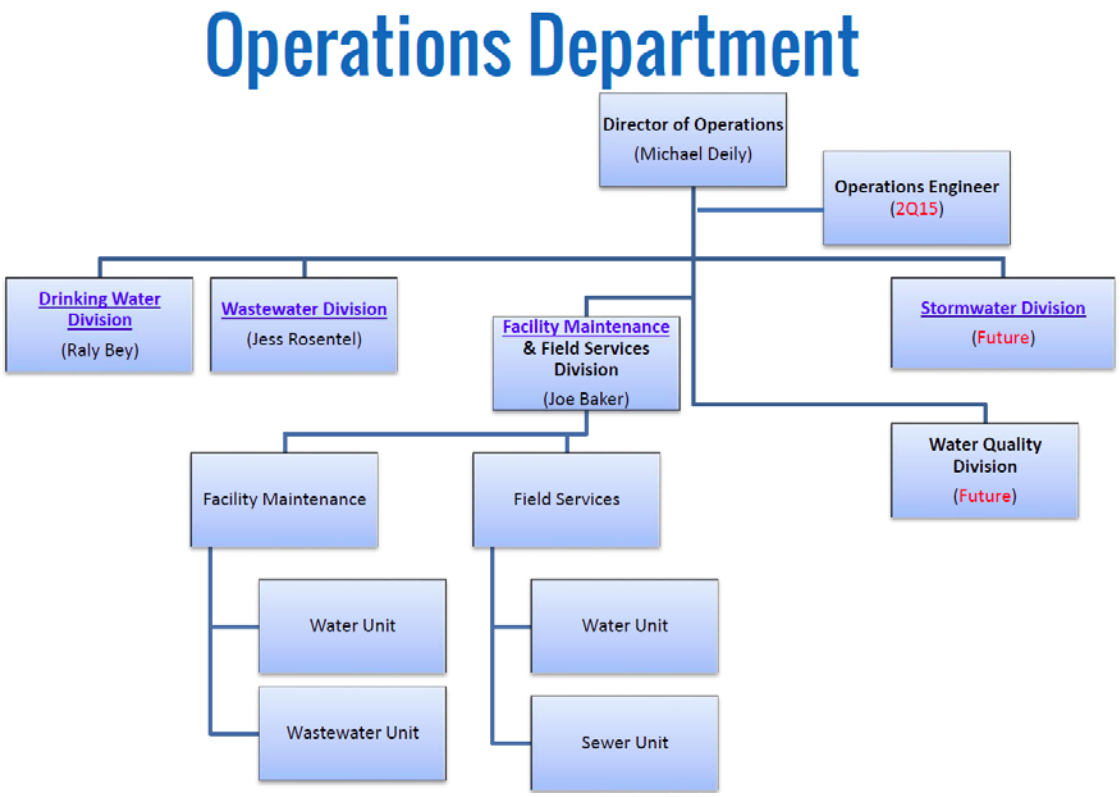
Finance, Engineering and Administrative Departments

The services currently provided by the Finance Department includes accounting, billing and collections, customer service, and payroll. The Engineering Department provides engineering support, project coordination, GIS coordination, wet weather coordination and asset management. The Administrative Department provides office management, information technology services, human resources, insurance, health and safety, and administrative support. It is our understanding that CRW has plans for a total of 40 positions for provision of these department services (21 for Finance, 9 for Engineering, and 10 for Administration) and 31 of the 40 positions are currently filled. Personnel expenses associated with these departments is allocated to each of the utilities based on budgeted time allocated to each of the services.

Operations Department

The Operations Department of CRW includes the following divisions: Drinking Water Division, Water Quality Division, Wastewater Division, Stormwater Division, and the Facility Maintenance and Field Services Division. The organization structure of the Operations Department is shown on Figure 2-2.

Figure 2-2: Organization Chart of CRW's Operations Division



The Operations Department is 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 Operations Department's Drinking Water Division includes plans for 16 positions of which 14 are currently filled. The Operations Department's Water Quality Division includes 4 filled positions dedicated to water quality and one open position for a Division head. The Facility Maintenance and Field Services Division includes 12 filled positions dedicated to the Water System.

In summary, CRW FY2016 Water System budget includes estimated costs associated with the current and planned employees dedicated to the Water System and the water utilities share of costs associated with the planned positions under Finance, Engineering and Administrative services which provide support to CRW's water and wastewater utilities. These employees are all employees of CRW, with the majority belonging to a new collective bargaining unit established separately from the City, even though certain

employees of the City became direct employees of CRW upon termination of the 1990 Management Agreement. CRW's current collective bargaining agreement is scheduled to expire at the end of 2016 (12/31/16).

The organizational structure of CRW provides strong opportunities for economies of scale through the sharing of finance, engineering and administrative services between the water and wastewater utilities. The structure is generally consistent with similar-sized combined utilities and, it appears that all required Water System utility functions of CRW are generally adequately staffed. However, there were a few observed shortcomings in the operation and maintenance of the system due to the shortfalls in staffing, particularly related to the lack of a valve exercising program, as discussed in Section 4 in this report.

3. Water System Performance

3.1. Service Area

The service area of the water system includes the City and portions of Penbrook Borough, Lower Paxton Township and Susquehanna Township, all located within Dauphin County, Pennsylvania. CRW maintains interlocal agreements with Penbrook and Lower Paxton and Susquehanna Townships that govern the provision of services to the customers located within these community boundaries. With the exception of some distribution system piping and related equipment, the majority of CRW's water assets are located within the municipal boundaries of the City.

3.2. Customer Base

CRW maintains approximately 20,700 active meter connections within the Service Area, of which the majority (82%) are located within the City. The remainder are primarily located in Susquehanna Township then Penbrook Borough. CRW only maintains two commercial connections in Lower Paxton Township. The total estimated population served by CRW Water System is approximately 66,550 of which approximately 44,000 are located in the City.

Table 3-1 provides a summary of the total number of connections within each community and the total metered water consumption in gallons per day (gpd) based on CRW records as of December 2014. Additional information on customers and water use can be found in CRW's Annual Water Supply Report and Annual Water Allocation Permit Compliance Report. CRW only recently took over billing and collections from the City and is still in the process of confirming the number of active metered connections. It appears that the number of active metered connections (approximately 20,700) is slightly less (on the order of 2% less) than the approximately 21,200 historically reported in last year's CEAR and the amount of water sold (4.9 MGD) also less (on the order of 8%) than the approximately 5.3 MGD sold in FY2014.

Table 3-1.
Customer Information[1]

Municipality Name	Domestic	Commercial	Other	Total	% Share
Harrisburg	15,084	1,597	520	17,201	83%
Susquehanna	2,806	96	8	2,910	14%
Penbrook	550	29	0	579	3%
Lower Paxton	0	2	0	2	0%
Subtotal Connections	18,440	1,724	528	20,692	100%
Water Sold (MGD) 2014	2.10	1.35	1.45	4.90	
% Share	43%	28%	29%	100%	

Notes:
1) Customer Count and 2014 metered water use based on CRW records for December 2014.

3.3. Water Supply and Demand

Pursuant to its Water Allocation Permit (Permit # WA-22-53B) issued by the Pennsylvania Department of Environmental Protection (DEP), CRW maintains a 13.5 MGD water supply allocation from the DeHart Dam and Reservoir and a 15 MGD secondary allocation from the Susquehanna River. The DeHart Dam, however, has an estimated safe yield of 10.5 MGD. The design flow capacity of CRW's water treatment facility is 20 MGD. No changes to the water allocation permit or CRW's water treatment capacity are currently anticipated.

Average daily water demand is currently approximately 5.0 MGD and has been trending downward. Peak demand, however, remains high at approximately 10 MGD. In addition, Non-Revenue Water (NRW) also remains high at an average daily rate of approximately 3 MGD or 35% of the average daily water production. Note that the Pennsylvania Public Utility Commission considers unaccounted for NRW greater than 20% of total water production to be excessive. Regardless, it appears that CRW currently has more than sufficient access to water supply, and storage and treatment capacity to meet demand. Table 3-2 presents a summary of current water supply and demand

Table 3-2.
Water Supply and Demand[1]

	Million Gallons Per Day (MGD)	
Water Supply	**2013 [1]**	**2014 [2]**
Water Supply Yield (MGD) - Primary - Secondary	 10.50 15.00	 10.50 15.00
Water Treatment Capacity (MGD)	20.00	20.00
Current Water Production (MGD)	8.45	8.45
Water Demand		
Average Metered Daily Consumption (MGD)	5.30	4.90
Peak Day Consumption (MGD)	9.94	9.44
Non Revenue Water (MGD)	3.15	3.55
Total Average Daily Water Demand	8.45	8.45
Performance Ratios		
Average Daily Non-Revenue Water as % of total produced	37%	42%
Average Daily Demand as % of Treatment Capacity	42%	42%
Average Peak Demand as % of Treatment Capacity	50%	47%

Notes:
1) Source: CRW 2014 Water Allocation Permit Compliance Report
2) Source: CRW 2014 Records
3) Source: Exhibit K to CRW Water Division Monthly Report

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3.4. Water Quality

Water quality is regulated by the Federal Safe Drinking Water Act, enforced through laws and regulations administered by the DEP. CRW publishes an Annual Drinking Water Quality/Consumer Confidence Report as required by the EPA. The Drinking Water Quality Report provides general information on the Water System and the results of water quality tests on CRW drinking water for that calendar year as compared to permitted maximum contaminant levels ("MCLs"). CRWs 2015 Drinking Water Quality Report (which reports the results for calendar year 2014) concluded that CRW water quality is good and continues to consistently exceed national quality standards.

CRW's water quality laboratory routinely collections drinking water samples from the distribution system. These samples are tested for multiple contaminants including the presence of Total Coliform and E.coli bacteria. All bacteriological samples collected and analyzed in 2014, along with the eight preceding years, were absent of coliform bacteria contamination.

In addition, the laboratory analyzes the DeHart Dam influent, the finished water and the distribution system for the following parameters: pH, total alkalinity, temperature, iron, total dissolved solids and total hardness. The DeHart Dam and finished water are also routinely monitored for turbidity and total organic carbon. Finished water is also tested for fluoride, aluminum, chlorine residual levels and orthophosphate levels. Orthophosphate levels are also monitored in the distribution system. Table 3-3 provides a summary of the key test results for 2014 as published in CRW's annual Drinking Water Quality Report and its comparison to established MCLs.

Table 3-3.
Drinking Water Quality

Contaminant	Units	MCL	Levels Detected (2013)	Levels Detected (2014)
Barium	ppm	2	0.019	0.012
Chlorine	ppm	4	1.2	1.2
Fluoride	ppm	2	0.62	0.48
Nitrate	ppm	10	0	0.11
Total Trihalomethanes	ppb	80	41.1	39.0
Haloacetic Acids	ppb	60	34.8	33.2
Arsenic	ppb	10	0	0
Radium-226	ppb	5	-	0.117
Chlorine Residual	ppm	Min. of 0.2(1)	0.74 – 1.79	1.14 – 1.67
Total Organic Compounds	% removal	35-45% (1)	36.7-68.7%	35.2-100%
Total Coliform Bacteria	% positive monthly samples	5%	1.12%	0%
Fecal Coliform or E.coli	ppm	0	0	0
Turbidity	NTU % samples below 0.3 NTU	1 95%	0.072 100%	0.121 100%
Lead	ppb	0	0	0
Copper	ppm	1.3	0.079	0.079

Note:
1) Chlorine residual and percent removal of total organic compounds are minimum level requirements and not a maximum level like all the remaining parameters.

As illustrated in Table 3-3, the drinking water quality of CRW Water System consistently meets or exceeds permitted MCLs. In addition, it is important to note that the EPA has launched several initiatives including the Long Term 2 Enhanced Surface Water Treatment Rule ("LT2") and Stage 2 Disinfectants and Disinfection Byproducts Rule ("DBP2"). LT2 is designed to reduce disease incidence associated with Cryptosporidium and other disease-causing microorganisms, while DBP2 protects against exposure to byproducts of the treatment process. As part of the LT2, CRW's two water sources, DeHart Dam and Susquehanna River were previously tested for Cryptosporidium. Testing conducted to date shows no indication of this organism in the water. Therefore, the System was classified as "Bin1" and no additional testing is required at this time. With respect to the DBP2 rules, water samples taken from the distribution system have historically shown little indication of the presence of Total Trihalomethanes ("TTHM") and Five Haloacetic Acids ("HAA5"),

CRW's copper and lead survey analysis completed once every three years since 2007 have shown copper and lead concentrations at residential taps remain well below MCLs. These results verify the success of CRW's corrosion control program which includes the addition of soda ash and caustic soda to raise pH levels in water supply to promote corrosion control. Zinc Orthophosphate is also added to promote corrosion control due to the success of historic sampling results, sampling is not required again until 2016.

Based on these results, it is no surprise that in 2015, CRW was once again honored with an award by the Partnership for Safe Water. This award marks 11 consecutive years of achieving voluntary water quality standard which exceed State and Federal water quality regulatory requirements. CRW was one of seven in the country to receive the prestigious Presidents Award in 2015. The Partnership for Safe Water is a voluntary optimization program led by the American Water Works Association, the EPA and other large water organizations.

3.5. Future Safe Drinking Water Regulations

Regulations are becoming increasingly more stringent. The following serves to summarize the status of several key proposals which could impact CRW's operations, including the following:

- Hexavalent Chromium (Cr-6)
- Final Regulator Determination for the Third Drinking Water Contaminant Candidate List (CCL3)
- Preliminary Regulatory Determination for the Fourth (RD4) Drinking Water Contaminant Candidate List (CCL4)
- Proposed Long-term Lead and Copper Rule (LCR)
- Proposed Carcinogenic Volatile Organic Compounds (cVOC) Rule
- Proposed Perchlorate Rule
- Third Six-Year Review
- Revised TCR (RTCR)
- Fluoride

3.5.1. Hexavalent chromium (chromium VI) [1]

EPA has an enforceable drinking water standard of 100 µg/L for total chromium, which is sum of chromium III and chromium VI. EPA has indicated plans to issue a human health assessment for chromium VI (Cr-6) toxicology, however, the date for issuance of the assessment has not yet been published. Issuance of a final assessment would be required prior to EPA establishing a new drinking water regulation for Cr-6 or a revision to the current total chromium standard. Given the publicity surrounding Cr-6, it is likely that the EPA will develop a revised federal standard for total chromium or develop a Cr-6 standard. As such,

[1] http://www.drinJustikingwater.state.pa.us/dwrs/HTM/Welcome.html

the l MCL for Cr-6 has not yet been determined. The State of California, however, had proposed a MCL of 10 µg/L for Cr-6 in California.

During the interim, EPA is requesting voluntary Cr-6 sampling of finished water both at points-of-entry and at maximum residence time sampling locations. It is recommended that during this time period, CRW conduct voluntary Cr-6 sampling and gathered relevant information to enable CRW to understand and respond to future requirements as it is likely that a regulation for Cr- 6 will be forthcoming.

As the l MCL for Cr-6 has not yet been determined, the potential impact on the Water System is not yet known.

3.5.2. Final Regulatory Determination for the Third Drinking Water Contaminant Candidate List (CCL3)

The Safe Drinking Water Act (SDWA) requires EPA to make regulatory determinations (either positive or negative) on at least five contaminants every five years. In 2013, the EPA made positive regulatory determinations for nitrosamines, strontium, and chlorate and final regulations are anticipated to be developed by 2019.

Water quality data for nitrosamines, strontium, and chlorate are not available for CRW system so a definitive understanding of how CCL3 could affect CRW's water treatment requirements is not possible at this time.

3.5.3. Preliminary Regulatory Determination for the Fourth (RD4) Drinking Water Contaminant Candidate List (CCL4)

The EPA's draft CCL4 includes the addition of manganese and nonylphenol to the contaminant candidate list. It is likely that a new regulation for manganese will be developed in the near future. The potential impact on the Water System is not yet known.

3.5.4. Proposed Long-Term Lead and Copper Rule (LCR)

CRW has consistently been in compliance with the LCR. CRW also adds a corrosion inhibitor to the water prior to entering the distribution system although it is not required to do so. As such, it is anticipated that the proposed revisions, as discussed further below, would not have a material impact on CRW operations.

The EPA proposed revisions to the Long-Term Lead and Copper Rule (LT-LCR), anticipated to be finalized in 2018, addresses:

- Lead service line replacement, partial or otherwise;
- How to determine when corrosion control is optimized, i.e., the acceptable ranges for water quality parameters;
- Sample site selection criteria; and
- Sampling issues such as the potential removal of aerators and the acceptable stagnation period.

Revisions to the sample site selection criteria may affect the Water System if any of the service lines are lead, as the change will likely be a new focus on more homes with lead service lines. A change in the sampling protocol could affect the Water System as the current protocol takes the "first flush" from the service line and the revision would take water that has been "overnighted" in the service line. This change could result in more violations of the lead action level in the future. EPA would also like to add an element of stakeholder outreach to the LT-LCR which could lead to more effort by CRW to engage stakeholders.

CRW will need to assess its existing plumbing inventory to determine if the new definition for "lead-free", from <8.0% to <0.25% lead, is being met for any new installation of pipes, fixtures and appurtenances. If it is not, cost will be incurred to purchase new pipes and fittings that meet the new definition.

In addition, it is imperative that CRW control the corrosion of pipes and service lines and household plumbing. Two keys to this are pH control of water entering the system plus regular line flushing. It is our understanding that the cost of these efforts are already included in the FY2016 O&M Budget.

3.5.5. Proposed carcinogenic Volatile Organic Compounds (cVOC) Rule

The EPA is planning to publish its Notice of Proposed Rulemaking for carcinogenic Volatile Organic Compounds (cVOC) in the Federal Register by 2016. The list of up to sixteen cVOCs will include trichloroethylene (TCE) and perchloroethylene (PCE); and may include up to six additional regulated VOCs; and up to eight unregulated VOCs from the EPA's Contaminant Candidate List 3. The list will build on the recently completed risk assessments to TCE and PCE for this determination. It is likely that 1,2,3-trichloropropane (TCP) will be a driver for this regulation since it is extremely carcinogenic. The future MCLs of TCE and PCE are anticipated to each be reduced to 1 µg/L or less and a total group MCL ranging from 2 to 5 µg/L by this upcoming regulation and the maximum contaminant level goal (MCLG) to remain "zero".

CRW data shows TCE, TCP and PCE levels have either not been detected in CRWs raw water or are not anticipated to exceed the future anticipated MCLs. As such, this rule is not anticipated to have a material impact on CRWs operations.

3.5.6. Proposed Perchlorate Rule

In 2011, the EPA announced that it is going to move forward with plans to develop a national standard for perchlorate in the near future. Perchlorate is both a naturally occurring and man-made chemical that is used to produce rocket fuel, fireworks, flares and explosives. It can also be present in bleach and in some fertilizers. Perchlorate removal is most often achieved using ion exchange. The Notice of Proposed Rulemaking establishing an MCL goal for perchlorate is expected to be published in the Federal Register in early 2016. The implementation of the new standard is not anticipated to have a material impact on CRW operations.

3.5.7. Third Six-Year Review

The EPA is required to conduct a review of drinking water regulations by 2016. In this process, the EPA evaluates all of the existing drinking water regulations and determines if a revision is necessary based on new information on health effects, analytical methods, occurrence and treatment data. The Third Six-Year Review will include an evaluation of the following regulations:

- Stage 1 and Stage 2 DBP Rule
- Interim Enhanced Surface Water Treatment Rule
- Long-Term 1 and Long-Term 2 Enhanced Surface Water Treatment Rules

The potential impact of the Third Six-Year Review on the Water System cannot be determined at this time.

3.5.8. Revised TCR (RTCR)

The Total Coliform Rule (TCR) has been virtually unchanged since 1989. This rule's main purpose is to protect public health by ensuring the integrity of public drinking water distribution systems and monitoring for the presence of microbial contamination. The Revised TCR, effective April 1, 2016, reinforces the intent and focus of the TCR as a process to identify the existence of potential pathways of contamination into the distribution system, which would be identified through a new distribution system assessment process. Under the Revised TCR, coliform detection in more than 5% of routine monthly distribution samples triggers a distribution system assessment process. The existing Total Coliform MCL, currently set at this same frequency of coliform detection, as well as the current MCL Goal of zero coliform would be replaced by a Treatment Technique. The Revised TCR defines this Treatment Technique to consist of the assessment process and correction of any sanitary defects identified in the assessment. The assessment process will also place the water supplier on a path for prompt corrective action to eliminate sanitary deficiencies uncovered in the assessment itself. Included in this assessment will be the need to inspect the interior and exterior of public water systems finished water storage facilities at least once every five-years. This will also serve as an important tool for capital planning and should be budgeted for on a regular basis.

For large, year round-operating public water suppliers, the current coliform monitoring requirements remain substantially unchanged. The notification requirements under the Revised TCR are as follows:

- The coliform detection frequency MCL, 5%, would no longer require Tier 2 public notification.

- The MCL for E. coli would remain unchanged and would remain an acute MCL violation requiring Tier 1 notification.
    - In addition to the Tier 1 Notification requirements, under the Revised TCR the E. coli MCL violation would also require a higher-Level 2 distribution system Assessment, intended to be more comprehensive than the Revised TCR Level 1 Assessment required for coliform.

Revisions to the TCR will likely impact CRW's current sampling protocols and coliform/E. coli MCL response procedures and potentially cause modification of internal procedures/documentation as required to comply with TCR revisions and conduct of Assessments. The Revised TCR contains a directive that systems must develop a written sample siting plan, subject to State review and revision, to be submitted no later than March 31, 2016. The cost to CRW to comply with these requirements are not anticipated to be material and therefore readily absorbed within the existing budget.

3.5.9. Fluoride

In January 2011, the US Department of Health & Human Services ("HHS") lowered the recommended level of fluoride in drinking water from a range of 0.7 to 1.2 mg/L to 0.7 mg/L. Despite the benefits of tooth decay prevention, some research has shown that fluoride can lead to mild to moderate mottling of teeth, particularly in formula-fed infants. The purpose of revision in the recommended fluoride level is to balance the benefits of preventing tooth decay while limiting any unwanted health effects. In response to this change, the EPA announced the intent to consider lowering the current 4 mg/L MCL for fluoride. If the EPA modifies the fluoride regulations, it is anticipated that CRW would still be in compliance and fluoride dosing, consumption and operating costs for CRW would remain unchanged.

3.5.10. Summary

Discussions with CRW indicated that CRW is not aware of any proposed regulation which would have a material impact on CRW operations. CRW has been in discussion with the DEP regarding potential need to increase the spillway of the Dam to meet 1990 regulations which require spillway capacity equal to the maximum storm flow. DEP is currently evaluating requirements and once finalized, CRW would have 10 years to implement. As such, the spillway project remains on CRW's CIP, however, no compliance cost or schedule has yet been developed. The review of potential future regulations indicate that at this time, a) the potential known impacts of currently proposed regulations are not anticipated to have a material impact on CRW operations, b) they have already been addressed in the FY2016 Operating Budget, or c) they have already been addressed in CRW's long-term capital plan.

4. Water System Condition

4.1. Overview

CRW staff strive to ensure the entire Water System is properly operated and maintained. The cost to provide routine and preventative maintenance is included in CRW's annual operating budget. The cost of any and all permanent improvements and replacements beyond those financed by the Water Revenue Bonds, Series of 1991 are classified as Capital Additions under the January 1, 1991 Trust Indenture. Capital Additions may be financed from CRW's annual operating budget, from Water System reserve funds or future borrowings. Major rehabilitation and replacements are funded by CRW through the Water System reserve funds or future borrowings.

4.2. Condition Assessment

Arcadis conducted a limited condition assessment of the key components of CRW Water System on September 9, 2015, which included a review of existing information provided by CRW, discussions with CRW staff, and visual observations during limited field visits of the facilities in the Water System. Based on the type of facilities, available documents related to the facilities and our experience with similar facilities, a representative sample of facilities was inspected on a limited basis to: (i) visually confirm the information provided; (ii) identify any apparent capital improvement needs; and (iii) discuss reliability and operation and maintenance performance with the operation and maintenance staff. No field investigations were conducted of the buried infrastructure.

The condition assessment of the facilities in the water system is 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 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
DeHart Dam and Reservoir	3
Dr. Robert E. Young Water Services Center	3
Upper Reservoir	4
Lower Reservoir #1	2
Lower Reservoir #2	2
Susquehanna River Pump Station	2
Gate House Pump Station	2
Union Square Booster Station	2
Transmission Mains • Mountain Line • Susquehanna Line • Plant-Gate-House-Reservoir Line	 4 2 3
Distribution System	3
Overall System Rating	**2.5**

Overall the Water System is in good condition, however, some components are aged and will require investigation and capital investment to preserve the asset and maintain high quality water and delivery of services.

The following provides a summary of the current condition of the major components, the rational for the risk scores assigned and the improvements needed to address moderate, significant and high risks. Appendix B provides a more detailed description of each of the major components of the water system.

4.2.1. DeHart Dam, Reservoir Control Building and Chemical Feed Facility

CRW routinely monitors and evaluates the DeHart Dam in order to ensure operational efficiently and regulatory compliance. These regulations include annual inspections, followed by a DEP on-site review. The Dam was originally built in 1940. Based on a review of the 2014 Dam Inspection Report prepared by others, it appears that the Dam is being properly maintained and that the Dam and Carsonville Weir are in stable and good condition. Similarly, the toe drains, overflow spillway crest, outlet tower, gates, baffles, screens, automatic valves and monitoring equipment are all reported to be in good working order. However, ongoing discussions with DEP indicate a potential need to increase spillway capacity to meet revised regulations. It is reported that upon determination of the requirements by DEP, CRW will have up to 10 years to complete the modifications. As such, CRW maintains the spillway project on its capital improvement plan, however, no compliance cost or schedule has been established. Upon receipt of DEP final requirements, CRW will conduct an evaluation to determine the compliance cost and schedule.

Table 4-3 identifies the anticipated additional capital and incremental O&M needs for the DeHart Dam that have not been already identified in the previous CRW Capital Improvement Plan ("CIP") for FY2015-FY2020, as presented in Appendix D..

Table 4-3.
DeHart Dam Improvement Needs

Description	Classification
Provide survey monuments for monitoring dam	Capital Addition
Replace hand rail	Capital Addition
Repair bridge over spillway	Capital Maintenance
Paint piping or dehumidify control building basement	Capital Maintenance
Repair parapet and cracks on control building	Capital Maintenance
Repair spillway (FEMA) if required	Capital
Repair vicinity of Carsonville weir	Capital Maintenance

4.2.2. Dr. Robert E. Young Water Services Center Treatment Facility

The Dr. Robert E. Young Water Services Center, located at the intersection of Pine Drive and Stanley Drive on the City of Harrisburg's municipal border with Susquehanna Township, treats raw water conveyed from either the DeHart Reservoir or the Susquehanna River. It also contains the CRW customer services office and maintenance garage. The Center utilizes chemical addition, flocculation, coagulation, sedimentation, filtration and disinfection to produce the Water System's finished water.

Available water treatment facility records were reviewed, which confirmed that the water provided by the plant during FY2014 and the first half of FY2015 was of high quality and consistently exceeds performance requirements as determined by state and federal regulations. However, the DEP gave the filter plant a "needs improvement" performance rating for its ability to consistently produce high quality water and provide long term reliability in it 2012 Filter Performance Evaluation Report. The DEP identified many issues and concerns requiring investigations or improvements. The DEP has not revaluated the plant since 2012. It will continue to categorize the plant as "needs improvement" until the problems are resolved and the DEP conducts a follow-up evaluation. In addition, it cited a leaking ammonia tank as a "violation" and the lack of auxiliary power to operate the plant during an extended power outage as a "minor sanitary deficiency" during its inspection of the Water System.

The plant appears to be in good overall physical condition. However some capital investments will be required within the next five years in response to DEP comments and some additional O&M expenditures should be incurred to improve the resiliency of its operation and satisfy the expectations of the regulatory agency.

Table 4-4 identifies the anticipated additional capital and incremental O&M needs for the Treatment Facility that have not been already identified in the previous CRW CIP as presented in Appendix D.

Table 4-4.
Water Treatment Facility Improvements

Description	Classification
Annual Confined Space Entry Training	O&M
Secondary Source Operations Plan/Training	O&M
Emergency Table Top Drills	O&M
WSC Staffing adequacy	O&M
WSC Inspect clear well	O&M
WSC Filter media replacement/refurbishment	Capital Addition
WSC Tube settler replacement	Capital Addition
WSC Influent streaming current meter	Capital Addition
Auxiliary Power (permanent solution)	Capital Addition

4.2.3. Finished Water Reservoirs

The Water System utilizes three reservoirs to store finished water for distribution throughout its service area. The reservoirs are located at Reservoir Park within the City of Harrisburg and serve two different pressure districts.

The Lower Reservoir consists of two six million gallon circular tanks constructed in 2002. This facility serves consumers who are generally located west of Eighteenth Street within

the City. The Lower Reservoir has an overflow elevation of 504 Feet and feeds the distribution system through a supply pipe which ranges in size from thirty to thirty-six inches in diameter. The last interior inspection of the Lower Reservoir tanks was in 2010. CRW has scheduled interior inspections for 2015 but these inspections had not occurred prior to our visit. Arcadis did not visit the vault containing the discharge piping because the vault is a confined space. The tanks appear to be in good overall condition based upon our exterior inspection. The concrete on the exterior walls has extensive hairline cracks with effervescence and also extensive discoloration caused by a biological film. The tanks should be power washed within the next five years and may require recoating to prevent further deterioration of their exteriors. CRW should monitor the cracks, especially the horizontal cracks which reflect the wire wrapping, to assure that water is not penetrating to the wire wrapping.

The Upper Reservoir is an underground reinforced concrete reservoir constructed in 1927. It has a storage capacity of 28 million gallons and is divided into two compartments. The Upper Reservoir serves the Water System high pressure zone. It supplies water to customers located east of Eighteenth Street within the City and in portions of Penbrook, Susquehanna, Swatara and Lower Paxton. The last interior inspection of the Upper Reservoir tanks was in 2008. CRW has scheduled an interior inspection for 2015 but that inspection had not occurred prior to our visit. Arcadis did not visit the vault containing the discharge piping because the vault is a confined space. Arcadis could not observe the condition of the tank vents or overflows because the hatches were spot welded closed for security. The Upper Reservoir has multiple leaks. CRW makes monthly estimates of only that leakage which surfaces in the vicinity of the reservoir. The leakage reported by CRW for calendar year 2014 was 5.7 million gallons which was approximately the quantity of water produced in a single day by CRW. The DEP cited CRW for a violation in July 2015 because the leakage resulted in chlorinated water being discharged to a storm drain in River Side Drive. The Upper Reservoir is operational but nearing the end of its expected service life. It requires investment to restore it to proper operating condition or to replace it.

Table 4-5 identifies the anticipated additional capital and incremental O&M needs for the Finished Water Reservoirs that have not been already identified in the previous CRW CIP as presented in Appendix D.

Table 4-5.
Finished Water Reservoir Improvements

Description	Classification
Upper Reservoir - Line interior to eliminate leaks. Make additional repairs identified by FY 2015 inspection	Capital Addition
Regular Reservoir Inspections	Capital Maintenance
Lower Reservoir - Clean and recoat exteriors. Make additional repairs identified by FY 2015 inspection	Capital Maintenance

It is anticipated that the regular inspection of the Upper Reservoir and Lower Reservoirs will include draining of tanks and manned interior inspection.

4.2.4. Susquehanna River, Gate House and Union Square Pump Stations

CRW's Water System utilizes three pumping stations to convey water and maintain adequate distribution system pressure.

The Susquehanna River Pump Station is located within the City, between Front and River Streets, north of Graham Street, and is used to transfer raw water from the Susquehanna River to the Dr. Robert E. Young Water Services Center. The facility draws water from the river via an inlet tunnel connected to four wedge wire screens located in the river. It was constructed in 1994. CRW typically exercises the equipment at the facility one day a year because of the Water System preference for utilizing water from the DeHart Reservoir. The facility appears to be in good condition and able to perform adequately without any evident capital requirements.

The Gate House Pump Station is located at the City's Reservoir Park and is used to transfer finished water from the Lower Reservoir or the Dr. Robert E. Young Water Services Center to the Upper Reservoir. It was constructed in the 1920s. The most recent significant upgrade was in 1994. CRW typically operates at least one pump 12 hours every day. The facility appears to be in good condition and able to perform adequately without any evident capital or additional O&M requirements.

The Union Square Industrial Park Booster Station is located within Susquehanna Township along Susquehanna Township's municipal border with Lower Paxton Township and is used to increase the water pressure within the outer reaches of CRW's distribution system which serves the Union Square Industrial Park. It was constructed in the mid-1990s. CRW rarely operates the facility because the system pressure is adequate for normal demands. The facility appears to be in good condition and able to perform adequately without any evident capital or additional O&M requirements.

Minor improvements were identified for FY2016 as summarized in Table 4-6.

Table 4-6.
Pump Station Improvements

Description	Classification
Recoat piping at lower level of Susquehanna River Pump Station	O&M

4.2.5. Water Transmission System

CRW has several water transmission mains. The most important transmission mains are 1) the DeHart Dam raw water line, known as the Mountain Line, 2) the raw water transmission main connecting the Susquehanna River Pump Station to the Dr. Robert E. Young Water Services Center and 3) the finished water transmission main connecting the Dr. Robert E. Young Water Services Center to Reservoir Park.

The Mountain Line is a reinforced concrete and prestressed concrete cylinder pipe pipeline that was placed into service in 1940. The portion of the pipeline though the Dauphin Narrows was relocated by the Pennsylvania Department of Transportation in 1965 when it was widening State Route 22/322. CRW has already budgeted for inspection and improvements of the Mountain Line to assure uninterrupted service to its customers.

The materials of construction and age of the Susquehanna River transmission main were unavailable at the time of preparation of this report. Its current state of repair and ability to deliver an adequate supply of raw water cannot be verified from the available information.

The materials of construction and age of the finished water transmission main from the Dr. Robert E. Young Water Services Center to Reservoir Park were unavailable at the time of preparation of this report. Its current state of repair and ability to continue delivering an adequate supply of finished water cannot be verified from the available information. This main is arguably the most critical main in the entire Water System.

Table 4-7 identifies the anticipated additional capital and incremental O&M needs for the transmission mains that have not been already identified in the previous CRW CIP as presented in Appendix D.

Table 4-7.
Transmission Main Improvements

Description	Classification
Susquehanna Line - Compile information on construction and improvements made to the main. Verify valve positions	O&M
Water Service Center Finished Water Transmission Main - Compile information on construction, improvements and operating history for the main	O&M

4.2.6. Water Distribution System

CRW water distribution system includes approximately 250 miles of pipe, 1,800 fire hydrants, 5,300 valves and 20,000 active services.

Delivered Water Quality

CRW provides the DEP with monthly reports on quality of its delivered water and publishes an Annual Drinking Water Quality/Consumer Confidence Report as required by the EPA. The Drinking Water Quality Report provides the results of water quality tests on CRW drinking water for that calendar year as compared to permitted MCLs. CRWs 2015 Drinking Water Quality Report (which reports the results for calendar year 2014) concluded that CRW's water quality is good and continues to consistently exceed national quality standards.

CRW has a routine sampling plan. Its day shift plant operators collect more than the minimum number of routine total coliform samples required from sites at commercial customers including customers located where the longest detention time is expected.

CRW maintains a detectable disinfection residual in its distribution system verified by the same sampling program used to monitor the absence of total coliform organisms in the water. It also monitors for disinfection by-products as required by the EPA and has been in compliance since 2012.

CRW maintains records of aesthetic water quality complaints and their resolution. It reports the number of water complaint calls in the Water Division Monthly Report reviewable on-line. Aesthetic complaints are infrequent and most often a consequence of CRW's hydrant flushing program.

CRW monitors 30 sites triennially in accordance with a sampling plan as required by the EPA for systems complying with the Lead and Copper rule without difficulty.

CRW flushes its distribution system at all hydrants beginning in the spring of each year beginning with high capacity mains and moving toward lower capacity mains.

CRW's delivered water quality program appears to be consistent with Section 4.1 of AWWA Standard G200, Distribution Systems Operation and Management based upon a limited review of documentation and an interview with the Superintendent on September 10, 2015.

Distribution System Management

CRW maintains the water in its finished water storage reservoirs at levels high enough to avoid low pressure complaints from customers. It monitors the water levels in the reservoirs but does not otherwise monitor the pressure in the distribution system. It posts boiled water notices on its web site for repairs or maintenance causing loss of pressure to customers. The minimum system pressure has not been established at the time of preparation of this report.

CRW does not have a comprehensive backflow prevention program complying with Part VII, Cross-Connection Control/Backflow Prevention of the DEP Public Water Supply Manual. Program implementation requires appropriate municipal ordinances and up to five years to educate customers, have customers install backflow preventers as appropriate and initiate a backflow device testing program.

CRW is unconcerned about organic solvents permeating into the system through PVC piping because it does not have any PVC piping in its system.

CRW is searching its distribution system for leaks and correcting a water meter recording problem in response to the significant water losses noted in Section 3.3 of this report. It does not have an explicit water loss goal or a formal action plan to address unaccounted for water. It has not utilized the AWWA Water Audit software to prioritize its effort to reduce water losses. It does report estimated volumes for several categories of water losses in Exhibit K, Miscellaneous Water Usage of its Water Division Monthly Report. Arcadis was unable to reconcile the losses reported therein with the apparent total losses while preparing this report. Table 4-8 provides a five-year comparison of the amount of unaccounted NRW percentage and number of water main and service line breaks for the CRW Water System.

Table 4-8.
Non-Revenue Water and Water Main Breaks

Year	Water Produced (MGD)	Non-Revenue Water (MGD)	# of Service Line Breaks	# of Water Main Breaks
2010	8.20		1	13
2011	8.11		0	8
2012	8.06		5	12
2013	8.45	3.15	1	13
2014	8.45	3.55	15	32
Average			**4.4**	**15.6**

Notes:
1) Source: CRW Reported Unaccounted for Water, Average Daily Water Production, Service Line Leaks and Water Main Break History.

The amount of NRW includes authorized usage attributable to fires, line flushing, street cleaning, lab testing, etc. as well as unaccounted for water attributable to a number of factors such as meter accuracy, finished water reservoir leaks, water main leaks, private service connection leaks, and potential theft/unmetered connections. CRW does maintain records on accounted for water, however, it is only a small percentage of the total NRW.

CRW does not have a valve exercising program satisfying AWWA G200 Paragraph 4.2.5 in place. It does report valves replaced, valves exercised and valves repaired on Exhibit I, Distribution System Activities its Water Division Monthly Report. CRW has identified valve replacement among the projects in it capital improvement plan. The total numbers reported for these categories for 2014 indicate that a more aggressive maintenance and replacement program could be justified. Approximately 90 percent of the valves in the system are thought to be operational.

CRW does attempt to test all hydrants annually. It does report hydrants tested, hydrants replaced and hydrants repaired on Exhibit I, Distribution System Activities its Water Division Monthly Report. Approximately 99 percent of the hydrants in the system are thought to be operational.

CRW does ensure that only NSF/ANSI Standard 61 approved coating and linings are used throughout its distribution system whenever new material is installed. However, much of the system predates the standard. Many service connections still have lead goose necks where they connect to the mains. Further review of CRW records are needed to establish the number of lead goose necks.

CRW does meter the finished water entering the distribution system to determine peak flows and maximum-day peak flows. Most of the customer meters in the system were replaced between 1999 and 2002. CRW believes that a great deal of the unaccounted for water is attributable to under-reporting of actual consumption caused by system-wide meter radio-read transceiver battery failures and conservative estimates of bills where there was lacking meter reads. CRW is actively replacing batteries to correct the problem and conducting manual reads as needed. Historically, CRW had approximately 6,000 estimated

bills per billing quarter. That number was reduced to less than 1,400 in 2014 and now less than 1,000 estimated bills per billing quarter for 2015. Residential domestic water use was estimated in 2014 to be approximately 32 gallons per person per day. This amount of water usage is low in comparison to communities indicating that the under reading of meters, due to battery failures or other reasons is likely. CRW also has a shop for testing meters. Standards for meters were not reviewed for this report. Arcadis could not confirm whether CRW's metering program conforms with AWWA Manual M6 while preparing this report.

The distribution system is capable of delivering the maximum day demand and satisfying fire flow requirements based upon information obtained from records and interviews. However no hydraulic model results or reports were reviewed.

CRW does record information related to main breaks including location, pipe material, diameter, type of break and soil type. Most breaks are reported to be random except for one neighborhood with aggressive soils. CRW does not have an external corrosion monitoring plan.

CRW does review construction projects for potential impacts upon its Water System. It has records for projects completed since the 1990s but not necessarily for earlier periods.

CRW does not have an energy management program intended to anticipate new distribution system facilities because new facilities are a relatively minor component of its capital improvement program.

CRW's distribution system management program appears to be consistent with Section 4.2 of AWWA Standard G200, Distribution Systems Operation and Management based upon a limited review of documentation and an interview with the Superintendent on September 10, 2015 except that in general more documentation is needed and programs for backflow prevention, leak management, valve exercising and meter management need enhancements.

Facility Operation and Maintenance.

CRW maintains the water in its finished water storage reservoirs at levels high enough to avoid low pressure complaints from customers. The reservoirs are too large to simultaneously have desirable turnover rates; a shortcoming mitigated by the generally excellent quality of the water being delivered. CRW has been inspecting storage reservoirs on a 5 to 8 year cycle, a cycle likely to decrease to five years based upon the revised EPA Total Coliform Rule.

CRW has written operating procedures for the Susquehanna River Pump Station but not for its other pumping stations. Its SCADA system records operational conditions. It has written maintenance procedures for all three of its pumping stations.

CRW has poor records as to the history of its distribution system pipelines. The average age of the distribution system is unknown as records regarding installation dates of pipes is not available for about 40 percent of the distribution system. Where records are available, they indicate an aged system, with over 90 percent of the records showing an installation date prior to the 1960s, and almost half of those installations occurring over 100 years ago. A nominal replacement rate of 12,500 linear feet per year might be justified based upon the age and size of the system. However for a long term program, more information is needed to prioritize main replacement locations.

CRW's distribution system operation and maintenance program appears to be consistent with Section 4.3 of AWWA Standard G200, Distribution Systems Operation and Management based upon a limited review of documentation and an interview with the Superintendent on September 10, 2015 except that in general more documentation is needed and the program for water main replacement needs enhancements.

Documentation

CRW continues to update and expand its GIS system including integration with CRW's City Works asset management program. CRW's plan is consistent with Section 5.1 "Documentation required" of AWWA Standard G200. CRW should continue to expand this program.

Table 4-9 identifies the anticipated additional capital and incremental O&M needs for the distribution system that have not been already identified in the previous CRW CIP as presented in Appendix D.

Table 4-9.
Distribution System Improvements

Description	Classification
Water Main Assessment to Prioritize Replacements	Capital Addition
Water Main Replacement	Capital Addition
Water Meter Replacement Program	Capital Addition
Leak Detection Program	O&M
Meter Read Auditor	O&M
Valve Exercising Program	O&M
Backflow Prevention	O&M
"Lead Free" plumbing assessments	O&M

4.2.7. Summary

Based on our review of the above information, it appears that the Water System is generally in good condition and being maintained and operated in accordance with generally accepted utility standards. However, based on review of the condition of the system, additional maintenance activities and improvements are recommended to be included in CRW's FY2016 budget in order to continue to maintain the Water System in good repair and sound operating condition. These improvement requirements are further summarized and discussed in the subsequent section of this CEAR.

5. Capital Improvement Plan

5.1. Overview

CRW maintains a long-term CIP that identifies the major planned projects and initiatives for the Water System. A copy of CRW's existing CIP is provided in Appendix D. The CIP includes projects that are required to meet future regulations, replace aging infrastructure, enhance or expand services to customers, provide resiliency and redundancy and increase cost effectiveness and efficiency. As such, while certain projects are required by regulations or needed to maintain proper operations (non-discretionary) others are discretionary in that the project is being undertaken to meet CRWs established goals but are not necessarily critical to the continued operation of the Water System. As such, the schedule for implementation of discretionary projects is often subject to change.

A review of CRW's long-term CIP, its past accomplishments and the current observed condition of key assets was completed to assess the overall condition of Water System, and to identify potential Capital Additions that should be considered for implementation by CRW for FY2016. The following presents a summary of the findings of our review.

5.2. Capital Program Accomplishments (FY2015)

CRW's capital program accomplishments in FY2015 included the following:

Water Line Replacement/Installation –CRW prepared and issued bids for the replacement of approximately 2,500 linear feet of water lines and associated valves and services. The replacements includes various sized distribution lines that had reached the end of their useful life and were resulting in labor intensive repairs. Construction is anticipated to commence in the fall of 2015 and should be completed within the next year. The estimated cost of the project is $1.405M, which was budgeted at approximately $2.8M in the FY2015 budget.

Distribution System Leak Detection - CRW's FY2015 budget included $370,000 for the development of a comprehensive leak detection program for its distribution system including pipes, hydrants, valves and meters. CRW, however, has been able to accomplish the majority of the compilation of data and development of the program with in-house staff. CRW continues to compile information relevant to the finalization of a proposed program and in the meantime has taken action to repair a leak detected in the upper reservoir, hire a water meter auditor, and increase accuracy of meter reads.

Valve Replacements - CRW completed the replacement of various valves (Front/Paxton, Front/Vine), 1300 Block of Cameron) that had reached the end of their useful life at a cost of approximately $75,000.

Repaving DeHart Complex – CRW's FY2015 budget included $645,000 for repaving of access roads at the Dehart Dam complex and updating the access gate. The design is complete and CRW has applied to FEMA for a grant to help pay for the work. CRW is waiting to receive a response from FEMA prior to initiating construction.

According to CRW, several capital projects that were anticipated to be initiated or completed in FY2015 were delayed or eliminated. These included the following:

Emergency Switchgear System/Emergency Generator Connection - CRW's FY2015 budget included $150,000 for electrical upgrades to the treatment facility to allow for supply of standby power from a generator in the event of major power outage. This project has been delayed to FY2016 as CRW evaluated permanent auxiliary power improvements.

Mountain Line Investigation – This large transmission line has been in service for decades and investigation of the pipe and valves is necessary to ensure an uninterrupted supply of source water. CRW had budgeted $935,000 in FY2015 for this work. Updated cost estimates obtained by CRW indicated the inspection of the transmission main could cost double the initial estimate. As such, CRW is currently in negotiations with Pure Technologies, Ltd to finalize scope, schedule and cost. Additional funding is being allocated in FY2015 based on the negotiations to provide sufficient funding for completion of the project.

Installation of Backwash Water Tank – The FY2015 budget included approximately $75,000 to evaluate the installation of a backwash water storage tank to help minimize fluctuations in finished water chemistry. This project has been put on hold until further notice as CRW continues to evaluate the cost benefit of this project.

Fluoride System Evaluation – The FY2015 budget included approximately $30,000 to evaluate the installation of a liquid versus powder system. This project has been put on hold until further notice as CRW continues to evaluate the cost benefit of this project.

Progress Ave Main Extension between Union Depot Road toward Derry Street (Construction) This project has also been delayed as CRW continues to collect information on the number of participating customers and their water use and needs including cost benefit of the project.

5.3. CRW Updated Five-Year Capital Improvement Plan

Table 5-1 presents a summary of the recommended CIP for CRW for the period FY2016 through FY2020 that reflects capital project delays in FY2015 and the new Capital Additions that were identified and recommended based on the document reviews, visual inspections, and discussions with CRW as part of this CEAR effort.

5.4. Discussion

The estimates of probable costs included in the recommended CIP are preliminary and developed based on visual analysis, without detailed review. They are intended to provide an order of the magnitude costs estimate of total project cost. As individual studies are prepared, costs shown in the CIP may increase or decrease based upon further definition of project scope. Similarly, the O&M estimates are preliminary and developed based on general engineering estimates.

CRW is currently aware of the condition of the Water System and capital projects needed to address the issues that were identified. As with any water utility, there is a need to prioritize capital projects given limited funds. It may be necessary for CRW to further analyze underperforming systems to best determine how to maximize existing available funds and properly identify future funding needs. It is recommended that CRW update its 5-year capital plan as soon as the results of the numerous currently ongoing studies are completed and in no event less than once per year. Changes to the capital plan should be readily communicated to the finance department so as to not delay the acquisition of funding to support the required capital projects, and CRW should aim to implement the CIP projects that it identifies and includes in its capital budget each year.

Table 5-1.
Recommended Capital Improvement Plan

Location	Description	Type	2015	2016	2017	2018	2019	2020
Dam	Repaving DeHart Complex	CM	-	645,000	-	-	-	-
Dam	DeHart provide survey monuments for monitoring dam	CA	20,000					
Dam	DeHart repair bridge over spillway [spalling and exposed rebar]	CM		110,000				
Dam	Dehart paint piping or dehumidify control building basement	CM		50,000				
Dam	DeHart repair parapet and cracks on control building	CM		50,000				
Dam	DeHart repair vicinity of Carsonville weir	CM		30,000				
Raw	Mountain Line & Secondary Transmission Main Investigation	CM	1,915,000	-	-	-	-	-
Raw	Mountain Line Repairs	CA	-	500,000	500,000	500,000	500,000	500,000
WSC	WSC Emergency Switchgear System / Emergency Generator Connection	CA		150,000	-	-	-	-
WSC	WSC Permanent Auxilliary Power	CA			1,300,000			
WSC	WSC Filter Media Replacement	CA		50,000				
WSC	WSC Tube Settler Replacement	CA		190,000				
WSC	WSC Replace FRP Rails	CA		570,000				
WSC	WSC Influent Streaming Current Meter	CA		50,000				
Storage	Inspect Upper Reservoir	CM		70,000				
Storage	Inspect Lower Reservoirs	CM		30,000				
Storage	Line and Rehabilitate Upper Reservior	CM		800,000				
Storage	Clean and Coat Lower Reservoirs	CM			200,000			
T&D	Progress Ave Main Extension Union Depot Road toward Derry Street (Design)	CA	-	-	200,000	-	-	-
T&D	Progress Ave Main Extension Union Depot Road toward Derry Street (Construction)	CA	-	-	-	1,200,000	-	-
T&D	Miscellaneous Water Line (2015 Project)	CA	1,405,000	-	-	-	-	-
T&D	Water Main Assessment	CA		200,000				
T&D	Water Main Replacement	CA		500,000	1,000,000	1,500,000	2,000,000	2,500,000
Misc	Water Meter Replacement	CA			1,000,000	2,000,000	2,000,000	2,000,000
Misc	Miscellaneous Projects	CA	-	-	-	1,000,000	1,000,000	1,000,000
	Total		**$ 3,340,000**	**$ 3,995,000**	**$ 4,200,000**	**$ 6,200,000**	**$ 5,500,000**	**$ 6,000,000**

CA = Capital, CM = Capital Maintenance

6. Operations and Maintenance Expense Review

6.1. Overview

The Trust Indenture (Section 7.11) requires CRW to adopt a Water System budget each year sufficient to meet all of CRW's projected financial obligations for the upcoming Fiscal Year. CRW's Fiscal Year runs from January 1 to December 31. 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 this budget. It is noted, however, that this CEAR only serves to provide advice and recommendations regarding capital additions and amount of money that should be expended to meet incremental O&M expenses. CRW must then establish a realistic financing plan that serves to meet these goals while still balancing other potential initiatives and water bill affordability to customers which may necessitate reprioritization of projects and programs.

6.2. Historical Water System Expenses

A review of CRW's historic and projected budget was reviewed to assess general alignment of overall system costs with the operating and capital requirements of the Water System. The following presents a summary of this review.

Table 6-1 compares historical financial results for FY2011 through FY2014 to the adopted budget for FY2015. As illustrated in Table 6-1, significant changes to operation and maintenance expenses, particularly to "Administrative Expenses" and "Capital Projects Funded with Cash" have occurred in the recent past. These variations were the result of the City's financial stresses and CRWs take back of operations from the City resulting from the termination of the 1990 Management Agreement in March 2014. The net effect has been a significant decrease in Administrative Expenses, a significant increase in Capital Projects Funded with Cash and an increase in Personnel Expenses. CRW also refinanced the 2002B and 2002C Bank Bonds in April 2014. These changes are positive in that they reflect an increased investment into the Water System and a conscientious effort to increase cost effectiveness.

Table 6-1.
Historical Water System Expenses

	FY2011[1]	FY2012[1]	FY2013[1]	FY2014[1]	FY2015[2]
Personnel Expenses					
Salaries and Wages	$1,642,305	$1,591,293	$1,317,521	$1,525,218	$1,836,537
P/R Taxes	127,939	123,738	52,703	176,820	189,817
Employee Benefits	387,463	446,967	214,495	656,263	611,138
Subtotal Personnel Expenses	$2,157,707	$2,161,998	$1,584,719	$2,358,301	$2,637,492
O&M Expenses					
Equipment Repairs/Maint.	$7,131	$12,728	$46,124	$91,453	$109,400
Vehicle Repairs/Maint.	43,323	81,832	7,274	89,921	288,000
Infrastructure Repairs/Maint.	112,793	417,013	183,243	515,689	522,260
Chemicals, Lab Supplies	229,697	18,327	70,044	244,787	247,247
Building, Grounds Maint.	8,966	15,066	4,369	19,862	14,000
Utilities	618,535	712,053	225,739	716,376	890,406
Lease Expense	155,124	42,139	0	0	0
Insurance	108,363	95,263	159,304	269,455	296,309
Computer and Software	18,074	17,375	165	0	0
Administrative Expenses	1,145,619	773,469	1,763,253	1,692,990	2,813,359
Other Operating Expenses	427,650	324,142	374,085	155,063	109,647
Subtotal O&M Expenses	$2,875,275	$2,509,407	$2,833,600	$3,795,596	$5,290,628
Capital Expenses					
Capital Projects Funded with Cash [(4)]	$325,507	$453,808	$51,891	$1,163,172	$5,109,352
Annual Debt Service (Net)	9,133,907	8,884,223	8,654,822	10,624,943	11,520,986
Subtotal Capital Expense	$9,459,414	$9,338,031	$8,706,713	$11,788,115	$16,630,338
Total Annual Cost [(5)]	$14,492,396	$14,009,436	$13,125,032	$17,942,012	$24,558,458

[1] Expenditures related to personnel, O&M, and capital costs were provided by CRW.
[2] Reflects budgeted expenditures for the fiscal year, as provided by CRW.

6.3. Additional Operations, Maintenance and Repair Costs

Several recommendations regarding the addition of O&M expenses in FY2016 for the proper maintenance, repair and operation of the Water System should be considered for implementation by CRW for FY2016 (as discussed in Section 4). Table 6-2 presents a summary of the estimate of the amount of funding associated with these recommended programs.

A recommended range of costs is provided as the actual costs incurred may vary depending on the extent that CRW has the capacity to conduct the services with existing in-house personnel, and requires the purchase of additional supplies and/or contracted services.

Table 6-2.
Summary of Additional O&M Costs

Location	Description	2015	2016	2017	2018	2019	2020
Raw	Recoat piping at lower level of Susquehanna River Pumping Station	-	-	-	-	-	-
WSC	WSC Inspect clear wells	-	5,000	-	-	-	-
WSC	Assess WSC Staffing adquacy	-	-	-	-	-	-
WSC	WSC Susquehanne River testing	-	-	-	-	-	-
WSC	Test WSC Susquehanne River operation	-	30,000	-	-	-	-
T&D	Compile information on Susquehanna Line, verify valve positions	-	-	-	-	-	-
T&D	Compile information on WSC Finished Water Transmission Main	-	-	-	-	-	-
T&D	Leak Detection	40,000	40,000	40,000	40,000	40,000	40,000
T&D	Meter Read Auditor	-	100,000	100,000	100,000	100,000	100,000
T&D	Valve Exercising Program	-	266,000	350,000	350,000	350,000	350,000
T&D	Backflow Prevention Program	-	15,000	5,000	5,000	5,000	5,000
T&D	"Lead Free" Plumbing Assessments	-	20,000	-	-	-	-
Misc	Confined space entry training	-	-	-	-	-	-
Misc	Emergency table top drills	-	-	-	-	-	-
	Total	**$ 40,000**	**$ 476,000**	**$ 495,000**	**$ 495,000**	**$ 495,000**	**$ 495,000**

7. Conclusions

Set forth below are the principal conclusions which Arcadis has reached regarding our review of the Water System.

1. The Water System is generally being managed in a professional and prudent manner with an appropriate regard for the level of service afforded to its customers within the available funding.The Water System condition, based on our review of the data and limited visual inspection, achieved an overall rating of 2.5 indicating that the Water System is generally in good physical and operating condition, however, certain components are aged or worn and will require capital investment within the next five years.
2. The Water System has consistently produced high quality water and is currently in full compliance with its permits and State and Federal regulations.
3. CRW's water supply and treatment capacity is sufficient to meet the current and projected future needs of the Service Area.
4. CRW's long-term capital plan is in general alignment with Arcadis's observed requirements for the Water System. CRW has a good understanding of additional capital projects needed, with the exception of the prioritization of specific water distribution line replacements, and it should endeavor to refine the list of projects based on ongoing engineering analysis.
5. Based on the available information, Arcadis recommends additions to CRW's CIP including the following:
    a. Procuring a permanent generator for Water Services Center Treatment Facility.
    b. Completing an assessment to prioritize its water distribution line replacement needs, and including capital funds annually to replace water distribution lines.
    c. Proceeding with the Mountain Line and Secondary Transmission Main investigation as soon as possible, and making line repairs as needed.
    d. Completing an assessment of DeHart dam spillway modification needs.
    e. Replacing tube settlers and filter media at the Water Services Center Treatment Facility.
    f. Completing inspections of the Upper and Lower Reservoirs, and lining and rehabilitating the reservoirs as needed.
    g. Implement a water meter replacement program.

    The estimated costs of these CIP items are included on Table 5-1.

6. The Water System is generally being maintained and operated in accordance with generally accepted utility standards, and overall the Water System is in good repair and operating condition. CRW has taken a number of steps and is working diligently to improve the condition of the Water System and the results evident in improved operating performance.
7. Based on the available information, Arcadis recommends CRW implement additional O&M efforts as described in this report, including the following:
    a. Making the DeHart dam repairs as identified, including bridge repairs, painting, spillway and Carsonville weir repairs.
    b. At the Water Service Center Treatment Facility, completing a staffing adequacy assessment, conducting Susquehanna River testing, inspecting the clear wells, completing confined space entry training, procuring emergency table top drills, and compiling information on the finished water transmission main.
    c. Continue with ongoing leak detection and fire hydrant flushing programs.
    d. Implement a valve exercising program.
    e. Implement a backflow prevention program.
    f. Complete a "lead free" plumbing assessment.
8. The additional O&M needs identified for the Water System are anticipated to require additional O&M budget funding in FY2016. Depending on whether CRW completes those maintenance items in-house or with outside contractors, the cost of the items could range from $475,000 to $500,000 per year beginning in FY2016.

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 CEAR.

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 (i) that degree of care and skill ordinarily exercised by members of the same profession currently practicing under same or similar circumstances and (ii) 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-US nor its parent corporation, or their respective subsidiaries and affiliates, makes any warranty, expressed or implied, with respect to such opinions.

Appendix A
Acronyms

A listing of acronyms or abbreviation of terms used in this Consulting Engineer's Annual Report is provided below:

AMR -Automated Meter Reading
cVOC - carcinogenic Volatile Organic Compounds
CCL3- EPA Third Contaminant Candidate List
CCL4 – EPA Fourth Contaminant Candidate List
CEAR – Consulting Engineer's Annual Report
CIP – Capital Improvement Plan
CRW – Capital Region Water
DBP2 – Stage 2 Disinfectants and Disinfection Byproducts Rule
ENR – Enginering News Record
EPA – United State Environmental Protection Agency
DEP – State of Pennsylvania Department of Environmental Protection
FTE – Full-time Equivalent
FY – Fiscal Year
GPM – Gallons per Minute
HAAS – Five Haloacetic Acids
HHS – U.S. Department of Health and Human Services
LCR - Lead and Copper Rule
LT2 – Long Term 2 Enhanced Surface Water Treatment Rule
MCL – Maximum Contaminant Level
MGD – Million Gallons per Day
NRW – Non Revenue Water
NTU - Nephelometric Turbidity Units
O&M – Operation and Maintenance
PPB – Parts per Billion
PPM – Parts Per Million**SDWA** - The Safe Drinking Water Act
TCE - trichloroethylene
TCR - Total Coliform Rule
TCP - 1,2,3-trichloropropane
TTHM – Total Trihalomethanes
PCE - perchloroethylene
VOCs – volatile organic compounds

Appendix B
Water System Description

Source of Supply, Transmission, Pumping and Treatment

The Capital Region Water's Water System includes two raw water supply sources. The DeHart Dam and Reservoir located in Rush Township, Dauphin County (primary water supply) and the Susquehanna River (secondary water supply). The DeHart Dam and Reservoir, lies within Clark Valley approximately twenty (20) miles northeast of the City of Harrisburg and impounds water flowing through the valley in Clark Creek and twenty-three (23) smaller tributaries producing a body of water with a 650 acre water surface area that extends four and one half (4.5) miles upstream of the dam. The DeHart Dam and Reservoir collects from a 21.62 square mile drainage area consisting of forest land between the ridges of Peters and Stony Mountains with a six (6) billion gallon storage capacity when full and a yield of ten and one half (10.5) million gallons per day.

The DeHart Dam and Reservoir's Control Building and Chemical Feed Facility, located on the southwest side of the dam and reservoir, provides flow metering and chemical addition to the raw water before it is conveyed by gravity via a combination of thirty-six (36) and forty-two (42) inch diameter transmission mains to the Dr. Robert E. Young Water Services Center in Susquehanna Township. Treatment of the raw water at the dam's Chemical Feed Facility consists of adding potassium permanganate.

The Susquehanna River, the water system's secondary water supply source, has an average flow of 34,410 cubic feet per second and an approximate drainage area of 24,100 square miles upstream of the City of Harrisburg. The river intake, constructed within the City of Harrisburg, north of the intersection of Front and Graham Streets, consists of a screened intake structure and a thirty-six inch diameter pipe with future provisions for chlorine dosing and air backwash capabilities to control zebra mussels and other aquatic organisms. Raw water flows by gravity through the river intake structure to the Susquehanna River Pump Station's intake well where it is then pumped to the Dr. Robert E. Young Water Services Center.

The Dr. Robert E. Young Water Services Center, located at the intersection of Pine Drive and Stanley Drive on the City of Harrisburg's municipal border with Susquehanna Township, treats raw water conveyed from either the William T. DeHart Dam and Reservoir or the Susquehanna River and houses the offices of the City of Harrisburg Department of Public Works, Bureau of Water. The Center utilizes chemical addition, flocculation, coagulation, sedimentation, filtration and disinfection to produce the water system's finished water.

The Dr. Robert E. Young Water Services Center has two parallel treatment process trains with a total design flow capacity of twenty million gallons per day. The process trains include two raw water flowmeters, two static mixers, four three-stage paddle wheel flocculators, four rectangular clarifiers, eight multi-media gravity filters with an air backwash system, two 150 HP centrifugal blowers, chemical feed equipment, two 9,400 gallon per minute backwash pumps, four 7,000 gallon per minute finished water pumps, and two finished water flowmeters. The Center's treatment capabilities include the chemical addition of alum; soda ash; powdered activated carbon; polyphosphate; hydrated lime; caustic soda; ammonia and sodium silicofluoride to the process water. Disinfection is achieved with chlorine, chlorine dioxide or chloramines (chlorine and ammonia). The four finished water pumps at the Dr. Robert E. Young Water Services Center are used to transfer finished water to the Upper and Lower Reservoirs located at Reservoir Park for eventual distribution throughout the water system. Two of the finished water pumps at the Center are used for standby service.

The offices of the Bureau of Water, located at the Dr. Robert E. Young Water Services Center, include the Administration, Metering, and Maintenance Offices. A Personnel Training Center is included within the facilities of the Administration Office. The Dr. Robert E. Young Water Services Center also contains the Operators, Wet Chemistry, and Microbiology Laboratories. Operational control and jar tests are performed at the Operators Laboratory and water quality tests on the raw water from the DeHart Dam and Reservoir and the Susquehanna River are performed at the Wet Chemistry and Microbiology Laboratories.

Transmission

The transmission system includes over twenty miles of forty-two inch diameter steel-reinforced concrete pipe which conveys water by gravity from the DeHart Dam and Reservoir in Clark Valley to the City of Harrisburg Dr. Robert E. Young Water Services Center. The forty-two inch diameter transmission main reduces to a thirty-six (36) inch diameter prestressed concrete cylinder pipe at the northwest side of the intersection of Division and Seventh Streets before it reaches the influent at Dr. Robert E. Young Water Services Center.

Storage

The water system utilizes three reservoirs to store finished water for distribution throughout its service area. The reservoirs are located at Reservoir Park within the City of Harrisburg and serve two different pressure districts. The Lower Reservoir consists of two (6) Million gallon Natgun built concrete wire wound tanks. These reservoirs serve the water system's low pressure zone. The Lower Reservoir Replacement project was completed in 2002 replacing the existing facility that was built in 1873. This facility serves consumers who are generally located west of Eighteenth Street within the City of

Harrisburg. The Lower Reservoir has an overflow elevation of 504 Feet and feeds the distribution system through a supply pipe which ranges in size from thirty to thirty-six inches in diameter.

Distribution

The water system's distribution network includes more than 250 miles of cast-iron, ductile iron, and pre- stressed concrete cylinder pipe in various sizes ranging from 4 to 42 inches in diameter. In addition, there are approximately 1,600 fire hydrants and 5,340 valves in operation.

Interconnections

There are four hydrant interconnections between the Capital Region Water's water system and the water distribution system owned by United Water Inc. United Water also has one raw water connection which allows them to draw raw water from the DeHart Reservoir during emergencies. The water system is not interconnected with any other privately or publicly owned water distribution system.

The four hydrant interconnections with the water distribution system owned by United Water, Inc. include:

- Intersection of Hoffman and Vaughn Streets within the City of Harrisburg.
- Intersection of Derry and Twenty-Ninth Streets within the City of Harrisburg.
- Interconnection located in the Edgemont area of Susquehanna Township along Edgemont Road.
- Intersection of Twenty-eighth Street/Locust Lane in Susquehanna Township.

The final interconnection includes a forty-two (42) inch line near the Rockville Bridge which can supply raw water to United Water's Filtration Plant on an emergency basis.

Pumping Facilities

The Capital Region Water's water system utilizes three pumping stations to convey water and maintain adequate distribution system pressure. The Susquehanna River Pump Station is located within the City of Harrisburg, between Front and River Streets, north of Graham Street, and is used to transfer raw water from the Susquehanna River to the Dr. Robert E. Young Water Services Center. The pump station houses three 400 HP vertical turbine pumps, each rated at 7,000 gallons per minute, to accomplish this transfer. Chemical treatment is provided at the Susquehanna River Pump Station and includes future provisions for chlorine dosing at the screened tee river intake structures. The

chlorine dosing with air backwash provisions on the intake structure will be used for the control of zebra mussels and other aquatic organisms.

The Gate House Pump Station is located at the City of Harrisburg's Reservoir Park and utilizes two 400 HP horizontal split case centrifugal pumps, each rated for 8,700 gallon per minute, to transfer finished water from the Lower Reservoir to Upper Reservoir. Piping capabilities at the Gate House Pump Station also allow water to be pumped directly to either the water system's high or low pressure zones.

The Union Square Industrial Park Booster Station is located within Susquehanna Township along Susquehanna Township's municipal border with Lower Paxton Township and is used to increase the water pressure within the outer reaches of the Capital Region Water's distribution system which serves the Union Square Industrial Park. The Union Square Industrial Park Booster Station includes a dual parallel pumping system consisting of a 750 gallon per minute triplex constant pressure booster pumping system and a 1,000 gallon per minute fire pump. The triplex constant pressure booster pumping system consists of one end suction centrifugal jockey pump and two end suction centrifugal pumps. The jockey pump is 7 1/2 HP rated 150 gallons per minute and the main pumps are each 15 HP rated at 300 gallons per minute. The fire pump is a horizontal split case pump with a 62 HP diesel driven engine.

Appendix C
History of the Water System

The water system was originally formed in 1839, when the Commonwealth of Pennsylvania granted Harrisburg permission to withdraw water from the Susquehanna River to serve roughly 20,000 City residents. Over the years, the system gradually expanded. In 1843, construction of the original Waterhouse was completed near Front and State Streets and a distribution reservoir was constructed in the vicinity of Sixth and North Streets.

In 1860, Harrisburg was incorporated as a Third Class City, and rapid expansion into the Hill and Uptown districts required a larger water distribution system. The original Lower Reservoir, located at Reservoir Park, was constructed in 1873 with a twenty (20) million gallon storage capacity. The elevation of the Lower Reservoir's location provided the City with the ability to feed the water system by gravity. A Pumping Station was built in 1874 at Front and North Streets, for the purpose of pumping water into the new reservoir. In 1903, the Pumping Station was re-equipped with new steam boilers, engines and pumps capable of meeting the demands of the more than 50,000 residents. The Filter Plant on City Island was completed in 1904, consisting of filtration, chemical treatment equipment and three fifteen million gallon per day steam driven pumps. Finished water from this facility was pumped to the Lower Reservoir in Reservoir Park for distribution.

In 1924, a number of improvements were completed to extend and enlarge the water system including increased capacity of the Filter Plant, addition of two turbine pumping units, installation of boiler equipment at the Pumping Station, installation of a new thirty-six inch transmission main from the Pumping Station to Sixth Street and a new covered twenty-nine million gallon capacity reinforced concrete reservoir, was constructed at Reservoir Park to supply areas which developed further away from the central part of the City and at higher elevated sections within the Hill District.

On March 19, 1936, the City of Harrisburg endured a devastating flood. The level of the Susquehanna River reached more than twenty-nine feet that inundated City Island and the southern section of the City with water.

To avoid future disruption to water supply as a result of river flooding, City Council approved development of a new mountain supply in Clark Creek, approximately twenty miles northeast of the City. The construction consisted of DeHart Dam, an impounding reservoir, and a large transmission main to deliver raw water from the Dam to the City.

The State and Federal governments assisted with funding of the facilities. The reservoir and transmission line were completed during 1940.

The new water supply gave the City's residents a natural supply of fresh water as well as an alternative supply source. On January 23, 1948, the old system consisting of the Pumping Station and Filter Plant were placed on a standby for use in an emergency.

Subsequent major improvements were made to the system including reinforced concrete lining of the lower reservoir in Reservoir Park in 1950, and erection of a wall around the open reservoir. In 1954, the spillway at the DeHart Dam and Reservoir was raised, to provide storage for an additional one billion gallons of water. In 1958, the Pumping Station was overhauled and the old steam engines and boilers were converted to new electric-powered equipment. The standby system for water from the Susquehanna River was ready to operate immediately in the event of emergency. In 1958, a new Chlorine Building was constructed at the DeHart Dam and Reservoir and lime feed and chlorine equipment were installed.

In 1965, the forty-two inch diameter water transmission main was relocated in the Dauphin Narrows due to the Pennsylvania Department of Transportation's widening of State Route 22/322 from two to four lanes.

In 1967, electricity was provided to the Filter Plant and the three steam driven pumps, air blower and wash water pumps installed in 1902 and other equipment installed in 1922 were replaced with new electrical equipment. This filter plant was later destroyed in 1972 by the Agnes Flood and the DeHart Dam and Reservoir became the City's sole water supply source.

There were no major improvements projects performed on the water system between the years of 1968 and 1987 other than small maintenance projects. In 1988, however, the Lower Reservoir was rehabilitated at an approximate cost of $810,000. The Lower Reservoir rehabilitation included the installation of a hypalon lining and floating cover to prevent the entry of contaminants into the water system and allow operational flexibility.

The ownership of the City of Harrisburg's water system was transferred to The Harrisburg Authority (now known as the Capital Region Water) in 1990 and The Harrisburg Authority entered into the 1990 Management Agreement with the City of Harrisburg for the operation and maintenance of the water system beginning January 1, 1991. At the same time, The Harrisburg Authority initiated the *Water that Works* capital improvements program which was the most comprehensive and extensive improvements and upgrading project ever undertaken on the water system. The *Water that Works* program provided the water system with filtration and treatment, and virtually guaranteed an

adequate water supply even during droughts. It also addressed the present and future water service and supply needs of population in the service area.

The *Water that Works* program included the following distribution and transmission system improvements:

- Replacement of thirty-six (36) Inch Diameter Water Transmission Main

  The project included the replacement of approximately 750 linear feet (LF) of a previously broken section of thirty-six (36) inch diameter pipe with thirty-six (36) inch diameter pre-stressed concrete cylinder pipe. The pipe was replaced along the State Street Ramp between Twelfth and Fourteenth Streets within the City of Harrisburg. The project cost was approximately $571,000 and was completed in September of 1991.

- Phase I - Miscellaneous Water Distribution System Improvements

  The project included the replacement of the existing water mains with 8,700 LF of new eight (8) inch and twelve (12) inch diameter ductile iron water pipe within Green, Susquehanna, Muench, Fifth, Reily, Briggs and Calder Streets in the City of Harrisburg. The project cost was approximately $750,000 and was completed in September of 1991.

- Phase II - Miscellaneous Water Distribution System Improvements

  The project included the replacement of the existing water main with 10,130 LF of new sixteen
  (16) inch diameter ductile iron water pipe within Seventh Street in the City of Harrisburg. The project cost was approximately $1,300,000 and was completed in August of 1992.

- Phase III - Miscellaneous Water Distribution System Improvements

  The project included the replacement and cleaning of the existing six (6) diameter water mains within Levan and Walnut Streets in Susquehanna Township. The project cost was approximately
  $111,000 and was completed in July of 1992.

- Phase IV - Water System Improvements: Water Transmission Mains

  The project included the installation of 26,300 LF of new thirty-six (36) inch diameter prestressed concrete cylinder pipe and six (6) tunnels under Conrail and PennDOT rights-of-way within the City of Harrisburg and Susquehanna Township. The project cost was approximately
  $7,000,000.

- Phase V - Miscellaneous Water Distribution System Improvements

  The project included the replacement of the existing six (6) and eight (8) inch diameter water mains with 5,282 LF of new twelve (12) inch diameter ductile iron water pipe within the Shipoke Area of the City of Harrisburg. The project cost was approximately $639,000 and was completed in August of 1994.

- Phase VI - Miscellaneous Water Distribution System Improvements

  The project included the replacement of the existing water mains with 249 LF of new eight (8) inch and 281 LF of new ten (10) inch diameter ductile iron water pipe within Second Street in the City of Harrisburg. The project cost was approximately $351,000 and was completed in November of 1992.

- Phase VII - Miscellaneous Water Distribution System Improvements

  The project included the replacement of existing four (4) and six (6) inch diameter water mains with 1,750 LF of new eight (8) inch diameter ductile iron water pipe within Ninth, Tenth and Walnut Streets in the City of Harrisburg. The project cost was approximately $223,000 and was completed in May of 1994.

The *Water that Works* program included the following major improvements to the water system's infrastructure:

- Dr. Robert E. Young Water Services Center (REYWSC)

  The project included the construction of a new water filtration facility with a design capacity of twenty (20) million gallons per day and a computerized process control system. The project cost was approximately $18,000,000 and went on-line in July of 1994.

- Administration Building

  The project included the construction of an Administration Building at the Dr. Robert E. Young Water Services Center. The project cost was approximately $450,000 and was completed in August of 1993.

- Maintenance Building

  The project included the construction of a Maintenance Building at the Dr. Robert E. Young Water Services Center. The project cost was approximately $819,000 and was completed in October of 1993.

- Susquehanna River Pump Station in the City of Harrisburg

  The project included the installation of a new raw water intake and pumping facility. The new river water intake included tee intake screens with a chlorination and air backwash system. The new raw water pumping facility included pumping equipment, chemical feed equipment, instrumentation, piping, and valves. The project was completed in September of 1994 and the project cost was approximately $2,600,000.

- Gate House Building Improvements at Reservoir Park in the City of Harrisburg

  The project included general building renovations and the replacement of the existing pumps, piping, valves, and instrumentation. The project cost was approximately $783,000 and was completed in the summer of 1994.

- DeHart Dam Reservoir Control Building Improvements at the William T. DeHart Dam and Reservoir in Rush Township.

  The project included general building renovations and the replacement of the existing chemical feed systems, chlorination system, hydropneumatic tank, pumps, piping, and valves. The project cost was approximately $680,000 and was completed in the summer of 1994.

The water system was also augmented with a booster station and a water main extension at the Union Deposit Industrial Park during 1993. This project was not part of the *Water that Works* capital improvements program. However, the project included the installation of a new 6,400 LF twelve (12) inch diameter ductile iron water main extension and a new booster station with a 1,000 gallon per minute fire pumping system and a new 750 gallon per minute domestic water pumping system. The project was completed in November of 1993.

Beginning in 1999, the Capital Region Water installed the Sensus Radio Read AMR automated meter reading system that allows for remote reading of water meters by simply driving or walking past the property served. The system consists of a transmitter unit attached to the outside of the building that is wired to the meter inside the building. The meter is being read by CRW employees using a radio receiver.

In addition, the system is capable of reading a majority of meters from Reservoir Park; however, some follow-up is still needed for meters not able to be read in this manner or where read errors are reported limiting the usefulness of this option. As of calendar year ending 2014, approximately 98 percent of all meters are remotely read. Certain large meters continue to be read manually.

In 2002, an in-line hydro-turbine generator was installed at the REYWSC. The generator utilizes flow from the reservoir to produce electricity thereby conserving energy and decreasing the amount of purchased electricity used to run the system.

In 2012, Capital Region Water completed an upgrade of the of the Supervisory Control and Data Acquisition (SCADA) system at the REYWSC in addition to telemetry upgrades at remote facilities including DeHart Dam, Gate House Pump Station, Riverfront Pump Station and City Island. These upgrades allow for important process information to be logged and for data to be conveyed between facilities.

The history of the water system clearly indicates that its development is based upon meeting the needs of the City of Harrisburg and its surrounding communities, by providing the area's population with an adequate and pure water supply. The Capital Region Water remains committed to supplying high quality water and maintaining regulatory compliance. This is evidenced by the 2010 development of a Capital Improvement Plan and annual Plan updates which are used to evaluate repair, replacement and upgrade needs over a 20-year future period to adequately plan and implement projects that keep the system in good repair and working order.

The transition of operating services from the City of Harrisburg to the Capital Region Water upon termination of the 1990 Management Agreement on November 4, 2013 provides the Capital Region Water with distinct benefits. It enables system operation and maintenance to be performed in an efficient manner and provides expanded opportunities for Capital Region Water to access the capital market for future system improvement needs. The Capital Region Water's name change from The Harrisburg Authority was officiated in March 2014. .

Development and implementation of the Capital Region Water's Geographic Information System (GIS) in 2013/2014 integrated highly accurate GPS locations of system components, essential for monitoring, operating, and maintaining and modeling a system of this size. The mapping is linked to custom databases which store vital information on system components, such as type, age and state. Information is being used to better maintain the water facilities, understand weaknesses and vulnerability issues, and prioritize future upgrades.

Appendix D
CRW's FY2014 Capital Plan for FY2015-FY2020

Description	2015	2016	2017	2018	2019
Emergency Switchgear System / Emergency Generator Connection	150,000	-	-	-	-
Repaving DeHart Complex	645,000	-	-	-	-
Miscellaneous Water Lines:					
- North 23rd Street 4-inch DI Main Installation (Design)	24,200	-	-	-	-
- North 23rd Street 4-inch DI Main Installation (Construction)	110,000	-	-	-	-
- Edward Street Main Installation on 500 Block (Design)	35,200	-	-	-	-
- Edward Street Main Installation on 500 Block (Construction)	160,000	-	-	-	-
- Industrial Road Main Replacement (Design)	116,667	-	-	-	-
- Industrial Road Main Replacement (Construction)	700,000	-	-	-	-
- Market Street Road Main Replacement (Design)	37,000	-	-	-	-
- Market Street Road Main Replacement (Construction)	166,500	-	-	-	-
- Paxton Street Bridge Main Replacement (Design)	27,500	-	-	-	-
- Paxton Street Bridge Main Replacement (Construction)	123,750	-	-	-	-
- Woodbine Street Main Replacement (Design)	33,500	-	-	-	-
- Woodbine Street Main Replacement (Construction)	150,750	-	-	-	-
- Herr Street Waterline Replacement (inc. beneath Paxton Creek (Design)	42,560	-	-	-	-
- Herr Street Waterline Replacement (inc. beneath Paxton Creek (Construction)	668,800	-	-	-	-
- Walnut Street Main Installation 3900 Block (Design)	6,700	-	-	-	-
- Walnut Street Main Installation 3900 Block (Construction)	56,950	-	-	-	-
- 10th Street & State Street Waterline Replacement (Design)	22,275	-	-	-	-
- 10th Street & State Street Waterline Replacement (Construction)	297,000	-	-	-	-
Subtotal Miscellaneous Water Lines:	**3,574,352**	**-**	**-**	**-**	**-**
Valve Replacement (Front / Paxton, Front / Vine, 1300 Cameron) (Design)	8,000	-	-	-	-
Valve Replacement (Front / Paxton, Front / Vine, 1300 Cameron) (Construction)	67,000	-	-	-	-
Mountain Line & Secondary Transmission Main Investigation	935,000	-	-	-	-
Mountain Line Repairs	-	500,000	500,000	500,000	500,000
Distribution System Leak Detection	370,000	-	-	-	-
Backwash Water Tank	5,000	425,000	363,878	-	-
Fluoride System Evaluation and Modification	30,000	-	-	-	-
Progress Ave Main Extension between Union Depot Road toward Derry Street (Design)	-	-	-	-	-
Progress Ave Main Extension between Union Depot Road toward Derry Street (Construction)	-	-	1,200,000	-	-
DeHart Dam Spillway Modifications	-	-	-	-	-
Miscellaneous Projects	-	-	-	1,500,000	1,500,000
Total CIP:	**$5,059,352**	**$1,125,000**	**$2,063,878**	**$2,000,000**	**$2,000,000**

Source: **Latest Water System CIP (as used in rate model dated 11-25-14)**