I/M/O the Board's Investigation Into Reliability Issues Related to New Jersey American Water's Swimming River Water Treatment Plant Pipe Bridge Collapse in Monmouth County

Prepared for

State of New Jersey Board of Public Utilities

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Executive Summary

On June 29, 2012, a pipe bridge owned by New Jersey American Water (hereinafter referred to as "the Company" and "NJAW"), a subsidiary of American Water Works Company, Inc. (hereinafter referred to as "American Water"), crossing the Swimming River in Monmouth County, New Jersey, collapsed. The bridge had supported three water pipelines (a 30-inch potable water main, a 36-inch potable water main, and a 42-inch raw water main) carrying water to and from the Swimming River Water Treatment Plant (SRWTP). The bridge can best be described as a 'unique asset" within NJAW's portfolio of assets. The SRWTP serves approximately 95,000 customers in Monmouth County, NJ and is owned and operated by NJAW. The collapse of the pipe bridge (commonly referred to as the "SRWTP pipe bridge") severed the three pipelines disrupting service to NJAW's customers in Monmouth County, resulting in the issuance of boil water advisory and an outdoor watering ban; an estimated 200 customers may have lost water service for a short period of time based on models and forecasts prepared by NJAW.

NJAW had recognized that the SRWTP pipe bridge had been damaged ten months prior to its collapse from the impact of Hurricane Irene which hit the area on August 28, 2011; the pipe bridge had been inundated from the rising waters of the Swimming River. Once the flood waters had receded exposing the pipe bridge, NJAW quickly initiated inspections and damage assessments of the pipes and bridge. NJAW initiated planning and design work for interim and long-term repairs to the structure and appurtenances, which included detailed design and permitting, and analysis of site constraints and constructability issues associated with the repairs. The selected repair projects were approved for funding in a timely manner and special materials were ordered. Bid packages for some of the repair work were distributed to qualified bidders and a bid-opening date had been set. NJAW was moving responsibly through the process to the best of their ability given input they received from their technical consultants. However, at the time of the collapse the pending project contracts had not been awarded and the repairs had not commenced.

To better understand the activities and actions related to the pipe bridge taken by NJAW prior to Hurricane Irene and after, as well as the activities and actions taken as a result of the pipe bridge collapse and the resulting disruption to water service, the State of New Jersey Board of Public Utilities (Board) approved NJAW's recommendation to engage CH2M HILL to act in the role of a Special Reliability Master (SRM) to perform the following work as stipulated in the Board's order dated August 15, 2012, Docket No. WO12070659:

1. An assessment of the Company's historic operation and maintenance practices (emphasis on inspections) with respect to the SRWTP pipe bridge and appurtenant piping, including any inspection logs/records since 2000.
2. Review the circumstances surrounding the bridge collapse at New Jersey American Water's Swimming River Treatment Plant on June 29, 2012, and critique the Company's restoration efforts after the collapse, including the deployment of resources to restore operations, service to customers and the Company's communications with government officials and customers.
3. Review and critique the Company's efforts post-Hurricane Irene related to restoring service at the Swimming River treatment plant, including the deployment of resources to restore operations, the restoration of service to customers and the Company's communications with government officials and customers.
4. Review of the post-Hurricane Irene inspection that determined that the SRWTP pipe bridge was fit for continued use.
5. Review the impact of Hurricane Irene on the bridge and related piping and the Company's plans and projects post-Irene to: assess any damage to the SRWTP pipe bridge assets; assess the condition of those assets; inspect and recommend repairs to those assets; develop a plan to implement and recommend repairs determined to be necessary; and the extent to which an effective interim monitoring protocol was established and maintained. This review should assess whether the Company acted prudently from an engineering and utility operating perspective to develop and implement a project(s) to complete repairs in a timely fashion.

6. Review the Company's governance related to prioritization of capital projects that were identified to complete repairs to the pipe bridge assets after Hurricane Irene, and assess whether sufficient controls were in place to provide budgeted funds and effective project timing.

The SRM Team has completed its review and has presented its findings, conclusions, and recommendations for improvement in Sections 4, 5 and 6 of this report.

In general the review revealed that NJAW has a well- documented and comprehensive incident and event management program which was effectively employed during Hurricane Irene and after the collapse of the SRWTP pipe bridge.

After the bridge collapsed, NJAW's Event Management Team quickly gathered information and evaluated the extent of the incident, assessed risk, coordinated restoration efforts, deployed the proper resources, and implemented an effective communication plan with internal and external stakeholders. NJAW contingency planning for this type of event facilitated quick modifications to plant and distribution system operations. A well prepared and organized staff responded to the challenge with the rapid design, construction and installation of temporary emergency bypass pumping and piping solutions to restore normal service to customers in a short period of time. Other water supplies and interconnections were also utilized to limit the outage time. Key vendors were under contract to provide emergency services which facilitated response and recovery efforts, although certain opportunities for improvement were identified and are presented in this report.

It was also evident from SRM Team's review of American Water and NJAW organizational structure, policies, protocols, and from our interviews with staff at various levels of the organization, that NJAW has developed a comprehensive and robust planning, budgeting and delivery platform for its capital investments, which provides the flexibility to fund priority projects as and when needed such as was necessary for the pipe bridge repairs.

Nevertheless, several areas in need of improvement were identified. These areas focus on NJAW's ability to assess the damage and condition of the SRWTP pipe bridge post-Irene and implement plans to complete appropriate repairs in a timely fashion. Although the adverse impacts of these "gaps" were mitigated by a well thought-out and executed event management, response and other contingency plans, seventeen (17) recommendations for improvement to overall system reliability have been identified by the SRM and are presented in Section 6 of this report. Seven (7) of which had been identified in NJAW's initial draft After Action Review (AAR) as potential enhancements to NJAW's event management and response processes and procedures that the SRM Team recommend be implemented.

It should be noted that based on SRM discussions with NJAW, they have proactively implemented many improvements as a result of the pipe bridge collapse. For example, NJAW has identified the other pipe crossings (where pipes cross a waterway or roadway) in its distribution system and inspected the most critical crossings. NJAW has also dismantled and removed the remnants of the collapsed pipe bridge and is in the process of implementing two pipeline replacement projects. One is the installation of a new 42-inch raw water pipe along the bottom of Swimming River Reservoir which will serve as one of two main raw water lines running to the SRWTP, providing the plant with redundant raw water supply feeds. This project is scheduled to be completed in the next several weeks. Once this project is completed the temporary raw water line running along the County road will be removed or converted to Middletown Gradient service. The second project is the installation of three new pipelines to replace those lost in the bridge collapse. These will be constructed in the sediment layer in the river directly below the location of the former pipe bridge. This project is scheduled to be completed in May 2013. When completed, these two projects will provide a high level of reliability to the SRWTP raw water supply through redundant submerged and buried pipelines, and increased reliability of potable water service to customers in this service area via the buried finished water pipelines. These two projects will enhance NJAW's prior improvements in this service area, including the interconnections between the Monmouth and Howell service areas, interconnections with other purveyors, and upgrades to wells and other assets to increase the capacity to the Jumping Brook Treatment Plant. These prior improvements helped to minimize the impact of this outage and the new projects will help to prevent a similar service disruption in the future.

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Acronyms and Abbreviations

AAR	After Action Review
AM	Asset Management
ASCE	American Society of Civil Engineers
NJAW (or Company)	New Jersey American Water Corporation
AWWA	American Water Works Association
BCTS	Business Center Technical Services
CIM	Capital Investment Management
CIP	Capital Improvement Program
CPS	Comprehensive Planning Study
EAM	Enterprise Asset Management
GIS	Geographic Information System
HMM	Hatch, Mott MacDonald
IAP	Incident Action Plan
ICS	Incident Command System
MCL	Maximum Contaminant Level
MGD	million gallons per day
NIMS	National Incident Management System
NOV	Notice of Violation
NJAW	New Jersey American Water Company
NJBPU	New Jersey Board of Public Utilities
NSPS	Newman Springs Pump Station
PPR	State of New Jersey Planning Study Program
RSL	Remaining Service Life
SAP	Company who makes business application software
SRM	Special Reliability Master (Jerry Notte, P.E. and CH2M HILL technical support)
SRWTP	Swimming River Water Treatment Plant
UPA	Utility Plant Accounting
WQ	Water Quality

SECTION 1

Purpose

On June 29, 2012, a pipe bridge owned by New Jersey American Water (hereinafter referred to as "the Company" and "NJAW"), a subsidiary of American Water Works Company, Inc. (hereinafter referred to as "American Water"), crossing the Swimming River in Monmouth County, New Jersey, collapsed. The bridge had supported three water pipelines (a 30-inch potable water main, a 36-inch potable water main, and a 42-inch raw water main) carrying water to and from the Swimming River Water Treatment Plant (SRWTP). The bridge was a unique asset in NJAW's portfolio of assets, with few comparable assets in service elsewhere in the Company's water systems. The SRWTP serves approximately 95,000 customers in Monmouth County, NJ and is owned and operated by NJAW. The collapse of the pipe bridge (commonly referred to as the "SRWTP pipe bridge") severed the three pipelines affecting service to NJAW's customers, resulting in the issuance of a boil water advisory and an outdoor watering ban; an estimated 200 customers may have lost water service for a short period of time. Other water supplies and interconnections were available and utilized to limit the outage time.

NJAW had recognized that the SRWTP pipe bridge had been damaged ten months prior to its collapse from the impact of Hurricane Irene which hit the area on August 28, 2011; the pipe bridge had been inundated from the rising waters of the Swimming River. Once the flood waters had receded exposing the pipe bridge, NJAW quickly initiated inspections and damage assessments of the pipes and bridge. NJAW initiated planning and design work for interim and long-term repairs to the structure and appurtenances, which included detailed design and permitting, and analysis of site constraints and constructability issues associated with the repairs. The selected repair projects were approved for funding in a timely manner and special materials were ordered. Bid packages for some of the repair work were distributed to qualified bidders and a bid-opening date had been set. NJAW was moving responsibly through the process given input they received from their technical consultants. However, at the time of the collapse the pending project contracts had not been awarded and the repairs had not commenced.

To better understand the activities and actions related to the pipe bridge taken by NJAW prior to Hurricane Irene and after, as well as the activities and actions taken as a result of the pipe bridge collapse and the resulting impact to water service, the State of New Jersey Board of Public Utilities (Board) engaged CH2M HILL to act in the role of a Special Reliability Master (SRM) to perform the following work as stipulated in the Board's order dated August 15, 2012, Docket No. WO12070659:

1. An assessment of the Company's historic operation and maintenance practices (emphasis on inspections) with respect to the SRWTP pipe bridge and appurtenant piping, including any inspection logs/records since 2000.
2. Review the circumstances surrounding the bridge collapse at New Jersey American Water's Swimming River Treatment Plant on June 29, 2012, and critique the Company's restoration efforts after the collapse, including the deployment of resources to restore operations, service to customers and the Company's communications with government officials and customers.
3. Review and critique the Company's efforts post-Hurricane Irene related to restoring service at the Swimming River treatment plant, including the deployment of resources to restore operations, the restoration of service to customers and the Company's communications with government officials and customers.
4. Review of the post-Hurricane Irene inspection that determined that the SRWTP pipe bridge was fit for continued use.
5. Review the impact of Hurricane Irene on the bridge and related piping and the Company's plans and projects post-Irene to: assess any damage to the SRWTP pipe bridge assets; assess the condition of those assets; inspect and recommend repairs to those assets; develop a plan to implement and recommend repairs determined to be necessary; and the extent to which an effective interim monitoring protocol was established and maintained. This review should assess whether the Company acted prudently from an engineering and utility operating perspective to develop and implement a project(s) to complete repairs in a timely fashion.

6. Review the Company's governance related to prioritization of capital projects that were identified to complete repairs to the pipe bridge assets after Hurricane Irene, and assess whether sufficient controls were in place to provide budgeted funds and effective project timing.

The following sections of this report provide background on NJAW and its systems and address these six items.

SECTION 2

Background

2.1 The Water System

2.1.1 New Jersey American Water Company and its Coastal North System

NJAW is the largest investor owned water utility company in the state of New Jersey. NJAW serves approximately 2.5 million people in 18 counties with water and wastewater services. NJAW's Coastal North System provides potable water to customers in 36 municipalities as well as to ten wholesale customers in Monmouth County. It is a relatively complex system with 15 pressure gradients and 1,800 miles of water main. The system serves 125,000 customers in Monmouth County and in the Lakewood and Howell systems in Ocean County. These systems are interconnected via large diameter mains of relatively recent vintage. The Monmouth system, described in more detail below, was the part of the Coastal North system affected by the bridge collapse.

The Coastal North System has a total production capacity of 92 million gallons per day (mgd), with an average demand of 50 mgd and maximum day demand of 83 mgd. The system is served by three surface water treatment plants (WTPs). They are the SRWTP (36 mgd capacity), the Jumping Brook WTP (25 mgd capacity) and the Oak Glen WTP (7.5 mgd capacity). There are two reservoirs with a total capacity of 3.4 billion gallons, 23 wells with a total capacity of 10 mgd, 29 storage tanks, and 34 interconnections in the system.

2.1.2 Swimming River Water Treatment Plant System

The Monmouth Service area serves approximately 95,000 customers in Monmouth County. The SRWTP is located in Colts Neck and supplies water to the Newman Springs Pump Station (NSPS), the Middletown Service Gradient, and the Main Service Gradient. The SRWTP is the primary source of supply for the Middletown Service Gradient, while the Main Service Gradient is also supplied through the Jumping Brook WTP and if necessary, the Oak Glen WTP through the interconnection to the Howell system.

Under normal conditions, the Middletown Service Gradient average daily demand is approximately 15 mgd, which is met as follows: approximately 10 mgd from the SRWTP high service pumps that discharge to the 30-inch Middletown high service transmission main along Swimming River Road, and approximately 5 mgd from the Middletown high service pumps at the NSPS. The Middletown Service Gradient also has multiple interconnections with Marlboro and Shorelands Water Company (SWC). Normal operation of these interconnections has NJAW supplying water to SWC and receiving supply from Marlboro. In an emergency, flow can be reversed at the SWC interconnections and increased at the Marlboro interconnections to deliver water supply to the Middletown Service Gradient.

The historic maximum daily demand for the Middletown Gradient has reached approximately 25 mgd. NJAW's Coastal North System distribution network is connected enabling water supply transfers from the Monmouth Main Service Gradient to the Middletown Gradient. Specifically, the Middletown Gradient can be supplied by transferring Main Service Gradient water supply to the NSPS and then relaying this water to the Middletown Gradient using the NSPS Middletown Pumps. This "back feed" configuration allows supplies from both the SRWTP and the Jumping Brook WTP which feed directly into the Monmouth Main Gradient, as well as supply from the Oak Glen WTP via a separate supply transfer to be conveyed through the Monmouth Main Service Gradient to the Middletown Gradient. In summary, although this configuration cannot meet historic summer max day demands in the Middletown Gradient, NJAW has the ability to utilize a combination of interconnections and supply transfers and other operational mitigation measures to meet average daily demands in the Middletown Gradient while still maintaining adequate pressure and flows within the Monmouth Main Service Gradient, as was the case in the aftermath of the pipe bridge collapse.

Until June 2012, raw water was supplied to the SRWTP via a 42-inch diameter steel pipe supported on the SRWTP pipe bridge which crossed the Swimming River. The bridge also carried two potable water pipes, one 30-inch steel pipe serving the Middletown Gradient, and a 36-inch steel pipe supplying water to the NSPS. Pipe segments were

40-feet long and joined together at their ends by means of Dresser couplings to accommodate minor movements due to expansion, contraction, vibration and line deflection.

2.1.3 SRWTP Pipe Bridge

The SRWTP pipe bridge was constructed in 1971 for the Monmouth Consolidated Water Company of Long Branch, New Jersey. The original design was for the bridge to support two water pipelines across the spillway of the Swimming River Reservoir Dam. A third pipe was added after its original construction. The bridge consists of 21 timber pile bents with a reinforced concrete pile cap beam. Its overall length (prior to the collapse) is approximately 400 feet and its width is 16 feet. The concrete pile caps are spaced at every pile bent along the length of the bridge. They measure 2.5-feet wide by approximately 16-feet long. The pipes are supported by cradles formed within the pile caps and are held in place by means of steel pipe straps anchored to the pile caps, and grout cradles on top of the pile caps.

The pipes were enclosed within timber siding and a timber walkway structure. The timber siding and walkway were attached to the pile caps by means of a vertical steel channel that is attached to the pile caps. The timber walkway on top of the bridge allow for maintenance personnel to access the entire length of the bridge.

2.2 Hurricane Irene

Early Sunday morning, August 28, 2011, Hurricane Irene struck the New Jersey shoreline as a Category 1 hurricane. Landfall was near Little Egg Inlet, approximately 50 miles south of the SRWTP. Later that day the eye of the storm passed close to or over the SRWTP. This was the first hurricane to reach landfall in New Jersey since 1903. Water levels in the Swimming River inundated the pipe bridge and the three pipelines (Figures 1 and 2). Within a 24-hour period, water levels receded.

Realizing that the pipe bridge may have sustained damage from the inundation and other impacts of the storm, NJAW initiated inspections of the pipe bridge. Four inspections and assessments were conducted of the bridge structure. The first one was conducted by NJAW staff; the second by NJAW's engineer-of-record[1] Hatch, Mott, McDonald (HMM), the third by TNJ and the fourth by the engineering firm, Wiss, Janney, Elstner Associates, Inc. A post-failure inspection was also performed by Ocean and Coastal Consultants Engineering. Results of the inspections indicated that the bridge exhibited a number of problems that questioned its short-term stability and longer-term reliability. The inspections however, found that the pipe bridge and its pipelines were fit for service. NJAW then retained HMM to assist with the bridge repair work which included evaluating damage and providing assessments, reviewing and evaluating long term alternatives for repairs to the pipe bridge, providing structural calculations, preparing cost estimates, assisting with permit requirements, coordinating and meeting with the NJDEP, reviewing and evaluating long term alternatives for repairs to the pipe bridge structure, and preparing a design report, design documents along with other related engineering services.

FIGURE 1
View of Inundated Pipe Bridge (to right of roadway)

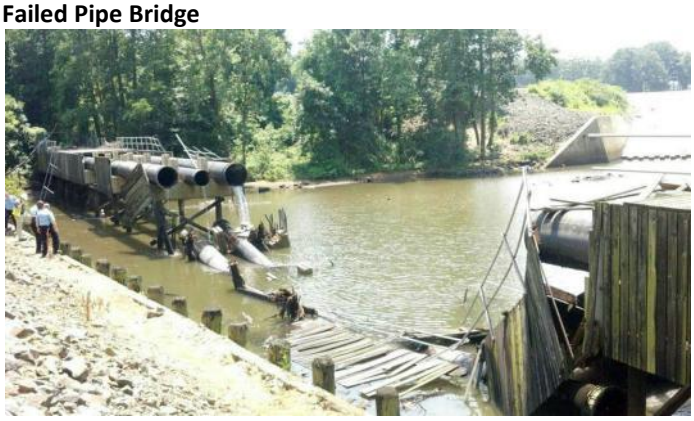
FIGURE 2
View of Inundated Pipe Bridge (beyond grassed area in the foreground)

[1] "Engineer- of- record" in this context refers to a licensed professional engineer responsible for the structural assessment, design and permitting and construction oversight of the pipe bridge repair work.

2.3 Pipe Bridge Collapse

On June 29, 2012 at approximately 12:45pm, the SRWTP pipe bridge failed. The bridge failure was sudden and catastrophic, severing the three pipelines and disrupting water service. Figure 3 shows the failed pipe bridge and severed pipelines, a few days after the collapse. Collapse resulted in 95,000 customers of NJAW (a population of approximately 280,000) in Monmouth County being subjected to a boil water advisory and outdoor watering ban. Additionally, it was estimated by that approximately 200 customers may have been without water service for a short period of time.

FIGURE 3
Failed Pipe Bridge



2.4 Post Bridge Collapse

On August 15, 2012, in Docket No. WO12070659, the New Jersey Board of Public Utilities (NJBPU or the Board) directed that NJAW retain CH2M Hill as Special Reliability Master (SRM) to "evaluate the design, operation, maintenance, reliability, safety and performance standards as they pertain to the SRWTP Pipe Bridge including a review of the inspection following Hurricane Irene that deemed the bridge appropriate for continued use, and make recommendations to NJAW and the NJBPU on the appropriate course of action necessary to ensure adequate reliability and safety at the SRWTP facility."

SECTION 3

Overview of Investigation

To undertake this assignment, CH2M HILL established a Special Reliability Master (SRM) Team consisting of experts in water treatment and supply, pipeline engineers, asset management, structural engineers and maritime engineering inspectors who specialize in underwater inspections. The team was led by Jerry Notte, PE, who has extensive experience and expertise in the management and operations of water systems and associated regulations in the State of New Jersey both as a utility manager and as a consultant.

In the course of the investigation, the SRM Team interviewed personnel from NJAW, American Water and HMM. The interviews were conducted to gain an understanding of the operations of the SRWTP and the Coastal North Service Area, along with the activities prior to and during Hurricane Irene, the post-Irene pipe bridge condition assessments, the planning and prioritization process for repair activities, the post-bridge collapse activities, and the practices related to capital project implementation and asset management. A list of those individuals and their roles in those organizations is included in Appendix A.

In addition to the interviews, the SRM Team reviewed numerous documents, including (for example): reports, maps, correspondence, project documents, task orders, proposals, designs and various other documents and processes relating to the pipe bridge; operations prior to, during, and after Hurricane Irene; response to and actions taken after the pipe bridge collapse; inspections, assessments, repair recommendations, project scope, approval and funding and other repair project and long term alternative project documents; and NJAW's planning, governance, funding and approval with respect to asset repair and capital rehabilitation projects.

The SRM Team also reviewed: Photographs of the pipe bridge pre- and post Irene, and post-bridge collapse; the timeline developed by NJAW chronicling key dates, milestones and sequence of events surrounding the pipe bridge collapse; and, NJAW's e-mails related to Hurricane Irene, the pipe bridge collapse, repairs and water service issues.

Field inspections of the SRWTP and the pipe bridge site were also conducted by the SRM Team, and inspections were made of the damaged sections of the pipe bridge, the pipelines and appurtenances. Photos taken are presented in Appendix C.

SECTION 4

Findings

The SRM Team's findings are presented as listed in the Scope of Work of the Board's Order of August 15, 2012.

4.1 Historic Operation and Maintenance Practices with Respect to the SRWTP Pipe Bridge and Appurtenant Piping since 2000

4.1.1 O&M Practices Prior to Hurricane Irene

Since its construction in 1971, and prior to Hurricane Irene in August 2011, the SRWTP pipe bridge was inspected only once, in 1991. No inspection or maintenance records were found prior to 1991. The 1991 inspection was performed by Killam Associates (acquired by HMM in 2001). By that point in time, ownership of the SRWTP and pipe bridge had passed to NJAW by a merger with the Monmouth Consolidated Water Company. The 1991 inspection was prompted by NJAW's concern for the condition of timber façade and the timber walkway planks and railings supported off of the concrete pile caps.

The inspection found that two piles were slightly out-of-plumb. The report further stated that a pile that observed to be out of plumb did not necessarily deviate from its original position. The report also states, "In general, the timber piles are in good condition." No recommendation for any remedial action was made other than several minor items of routine maintenance. Recommendations for pipeline maintenance included the repair of areas of deteriorated coating on the pipes and couplings, and repair of the hold down straps at seven locations where they had become disconnected from the pile caps.

The Killam Associates report also stated, "*In general, the timber piles are in good condition. No excessive splitting or splintering of the piles is evident. The visual observations of the piles below the water level from the boat utilized during the previous inspection indicated that the piles are not experiencing decay or rotting below the water level and are in good condition. Based upon the previous visual observations, no cracking within the concrete pile (sic. pile caps) had occurred."* Although a "previous inspection" is mentioned in the Killam report, documents of a previous inspection could not be located and therefore were not provided to CH2M HILL. Further, during a conference call on November 19, 2012, Javier Jimenez, a structural engineer with American Water, was questioned about inspection reports prior to 1991. Mr. Jimenez responded by stating that no prior documents could be located.

Also in 1991, it was determined that the mud-line of the Swimming River, in the area directly below the pipe bridge had significantly receded. This loss of embedment length of the piles supporting the pipe bridge may have reduced their structural capacity. There was apparently no follow-up inspection of the mud-line below the bridge until after Hurricane Irene. In fact, there were no records of any inspections or maintenance activities on the pipe bridge or the three pipes after 1991 until the inspections performed in 2011.

In addition, it was found that NJAW did not have the pipe bridge in its asset database. The only related asset documentation was a node-to-node line pipeline segment in the GIS showing the approximate location of pipelines. Until Irene in 2011, there were no documents describing the pipe bridge physical attributes or condition.

NJAW's 1993 Monmouth County Service Area Comprehensive Planning Study (CPS) does however reference the timber pipe bridge and it importance in supporting the sole line supplying raw water to the SRWTP, the line supplying finished water to the Newman Springs Station, and the sole line supplying water to the Middletown gradient. It goes on to state how a break in one of the lines would jeopardize the other two and discusses possible projects for new pipeline alignments and a new raw water intake location that would be reliable alternatives to the three mains on the timber bridge but there was no discussion regarding the pipe bridge condition.

It is apparent that the consensus among NJAW staff was that the pipe bridge and pipelines, prior to the hurricane was in good, working condition with no concern of structural integrity or hydraulic reliability.

4.1.2 O&M Practices since Hurricane Irene

After Hurricane Irene, several inspections and assessments of the pipe bridge structure were conducted by the Company and other contractors. Four inspections/assessments were done prior to the pipe bridge collapse; the fifth was a forensic assessment conducted after the bridge collapse. The first inspection was performed by American Water's Business Center Technical Services (BCTS), the second also by BCTC supported by TNJ Marine, Inc. an underwater inspection contractor engaged by NJAW. The third inspection was conducted by NJAW's engineering consultant and engineer-of-record HMM which included a site visit on September 28, 2011; and a fourth was made by Wiss, Jenny Elstner, Associates, Inc., (WJE) an engineering consultant to NJAW's Insurance Company; and the fifth inspection, performed after the pipe bridge collapse, was conducted by Ocean and Coastal Consultants Engineering.

The BCTS, HMM and WJE inspections yielded recommendations for repairs to the pipe bridge. In September 2011, NJAW entered into discussions with HMM for a broad range of work, including an assessment of damages to the bridge; short and long term repair recommendations; and recommendations for long term alternatives to the pipe bridge. In early October, HMM was formally retained by NJAW to perform that work. By November NJAW had approved preliminary repair recommendations, and HMM submitted a proposal for repairs to the pipe bridge, including the design of short-term (immediate) repairs as well as long-term (permanent) repairs to the pipe bridge. Project review and approval, funding approval, engineering analysis, design, permitting, and procurement and had all been undertaken after Hurricane Irene and prior to the collapse, and at least one contract had been awarded. Despite this activity, there is no evidence that any repairs or maintenance of the pipe bridge were performed from the time Hurricane Irene hit on August 28, 2011 to the time of the pipe bridge collapse on June 29, 2012.

Section 4.5 of this report presents the results of the inspections, assessments, repair recommendations, project approval and funding, design, permitting, contracting and other details for the progress of the repair projects between August 28, 2011 and June 29, 2012.

4.2 Bridge Collapse and Restoration Efforts

4.2.1 Incident Response

On June 29, 2012 at 12:45 PM the system operator at the SRWTP detected a sudden change in plant operating conditions. In accordance with standard protocol, the operator contacted the SRWTP supervisor. Within minutes the source of the problem was identified as the collapse of the pipe bridge and the free-flow of water from the three pipelines severed by the collapse.

For all incidents, NJAW follows American Water's Incident and Event Management Practices document, which complies with the National Incident Management System (NIMS). The document requires NJAW's operations and functional areas to prepare specific incident management procedures that are compliant with the Practices and provide specific and adequate arrangements for:

- Safety management (e.g. people, environment, product, property)
- Business continuity (e.g. repair of damaged assets, restoration of service)
- Interactions with clients, regulators and other key stakeholders
- Incident assessment and reporting arrangements that comply with established reporting thresholds and processes
- Incorporation of the National Incident Management System (NIMS)
- Incident Command System (ICS).

The document provides seven specific action cards and forms to guide the staff in managing resources and operations of prior to, during, and after an incident or event. The actions covered are:

1. Incident recognition
2. Risk Assessment
3. Risk Assessment Process
4. Incident Action Plan (IAP)[2]
5. Communications plan
6. Reporting to Corporate
7. Incident Closedown

For all incidents, NJAW establishes an Event Management Team led by an American Water executive, supported by an Incident Owner from NJAW and an Incident Commander also from NJAW. The other members of the Event Management Team include a Safety Officer, an Information Officer, a Government Officials Liaison, a Customer Relations Officer, an Incident Coordinator and other staff specialists needed to manage the incident. The organizational chart for the Event Management Team established for the SRWTP pipe bridge collapse is shown in Figure 4.

In addition to the information shown on the organizational chart, NJAW provided the following information:

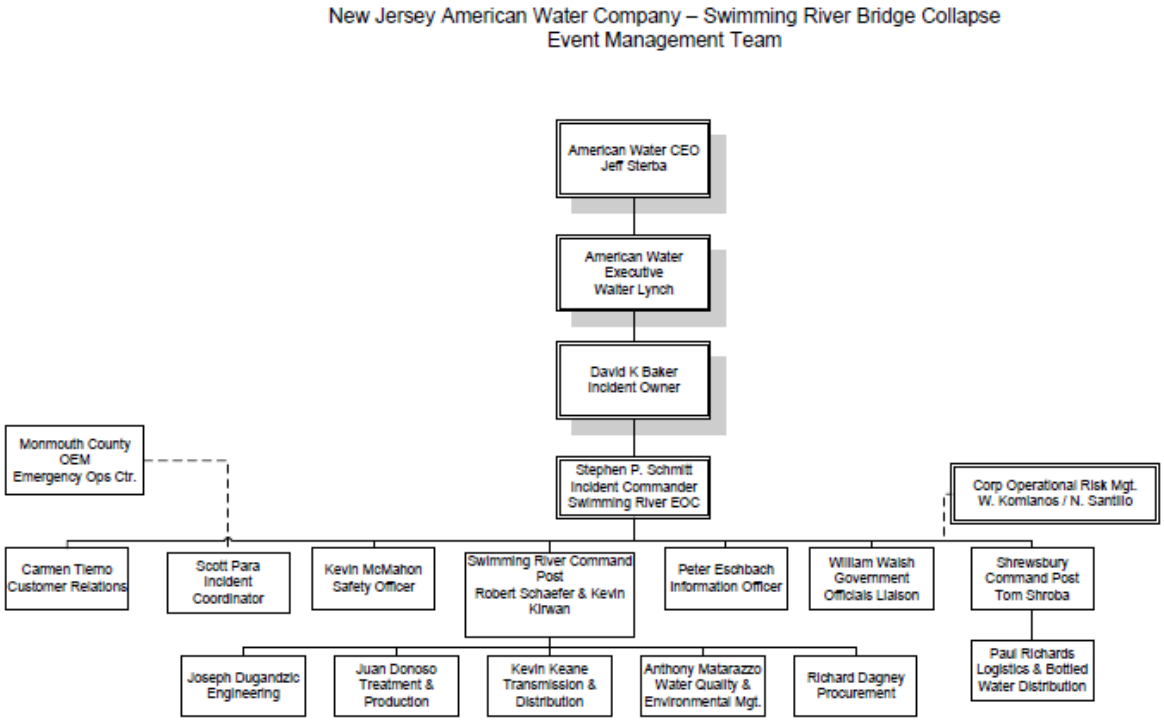
- The liaisons with regulators were: David Baker and Steve Schmitt for BPU; Anthony Matarazzo for DEP; Peter Eschbach and Richard Barnes for media; and Bill Walsh and Kevin Watsey for external stakeholders which include State, County and local government officials
- Managing the management of the incident: Bob Schaefer
- Managing the implementation of the IAP: Bob Schaefer for Water Production; Kevin Kirwan for Water Distribution; Joe Dugandzic for Engineering; and Anthony Matarazzo - Water Quality
- Liaison between local and corporate Incident Management Teams: Steve Schmitt.

Additionally, Nick Santillo and Scott Para from NJAW's Operations Risk Management Department served as NIMS liaisons.

This incident was a County-declared emergency, and NJAW employed around the clock staffing and were in constant communication with the Monmouth County Office of Emergency Management (OEM) and their Emergency Operations Center in Freehold.

[2] Instead of an IAP, NJAW uses an "Event Log" file which serves as the planning and tracking sheet for their event action plan.

FIGURE 4
SRWTP Pipe Bridge Collapse Event Management Team



4.2.2 Restoration of Operations and Service

The chronology of NJAW's activities in response to the pipe bridge collapse is shown in Table 1. Concurrent activities by NJAW's Event Management Team, supported by other staff included isolating the severed pipelines, reconfiguring the flow scheme to minimize pressure loss, mobilizing portable pumping equipment, notifying wholesale customers to reduce dependence on NJAW's supply, notifying customers and regulatory agencies, and working with vendors to rapidly procure pipe and other materials to install a bypass pipelines around the severed mains.

TABLE 1
Pipe Bridge Collapse Response Log

Date	Time	Activity
6/29/2012	12:45 PM	The system operator at the Swimming River Water Treatment Plant (SRWTP) detects a sudden change in plant operating conditions. Per protocol the Plant Supervisor is contacted and the emergency plan enacted. Inspection confirms the failure of the timber pipe bridge and operators proceed to shut down pumps and chemical treatment at SRWTP.
	1:00 PM	Crews dispatched to isolate the transmission mains and to Newman Springs Pump Station (NSPS) to reconfigure pumping to divert water from main service to Middletown pressure zone.
	1:00 PM	Portable pumping equipment is mobilized to the Swimming River plant from other NJAW facilities and contractors.

TABLE 1
Pipe Bridge Collapse Response Log

Date	Time	Activity
	1:00 PM	Production rates at jumping Brook and Oak Glen Water Treatment Plants are increased.
	1:15 PM	Shorelands Water Co. contacted and asked to curtail usage being delivered by NJAW.
	1:15 PM	Water transfers from Shorelands Water Co. and Marlborough Township to NJAW are activated.
	1:15 PM	Transmission mains isolated and NSPS reconfiguration to divert pumping to Middletown pressure zone complete.
	1:30 PM	First internal conference call is initiated. Operations and engineering staffs begin developing emergency measures to restore delivery of raw and finished water from the plant. Bulk sale customers are notified and curtailed. Notification to NJDEP, NJBPU, State & Local Officials commences.
	2:45 PM	A boil water notice is issued to affected customers in 22 Monmouth County communities. Customers served in the immediate area of the pipeline failure would have lost pressure prior to the main being isolated and NJAW was not sure of the potential for broader system impact at this point especially due to anticipated high system demands due to weather and holiday influx of seasonal residents and visitors.
	3:00 PM	NJAW arranges for delivery of bottled water supply and tankers to Monmouth service area.
	5:30 PM	Drafting commences from the Swimming River reservoir begins using portable pumps directly into the treatment plant.
	6:00 PM	Monmouth County OEM declares a state of emergency calling for ban on outdoor water use and water conservation for all county residents.
	10:00 PM	Engineering and Operations continue with emergency pipeline options. Raw water pipeline is critical to recovery – after a nationwide search US Pipe is authorized to expedite shipment of 1,000' of 36" restrained joint pipe from its foundry in Bessemer AL. This pipe had been manufactured for another Utility but was redirected to NJAWC due to the emergency.
6/30/2012	12:00 AM	Main service pressure zone is stable and Middletown pressure zone is below normal but holding as indicated by tank levels. Concern is the anticipated early AM automatic sprinkler load. Operational decision made to preserve ground storage tank volumes for emergency use – i.e. do not start pumps to meet irrigation load.
	8:00 AM	Water distribution centers are opened at three locations designated by Monmouth County OEM (Oceanport, Middletown High Schools - North and South).
	8:30 AM	As anticipated, automatic sprinkler irrigation load begins around 3 AM and places high demand on system. Main service is able to meet demand but higher elevation of Middletown (Navy Tank) is not and tank empties and system loses pressure over the next 5 hours with the tank recorded as having no water at approximately 8:30 AM.

To alleviate the impact of the boil advisory NJAW worked with Monmouth County OEM to establish three bottled water distribution centers (Oceanport, Middletown High Schools North & South). Over the course of three days more than 50,000 cases of bottled water were procured and distributed to the community. Direct deliveries to nursing homes and elder care facilities were made. Also, NJAW dispatched Water Quality personnel to the Monmouth County Hospitals to conduct on-site water quality testing. This testing allowed the hospitals to continue normal operations without patient impact due to the precautionary boil order advisory. By July 1, 2012, two days after the collapse, the precautionary boil water advisory had been lifted for 18 of 22 communities served by the SRWTP. By July 2, 2012, the precautionary boil water advisory was lifted for all communities, and the emergency raw water supply to SRWTP was brought to 42 percent of capacity. On July 4, 2012, a 36-inch raw water pipeline was placed into service restoring the SRWTP to its full capacity, and allowing the emergency supply to be curtailed. On July 5, 2012 a 24-inch pipeline to NSPS is placed in service. The following day, July 6, 2012, a 24-inch pipeline to the Middletown Gradient is placed into service and all customers were reported to have full service and fire suppression service was restored to normal conditions, seven days after the collapse. On July 9, 2012, the County lifted the state-of-emergency.

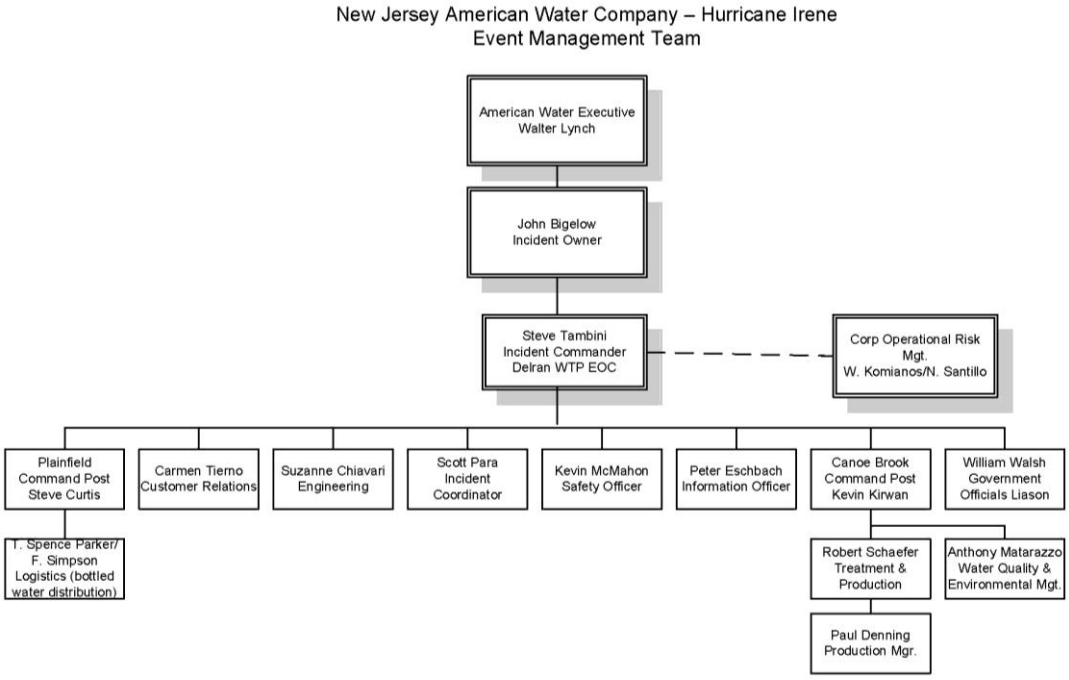
Communications throughout the incident response was handled as part of the event management process. A situation report was provided to the SRM Team as a sample of the daily communication that was being widely circulated both internally and externally with the BPU, DEP and the County OEM, as well as with other affected parties. Several communication vehicles were used including NJAW's Webpage, Facebook, press releases, reverse 911 calls to residents, and daily email updates to regulators and local officials. There was also frequent interaction with the County Information Officer and the County OEM. Additionally, interviews of NJAW officials were broadcast on both TV and radio.

4.3 Hurricane Irene Efforts

4.3.1 Hurricane Preparation

NJAW began preparations for Hurricane Irene during the week of August 22, 2011. Following American Water's Incident and Event Management Practices document, as described in Section 4.2 of this report, NJAW established an Event Management Team. The organizational structure for that team is shown in Figure 5.

FIGURE 5
Hurricane Irene Event Management Team



The Event Management Team was led by an American Water executive, supported by an Incident Owner from NJAW and an Incident Commander also from NJAW. The other members of the Event Management Team include a Safety Officer, an Information Officer, a Government Officials Liaison, a Customer Relations Officer, an Incident Coordinator and other staff specialists needed to manage the event. In the days prior to Hurricane Irene's landfall at Little Egg Inlet, the team participated in Event Management Conferences with utilities in other states.

The Event Management Team focused their operations in a designated room and maintained the IAP on a whiteboard. Communications between NJAW and the State Emergency Operations Center, other state agencies, municipalities, and electric utilities were maintained throughout event preparation as well as during and after the event.

On August 26, 2011, two days prior to the hurricane's landfall in New Jersey, NJAW issued communications to customers to prepare for the hurricane by taking steps such as filling bathtubs and other containers, conserve water, and to close their main water shut off valve if they are asked to evacuate their properties. The communications also assured its customers that they are taking the necessary steps to prepare for the potential impacts of the hurricane and that they will restore service as soon as possible should service be interrupted. They

also said they would keep customers informed as best as possible and provided the address for their Website and their Facebook page.

4.3.2 Hurricane Irene's Impact

On the day of the hurricane, August 28, 2011, NJAW issued a press release, "asking residents and industrial customers to reduce water use while the company deals with flooding, power losses and communications issues at several of its water treatment plants and pumping stations."

Many of NJAW's facilities and systems were impacted by Hurricane Irene. The Canoe Brook Water Treatment was flooded and several other facilities lost power, temporarily disrupting supply and resulting in the issuance of a boil-water advisory affecting nearly 47,000 customer, there was some flooding at the Raritan –Millstone WTF, and some damage to various structures.

The SRWTP, however, did not lose power and was able to maintain full service throughout the hurricane and post hurricane period. However, as presented in other sections of this report, the SRWTP pipe bridge was inundated and sustained damage as identified through subsequent inspections.

4.3.3 Post-Hurricane

During the months of October and November 2011, NJAW conducted an After-Action Review (AAR) of the activities it took to prepare and respond to the hurricane and its impacts. The AAR process also complies with American Water's Incident and Event Management Practices. The final AAR report was completed in December, 2012 and titled, "*Swimming River Pipe Bridge Event Recovery After-Action Review"*.

The AAR process included a review of the NJAW's activities around the storm including survey of employees on how NJAW performed. Topics posed to NJAW's employees included:

- Equipment and Asset Performance
- Event Planning and Preparation
- Customer Needs and Issues
- Communication
- Environmental Issues and Water Quality
- Workforce Management
- Labor Availability
- IT Issues
- Procedures - including Availability, Relevance and Adherence
- Event Management Coordination
- Health and Safety Issues or Concerns
- Roles and Responsibilities
- Organizational or Cultural Issues that impacted Performance
- Contractor's availability, performance and communications

Results of the survey, indicated that the vast majority of employees felt the Company performed well:

- 90% of employees rated their local management team's planning for the event as "excellent" or "good"
- 100% of employees rated their local management team's actions during and after the event as "excellent" or "good"
- 88% of employees rated the state-level management team's planning for the event as "excellent" or "good"
- 92% of employees rated the state-level management team's actions during and after the event as "good" or "excellent"

The AAR report also identified several positive outcomes under the categories of:

- Customer Impacts
- Operational Impacts
- Event Management
- Internal Communications

- Employee Impacts
- External Communications

As well as numerous lessons learned and opportunities for improvement under the following categories:

- Event Management
- Planning and Preparation
- Assets and Equipment
- Water Quality
- Customer Service
- Communications, External and Internal
- Workforce Management
- Information Technology

4.4 Review of Post-Irene Pipe Bridge Initial Inspection and Decision for Continued Use

The SRM Team reviewed the details of NJAW's post-Hurricane Irene inspection that led to the determination that the SRWTP pipe bridge was fit for continued use.

Although the SRWTP pipe bridge was submerged in the runoff water from the reservoir spillway, the bridge and the three water mains that it carried remained functional, albeit damaged, as a result of the flood waters that resulted in the days after the hurricane.

AW's Business Center Technical Services (BCTS) engineering staff conducted an initial investigation and conducted an on-site damage inspection one day after the hurricane on August 29th and another (by boat) on August 31st after the flood waters had receded. Initial findings of the preliminary damage inspection were revealed in the BCTS Preliminary Inspection Report dated September 20, 2011. The report was presented on September 28, 2011 to NJAW staff and HMM during a meeting at the SRWTP, which was followed by a site visit attended by BCTS, NJAW and HMM. The report stated that with regard to the pipelines there was no evidence of leakage on the pipelines, that there were rotations at coupling joints but they were within manufacturers' tolerances, that the hold down straps were in need of minor repair, and that there was no evidence of cracking of the concrete pile caps.

While there was evidence of some structural issues in pipe support system reported (which are discussed in detail later in section 4.5.1.1), the BCTS investigation team did not find that the bridge was in imminent danger of failure in the near term and thus no emergency condition was identified in the preliminary Inspection report. Additional investigations to assess the extent of the damage were recommended in the BCTS report, including a topographic survey and underwater inspection of the bridge support piles. The BCTS report included repair recommendations as well as a recommendation that a review of alternatives to the pipe bridge should be considered.

Because no one had raised the condition of the bridge to an emergency status, the pipeline and pipe bridge although recognized to be somewhat damaged, remained in service pending further investigations and alternative analyses for repairs or replacement. A hard deadline for repair or replacement was not set. The SRM Team interviews revealed that the consensus among HMM, NJAW and BCTS was that repairs needed to be completed before the next "storm season" further defined by some interviewed to be sometime before August 2012. (The SRM Team investigated this further and found that the NOAA Atlantic Hurricane Season runs from June 1 through November 20, but as demonstrated by the 2005 season which included including Hurricane Katrina, this time frame can vary. For New Jersey, the *peak time* for hurricanes and tropical storms typically runs from mid-August through the end of October).

4.5 Review of NJAW's Post- Irene Pipe Bridge Damage Assessment and Implementation Plan for Repairs

The SRM Team, which included two maritime structural engineering specialists, reviewed reports and emails, and conducted interviews to evaluate NJAW's: 1) assessment of the damage to, and condition of, the SRWTP pipe bridge; 2) inspection and plans for necessary repairs to the pipe bridge; 3) monitoring protocol; and 4) to determine if NJAW acted prudently from an engineering and utility operating perspective to develop and implement a project(s) to complete repairs in a timely fashion.

4.5.1 Inspections, Damage and Condition Assessment

In order to assess the damage to the pipe bridge after Irene, four investigations/assessments were conducted: one by the BCTS group, a second by BCTS with support from TNJ, another by HMM, and a fourth by Wiss, Janney, Elstner Associates, Inc. (WJE). The BCTS and WJE reports were reviewed by the SRM Team and the following subsections of this report provide some details regarding these reports. The SRM Team also reviewed HMM's report, and HMM's investigation is presented in subsection 4.5.2.

4.5.1.1 American Water BCTS Assessment

Part I - Preliminary Inspection Report

AW's BCTS engineering staff conducted an initial investigation of the pipe bridge beginning one day after Hurricane Irene. They reported their findings in a preliminary report entitled, "Swimming River Pipe Bridge Damage – Preliminary Report" dated September, 2011 prepared by Javier Jimenez, P.E., a structural engineer with BCTS. This was the first of a three part inspection report.

This initial report lists the following findings:

- No evidence of leakage on the pipelines;
- Rotations at coupling joints but within manufacturers' tolerances;
- Supporting cradles in good condition;
- Minor repair needed of hold down straps;
- No evidence of cracking of the concrete pile caps;
- 60% of piles exhibit shift / displacement;
- Evident failure of one pile (Pile 5A West);
- Severe rotation of pile caps 5A and 6B;
- Seven pile caps exhibited rotation

Mud-line profiles below the bridge in 1971, in 1991 and in 2011 were also presented in this report. These three profiles indicate scour over a forty-year timeframe and loss of embedment length for most of the piles which indicate a significant loss in strength.

Part II – Underwater Inspection

Part II of the BCTS inspection report was the Underwater Inspection Report. This part of the report was written by Javier Jimenez, P.E. of AW and it included the observations made by TNJ Marine, Inc, who supplied commercial divers. The commercial divers performed the actual underwater inspection, and conveyed their observations to Mr. Jimenez. This report contains a thorough summary of inspection findings, listed in tabular form, of each pile inspected. This report lists cracking, crushing and brooming in pile 4B West and the failure of Pile 5A West.

The report also contains the visual and tactile observations of TNJ Marine, Inc. TNJ Marine was engaged by NJAW to perform the underwater inspection of the bridge pilings because they were already onsite to perform maintenance cleaning of the bar rack at the intake to the SWRTP raw water pump station. BCTS and NJAW took advantage of having a dive team available onsite to obtain, in the quickest possible way, a verbal description of conditions under the water surface. TNJ Marine was not engaged for structural evaluation purposes. Rather, they served the "in-water eyes and ears" to help BCTS provide NJAW with a more complete preliminary structural evaluation of the bridge.

Although TNJ diver observations are noted in the report, no formal report was prepared by TNJ Marine. Our review revealed that no recommendations or conclusions were given to NJAW by TNJ marine. TNJ provided commercial divers to visually inspect the bridge's underwater portions by means of purely visual and tactile methods and did not utilize tools or measuring devices.[3]

[3] Turbid conditions in the water prevented the use of underwater video for the inspection.

TNJ Marine, Inc. is an underwater inspection service that provides underwater commercial divers for a multitude of underwater services, including maritime construction inspection, below water ship hull condition inspection, and similar services. TNJ does not employ licensed professional engineers. As such, they are qualified to inspect and report on underwater structural conditions but they are not licensed to provide engineering analysis or recommendations on their findings. Their assignment was merely to inspect and report their findings.

The results of the underwater inspection, which was set forth in Section II of the BCTS Preliminary Inspection Report, are summarized as follows:

- Apparent failure of Pile 4B West below the waterline due to flood damage as evidenced by "brooming";
- Vertical settlement on pile 5B east as evidenced by diagonal brace damage and soil disturbance;
- Superficial structural damage and/or minor longitudinal cracks;
- Evidence of Collision and impact damage that was categorized as "Non-severe";
- Limited number of shallow splintered/delaminated areas;
- Significant diagonal bracing damage in the mid-third part, most tensional and/or rotational; one in compression;
- Evidence of scouring.

In the BCTS presentation made on September 28, 2011, the Preliminary Inspection Report results summary states that there is a *"Confirmed failure of one of the piles and imminent risk of failure in three other piles"* and presents recommendations to *"Repair 4 partially or completely failed piles by temporary jacking or crane support of pile cap and insertion of a sound timber section with sleeve clamps."* This statement reflects that the BCTS (internal engineering staff) recommended the repair of four damaged and/or failed piles in September 2011.

Part III - Evaluation of the Load Capacity of the Piles

This report section is part 3 of "Swimming River Pipe Bridge Damage – Preliminary Report" dated September, 2011 and is a study of the lateral load on the timber piles of the pipe bridge as performed by BCTS engineering staff. The report concludes by stating that eight of the timber piles of the bridge are overstressed.

4.5.1.2 Wiss, Janney, Elstner Associates, Inc. Assessment

Wiss, Janney, Elstner Associates, Inc., (WJE) a firm who undertake forensic structural engineering investigations, was retained by NJAW's Insurance Company, GAB Robbins Executive Loss Adjusting (A division of Cunningham Lindsey). Andrew Osborn, P.E. of WJE, visited the pipe bridge site on September 16, 2011. His observations included the fact that several wooden piles were fractured. Mr. Osborn does not give a firsthand reporting of the locations, number or magnitude of the cracks; rather, he relies on the in depth inspection of the affected piles included in the BCTS report.

On Page 2, under WJE Observations, the report states:

> *"Fractures occurred at several wood piles (Figure 8). Mr. Jimenez had inspected the piles close up from a boat and had reportedly discovered apparent damage at eight piles, representing about 20% of the total. He marked those locations on a plan view drawing of the bridge (Figure 9). He also showed us an investigative report of the damages written by him. We asked for a copy of any reports and drawings. None have been provided to us to date."*

Mr. Osborne states under "Discussion and Conclusions" of the report that his recommendation is to restore the bridge to its "Pre-loss condition."

His recommendations include the statement:

> *"The damaged timber piles can be repaired with polymer or stainless steel wrapping meant for underwater use. A set of drawings and specifications for pile repair published by Master Builders is presented in Appendix A. There are potentially eight piles that would need repair. Replacement of*

damaged piles is not economic because that would require replacement of the pile cap girder and temporary removal of pipe sections."

4.5.2 Recommended Repairs by HMM

As a result of NJAW's review of the BCTS inspection report findings and its own ongoing asset planning process, and ongoing discussions between NJAW and HMM, HMM submitted proposals for bridge repairs and for the development of long-term alternatives to the pipelines on the pipe bridge on October 5, 2011. NJAW issued two Task Orders to HMM on October 6, 2011 (for the repair work) and November 9, 2011 (for the long-term alternatives work). Agreements between NJAW and HMM for two separate tracks of work were then finalized. The scope of the repair work was set forth in the HMM proposal and corresponding task order issued under the pre-existing Master Services Agreement between NJAW and HMM, dated December 6, 2006. HMM proposed to provide engineering services for immediate repair design and details for repairing the existing bridge; the repair project proposal, approval, staffing and timeline was separate from the project for the development of long term alternatives to the existing bridge structure. The time period for HMM to perform the repair project tasks under the original task order began on October 6, 2011 and ended on October 6, 2012; the long-term alternative study project began on November 9, 2011 and had an initial delivery date of March 9, 2012.

In November 2011 BTCS reviewed the interim structural repair preliminary report submitted by HMM. The HMM report presented two options for repairs to the pipe bridge and pipelines. The first option (Option #1) included recommendations for encasing four of the most severely damaged piles, replacement of the diagonal bracing, upgrading the Dresser couplings, and replacing the timber siding of the bridge. The second option (Option #2) included all of the work proposed in Option 1 and proposed additional work designed to restore the bridge to its pre-Irene condition, including the full encasement of all timber piles with concrete (42 piles total), replacing the timber diagonal pile bracing with steel framing members, driving additional piles, adding lateral bracing, and upgrading the Dresser couplings. After reviewing the options proposed by HMM and considering the potential time frame for long-term alternatives to the pipe bridge to become a reality, BCTS and NJAWC advised HMM that NJAWC would pursue Option 2 as the pipe bridge repair project; HMM provided a formal proposal for that work to NJAWC on November 28, 2011.

In January, 2012, HMM issued its final report (Swimming River Timber Pipe Bridge Interim Structural Repairs, Final, January 12, 2012).The report cited all information from NJAWC and BCTS requested by and provided to HMM for their use, including:

- 1991 Killam Associates Inspection;
- AW BCTS Engineering Division August 2011 Inspection[4];
- AW BCTS/TNJ Marine Underwater Inspection[5].

This final report is similar to the preliminary report issued in October, 2011 for review and comment, and cites the same information requested by and provided to HMM for their use and information, which were the 1991 Killam Associates inspection report, the AW BCTS Preliminary Inspection Report dated September 23, 2011 (Parts 1 and III) and the AW BCTS and TNJ Marine Underwater Inspection Report (Part 2 of the September 23, 2011 Preliminary Inspection Report.)

4.5.2.1 Options for Repairs

The HMM final report provides a list of suggested repairs and associated costs, and compiles these into two options. These options are summarized below:

Option #1

- Pipelines: Installation of a Dresser Style 440 Joint Harness or Smith-Blair Harness Assembly in accordance with AWWA Manual M-l I. Removal of all deteriorated coating and rust from isolated areas and recoat rusted areas

[4] Parts 1 and 3 of the BCTS Preliminary Inspection Report, September 23, 2011

[5] Part 2 of the BCTS Preliminary Inspection Report, September 23, 2011

with bituminous coating. Remove all deteriorated coating on Dresser couplings and recoat couplings. Hold down straps that are loosed and not tightened against the pipe should be retightened.

- Pile Support System: Install reinforced concrete encasement of the four severely damaged piles, replacement of diagonal bracing between pile bents 4A & 9A, replacement of missing lag screws at two pile bents and continual monitoring of pile supports and pile caps for signs of settlement.
- Timber Deck: Replace all upstream siding, remove all downstream 7' long lumber and replace downstream siding with 5' long lumber. Install new 2" x 8" joists spanning from pile cap to pile cap, and replace all timber decking with new 2" x 6" pressure treated lumber.
- Handrails/Fencing: Replace existing handrail system to meet OSHA standards, replace existing fencing at north and south ends of bridge with operational gates for access by authorized personnel.

Option #2

Recommendations for the pipelines, handrails and fencing for Option #2 were the same as Option #1. Recommendations for the pile caps and piles for Option #2 included the full encasement of all timber piles, replacement of timber cross bracing with steel bracing, installing additional piles to provide redundancy, adding longitudinal steel framing to support a pile cap in the event of a pile failure, and adding lateral steel framing in order to provide lateral bracing of the pile caps.

4.5.2.2 Discussion of Options

As a result of HMM's Report, a series of internal emails were exchaned among AW personnel. In an email dated November 7, 2011, BCTS recommended Option #1 due to their awareness that NJAWC was simultaneously considering long-term alternatives to the pipe bridge and pipelines. This email reads,

> *"This alternative provides immediate stabilization of the most significantly damaged structural elements of the Bridge."*

In a memorandum dated November 7, 2011, Javier Jimenez and Peter Keenan of BCTS wrote:

> *"American Water Corporate Engineering recommends Option 1 as the short term mitigation approach until a permanent solution can be implemented. This alternative provides immediate stabilization of the most significantly damaged structural elements of the bridge and should be sufficient to prevent catastrophic failure absent a future flooding event. Option 2 would further reinforce the structure, but it is not clear if it would significantly prolong the life of the bridge. NJAW is currently evaluating several long-term options for retaining or replacing these pipelines. If the long term recommendation is to retain the structure for an extended period, i.e. greater than three years, then the Option 2 reinforcements would be recommended."*

There was subsequent e-mail correspondence exchanged between Joe Dugandzic, P.E., Engineering Manager for NJAWC and Javier Jimenez of BCTS on November 10th, 11th, and 13th, wherein Joe Dugandzic proposes Option #2 as potentially being a more appropriate interim solution because of the possibility that a project to completely replace the bridge pipelines could take several years to complete. In his November 13th e-mail response, Joe Dugandzic also stated the following:

> "*I believe that we all are in agreement that we proceed with Option 1 now to make all repairs that we can, as soon as we can, to minimize further damage to this asset. It is my understanding that we can make repairs to an existing structure without any significant environmental permitting. NJAW will engage an Environmental Consultant to verify this claim. We will also discuss driving additional angled piles "outboard of our structure" as proposed in Option 2 to identify if there are implementation obstacles."*

HMM was advised shortly thereafter that NJAWC wished to implement Option 2. Based on the correspondence discussed above, it appears that the original repair recommendations offered by HMM in their Interim Report of October 14, 2011 were still understood by NJAWC as being able to be constructed without the need for permits. By November 28, 2011, HMM had performed sufficient preliminary design work to be able to provide NJAWC with a formal proposal for "Phase I" of the repair project, consisting of the repair work originally outlined by HMM as

"Option 1". The HMM proposal clearly anticipates the Phase I work being performed in a "fairly quick manner" without the need for permits, as opposed to the Phase II work referred to in the November 28, 2011 HMM proposal and is discussed in more detail in Section 4.5.2.4 of this report.

4.5.2.3 Classification of Timber Pile Damage/Conditions

Throughout the numerous inspection efforts by the above mentioned firms, it is noteworthy to summarize the condition of the timber piles prior to and in the aftermath of Hurricane Irene.

In HMM's preliminary (October 14, 2011) and final (January 12, 2012) reports, HMM refer to the BCTS August 29 and 31, 2011 inspections, as well as the September 16, 2011 BCTS/TNJ Marine inspection; the September 23, 2011 BCTS Preliminary Inspection Report; and the September 28, 2011 Preliminary Inspection Report presentation by BCTS to NJAWC and HMM at the SRWTP. HMM's reports, preliminary and final, reiterate the BCTS observations, stating, "One evident failure of pile (5A West)." However, in their "Conclusions and Summary" section of the report, HMM recommended, "Reinforced concrete encasement of four severely damaged piles," without making reference to any pile as "evidently" failed or apparently failed, as described in the BCTS report. Hence, the severity of the condition of Pile 5A West is apparently downgraded from a previous classification of "evidently failed pile" to "severely damaged pile."

Also, in the above mentioned reports by HMM, in section 2.2.3 TNJ Marine, inc. (August 2011 Inspection[6]) in both the preliminary and final reports, under observations, it states,

> *"Apparent failure of pile 4B west below the waterline due to flood damage as evidenced by 'Brooming.'"*

The significance of the above is that HMM was given reference information of two previous inspection efforts, both from the BCTS inspection and from the BCTS/TNJ Marine's underwater inspection that one pile was "evidently failed" and one was apparently failed. The condition of these two piles is apparently downgraded to "Severely Damaged" when HMM completes its reports. HMM did not offer an explanation for this apparent change in the way the condition of these two piles was described.

4.5.2.4 Prioritization and Packaging of Repair Options

In the aftermath of Hurricane Irene, the repair project moved through NJAWC project funding and approval processes without delay. However, the scope and timing of the repair work being considered for the pipe bridge changed over the course of the major project milestones and those changes tended to elongate the project timeline rather than compress it. Those major milestones included: the initial repair recommendations made by the BCTS in the September 23, 2011 Preliminary Inspection Report and September 28, 2011 presentation; the repair options presented by HMM in their October 14, 2011 Interim Assessment and Repair Report; the consideration of repair options and choice of Option 2 by NJAWC and BCTS in mid-November, 2011; the decision to break the repair project up into Phase I and Phase II memorialized in the HMM Phase I project proposal; the impact of the discovery of the need for permits for virtually all of the repair work, including the impact of permitting on the timing of the repairs; the addition of temporary cross-bracing to the project design; and other constructability issues.

American Water's BCTS Option Preference

In HMM's Interim Structural Repairs report of October 14, 2011, a variety of repairs were recommended and presented as Option 1 and Option 2. Option 2 included all of the work proposed in Option 1. The HMM report indicated that the Option 1 repairs may not require permits, while most of the Option 2 work would require permits. In a memo of November 7, 2011 from BCTS to NJAWC, BCTS recommended Option #1 as presented in HMM 's interim report. Option #1 included the repair of the "Four most significantly damaged structural elements." After consideration of Option 1 and Option 2 by BCTS and NJAWC (see Section 4.5.2.2. above), NJAWC advised HMM to submit a proposal for repairs to the SRWTP pipe bridge that incorporated both Option 1 and Option 2. Please note that Option 2 included all design elements that were included in Option 1 and some additional repairs. In general, Option #2 included the full encasement of all timber piles, replacement of timber

[6] As noted elsewhere, the BCTS/TNJ Marine inspection was conducted on September 16, 2011.

cross bracing with steel bracing, installing additional piles to provide redundancy, adding longitudinal steel framing to support a pile cap in the event of a pile failure, and adding lateral steel framing in order to provide lateral bracing of the pile caps.

On November 28, 2011, HMM submitted a proposal to AW for the preparation of professional engineering services for "Phase 1 – Interim Structural Repairs."

The proposed scope of work for Phase 1 repairs included:

- Construction of restrained harnesses at each pipe joint (30 total);
- Concrete encasement of (all) existing piles (42 total);
- Steel diagonal bracing of existing piles.

In the proposal, there is mention of Phase II work to be the subject of further correspondence at a later date. The design work was divided in two phases based on environmental permitting requirements. The HMM proposal for Phase 1 mentions permitting requirements for Phase II work, but there is no mention of permitting requirements for Phase I work. In December, 2011, NJAW recommends the issuance of a Task Order authorizing HMM to proceed with Phase I repair design work. As HMM was in the process of designing Phase 1 repairs, HMM and NJAW learned from the New Jersey Department of Environmental Protection (NJDEP) in February 2012 that certain repair activities included in Phase 1 design would require environmental permitting from the NJDEP. The permitting timeline is further discussed in Section 4.5.2.5.

The final design drawings for the Phase 1 Repairs, dated May 1, 2012, include upgrades for the pipe harnesses, repairs to the concrete pedestals on top of the pile caps that support the walkway stringers, and replacement of diagonal cross bracing of pile bents 4A, 4B, 5A, 5B, 6A, 6B, 7A, 7B, 8A, 8B, and 9A.

It is noteworthy that the repair of the damaged piles themselves, initially recommended by HMM in their Option #1 scope dated October, 2011 as in need of repair (consistent with the preliminary report prepared by BCTS in September, 2011) is not included in the final design drawings for the Phase 1 Repairs as designed and recommended by HMM because these repairs, along with the cross bracing repairs, temporary bracing and other structural repairs were all subject to permitting requirements as discussed above and were therefore shifted to Phase II.

Although no written correspondence appears to explain the absence of pile repairs as part of the final Phase 1 scope, the original Phase 1 design submission made by HMM on January 31, 2012 did include details for concrete encasement of the damaged piles along with steel diagonal bracing. The subsequent Phase 1 design submission that was made on March 23, 2012 excluded the concrete encasement, and showed timber diagonal bracing details in lieu of the steel bracing system included in the original January submission. The decision to move the concrete encasement and diagonal bracing work from Phase I to Phase II came after HMM advised NJAWC that HMM had received feedback from NJDEP that installing the proposed concrete timber pile encasements required permits.

4.5.2.5 Permitting Issues

HMM's October, 2011 and January, 2012, Interim Structural Repairs Engineering Study Reports, both contained the following language regarding permits,

> *"The existing structure is in the Waterfront Development and Flood Hazard Zones regulated by the NJDEP Land Use Regulation Program (LURP). The flood hazard regulations provide for a "permit by rule" exemption for repairs to lawfully existing structures (N.J.A.C. 7:13-7.2b(4)). Further clarification can be obtained by submitting an applicability determination to the NJDEP LURP. Although there is an exemption for redecking bridges in the tidal zone under the Waterfront Development program, the bracing and pile repairs appear to require permits, as they do not meet the strict repair exemptions under the Waterfront Development regulations. Since the structure is within 500 feet of the tidal waterway, a full application may be required for any additional repairs beyond the redecking. The application fee for the individual Waterfront development permit is in the range of $15,000 to $20,000. Significant documentation and*

> *project justification, in addition to environmental impact statements are required for the individual permit application"*,

In the January, 2012 document HMM also stated,

> *"Phase 1 repairs consist of addressing the structural elements, in a quick manner, to provide immediate stabilization to the bridge without the need of permits. Phase 2 repairs will consist of repairing the damaged sections, restoring strength to the remaining piles, cross bracing, and providing support and stability between pile caps; this will include obtaining permits as summarized in Section 3.0."*

This statement appears to be in conflict with the verbiage above which states that the bracing and pile repairs appear to require permits.

On February 21, 2012 HMM advised NJAW in an email from Edward Gajek, P.E. of HMM to Adam Kane of NJAWC, of the need of a Waterfront Development Permit due to the proposed encasement of the damaged piles. HMM was in communication with the NJDEP and the NJDEP was aware of the condition of the bridge. HMM anticipated an expedited review by the NJDEP in order to acquire the required permits. The significance of this date is the fact that nearly six months have elapsed since Hurricane Irene and the first dialogue begins with the NJDEP on the necessity of a permit to perform structural repair work that was caused by a catastrophic event.

After receiving a notification from HMM that a Waterfront Development Permit would be required for Phase 1 structural repairs, NJAW engineers discuss the LURP application and that a 90 day review period will be required in their in February 2012 monthly engineering call. NJAW also decided to revise the scope of work for Phase 1 to eliminate the items that required environmental permitting and the new Phase 1 scope mainly included installation of joint harnesses.

On February 28, 2012, HMM advises NJAW that they are planning on having the permit application completed by the end of March and will include permit applications for Phase 1 (for items eliminated from original Phase 1) and Phase 2 work. Based upon the anticipated turnaround time for the permit (approximately 90 days), Edward Gajek anticipated a combined Phase 1 / Phase 2 bid date of May/June 2012.

On March 12, 2012 Adam Kane of NJAW forwarded a check in the amount of $30,000 to Edward Gajek of HMM payable to the "Treasurer, State of New Jersey" as a payment for NJDEP's review of the Waterfront Development permit application package for Phase 1 (for items eliminated from original Phase 1) and Phase 2 work.

On Wednesday, April 4, 2012, in an email from Edward Gajek of HMM to Kara Turner of the NJDEP, Edward Gajek informed Ms. Turner that a permit application will be forthcoming that week. Mr. Gajek references prior discussions between Ms. Turner and Robert Lin of HMM concerning the critical nature of the bridge and the possibility of pile failures without the repairs. Hence, HMM is in agreement that pile repairs are necessary immediately but proceeds in a course of action that includes all permit review and approval protocols. Alternatively, a more expeditious course of action could have been to recommend immediate repairs to the piles and request a waiver from DEP on obtaining the required permits as the bridge was in danger of collapse.

On June 7, 2012, the NJDEP issued a Permit for Waterfront Development and Water Quality certificate to American Water for repairs to the SRWTP pipe bridge.

NJDEP Tidelands License:

During the planning stage of the bridge repair project Phase 2, it was originally anticipated that a Tidelands License would be required for this project. On March 28, 2012, a "Tidelands License Application Form" was signed by Eric Hahn of NJAWC and it was submitted to the NJDEP on April 3, 2012.

On June 15, 2012, HMM provides additional supporting information for a Tidelands License from the NJDEP. A letter from the Freehold Soil Conservation District is included within this communication.

Soil Erosion and Sediment Control:

A letter requesting an exemption is sent from HMM, as an agent for NJAW, to the Freehold Soil Conservation District on April 17, 2012. On May 20, 2012, NJAW is notified by the Freehold Soil Conservation District that a permit from them is not required due to the fact that the size of the project is less than 5,000 square feet.

Army Corps of Engineers:

Permit application was submitted to the U.S. Army Corps of Engineers for Phase 2 Bridge Repair project. HMM and NJAW later learned that a U.S. Army Corps of Engineers permit is not required because the repair work was the direct consequence of a natural disaster.

4.5.3 Soil Investigation – French & Parrello (Long Term Alternatives Project)

A Subsurface Exploration and Geotechnical Engineering Evaluation was conducted by the geotechnical consulting firm of French & Parrello Associates, Consulting Engineers. French & Parrello who were retained by HMM as a subconsultant the long-term alternatives projects.

In their report, dated April 10, 2012, French & Parello state, "Our analysis indicate that the upper 13 feet of the soil profile, which includes the marine tidal marsh deposits and very loose to loose granular soils, should not be relied upon for the lateral support of pile foundations." While this work was not conducted as a part of the Phase 1 SRWTP pipe bridge work it does underscore the weakness in the materials supporting the bridge piles in general.

4.5.4 Ocean and Coastal Consultants Engineering Report

Since the pipe bridge's construction in 1971, the investigation by Ocean and Coastal Consultants Engineering, P.C. (OCC), performed in August, 2012, after the collapse of the pipe bridge, was the second attempt (first conducted by BCTS) to quantify service loads on the existing timber piles and to determine the load carrying capacity of the timber piles. Previous investigations by HMM and WJE did not provide any structural analysis, nor did they attempt to assess the load capacity of the timber piles.

OCC reported the results of several computer models of the pipe bridge structure[7]. Loads that are included in the various model scenarios include the load of the pipes, the load of the water within each pipe (assuming all pipes are completely filled with water), and the load of the concrete pile caps. OCC's analysis only included vertical loads, as other loads (e.g., wind, seismic, thermal, etc) were deemed to be inconsequential in the pipe bridge's failure on June 29, 2012.

OCC's report concluded that with a single pile removed, *"… the structure was found inadequate to safely support water-filled piping loads.*" The OCC report also states, *"The standing portion of the bridge was found to support current loadings with a factor of safety adjustment."* It can be inferred from this statement that factors of safety are less than acceptable factors of safety, thus the likelihood of failure of the standing portion of the bridge is greater.

The report also stated:

> *"Additionally, the geotechnical records indicate that the elevation of the mud-line along the northern half of the bridge is generally level and that the property of the soil are particularly poor in the upper 20 ft of soil, resulting in a significant increase in the depth to fixity and consequently the unbraced length of the timber piles."*

Overall, the OCC analysis confirmed that adjacent piles are overstressed due to the failure of a single pile. This confirms the inherent non-redundancy of the pipe bridge's initial design. By removing a single pile using the computer model, it is seen that adjacent piles are overstressed by the redistributed additional load and therefore, failure would be likely.

[7] The analysis prepared by OCC was based upon acceptable design standards for structural timber as promulgated by the American Institute of Timber Construction.

4.5.5 Monitoring Protocol and Project Management

A review of the project management including schedule and monitoring protocol for the identified repair projects was undertaken by the SRM Team. This was done in order to assess whether NJAW had developed an appropriate repair plan, and if NJAW acted prudently to develop and implement the projects and to complete repairs in a timely fashion.

4.5.5.1 Project Schedule

A review of key dates and events affecting the repair projects' schedule was undertaken by the SRM Team. The following is a snapshot of transpired from Hurricane Irene to the collapse of the SRWTP pipe bridge collapse.

Date Event	Milestone
08/28/2011	Hurricane Irene
08/29/2011	Preliminary Site inspection - AW/NJAW
08/31/2011	Site inspection - AW/NJAW
08/31/2011	Site inspection - Eric Ditchey (dam and spillway)
09/13/2011	Inspection/Remediation Report – AW
09/16/2011	Underwater Inspection - TJN Marine Inc.
10/14/2011	Draft Inspection/Remediation Report – HMM
01/12/2012	Final Inspection/Remediation Report – HMM
11/28/2011	Design Proposal submitted
12/21/2011	Signed Task Order for Design Services
02/09/2012	30% Design Review Meeting
03/27/2012	60% Design Review Meeting
03/29/2012	CPI performed thickness testing on water mains over bridge
04/04/2012	Waterfront Development Permit (LURP) submitted to DEP
04/04/2012	Request sent to DEP for emergency permit for repairs to existing piles
04/04/2012	Request for meeting sent to DEP to discuss project
04/10/2012	DEP response - permit will be expedited. No meeting required.
04/17/2012	Freehold Soil Conservation District Exemption Request Submitted
04/20/2012	Freehold SCD Exemption Certificate Received
05/09/2012	Pre Bid Meeting - Phase 1
05/17/2012	90% Design Review Meeting
05/30/2012	Phase 1 - Bids Due
06/04/2012	Joint Harness - Purchase Order issued
06/05/2012	Meeting with JCP&L to discuss moving of power lines for construction
06/06/2012	Kennon Surveying performed pre-construction survey
06/12/2012	Meeting with County to discuss traffic control / detour plans
06/13/2012	Notice of Award to Contractor - Phase 1
06/14/2012	Received NJDEP Waterfront Development Permit (LURP)
06/14/2012	Pre-Bid Meeting - Phase 2
06/29/2012	Pipe Bridge Collapse

Immediately following Hurricane Irene, NJAWC requested assistance from BCTS in inspecting and assessing the damage to the SRWTP pipe bridge. Once the flooding subsided, NJAWC coordinated inspections with AW BCTS and other contractors. Upon receiving and reviewing the BCTS Preliminary Inspection Report, NJAW immediately raised recommendations to evaluate and determine repairs to a Priority A status and identified Joe Dugandzic as Project Manager Supervisor, Eric Hahn as Project Manager (with support from Adam Kane). Mr. Dugandzic served in that role from January 2012 until February 2012 when he was replaced by John Travaglini as Supervisor due to an organizational restructuring. Mr. Dugandzic did remain involved as technical resources throughout the period and Eric Hahn continued as the project manager. Frank Cook was the Capital Program lead to make sure funds were available for repair or replacement work.

Project Management proceeded according to NJAW engineering procedures and funding was made available through the Capital Investment Management (CIM) process for the Phase 1 and Phase 2 project and the CIM Committee was kept apprised of the status of the projects on a regular basis. While there are project in-service dates in the governance documents that show the project, as approved, included a project delivery schedule that

might have met the August 2012 storm season deadline, no hard deadline appears to have been established for when Phase 1 should be completed other than before the next storm season.

4.6 Review of NJAW Governance and Capital Project Prioritization

A general review of NJAW's governance related to prioritization of capital projects was conducted by the SRM Team. This was done to assess whether an effective system was in place to enable the completion of the SRWTP projects including the repairs to the pipe bridge assets after Hurricane Irene, and to determine whether sufficient controls were in place to provide budgeted funds and to enable effective project timing. With regard to project funding and project approval (governance) as it relates to SRWTP pipe bridge, repair projects and funding were approved in a timely manner.

Much of the review focused on American Water's guidance documents for capital and business planning, supplemented by information gathered from interviews with the staff of American Water and NJAW, as well as written correspondence.

4.6.1 Capital Investment and Improvement Program

4.6.1.1 Asset Investment Strategy Guidance

NJAW follows American Water's document titled, Asset Investment Strategy Guidance for Business Planning. American Water employs a 5-year business planning cycle. The current Guidance document defines the capital investment strategy for the period 2012-2016 and provides the process for the development American Water's subsidiaries' (e.g., NJAW) capital plans. The current Guidance document is the ninth update of this document. It is modified on regular basis to accommodate industry dynamics.

The document defines capital investment as the key driver for meeting service needs of American Water's customers.

Of significance to the SRM Team's review were the following key messages in the document:

- The drivers that result in capital expenditures are clearly delineated;
- Guidance on prioritization of those capital expenditures is provided;
- The Company recognizes its limits on capital resources and that customers' ability to pay their water bills is not limitless;
- Areas where needs may have to be extended over a longer period in order to align with economic realities are addressed;
- The Company recognizes that when prioritizing allocation across states (i.e., their subsidiaries such as NJAW) and balancing capital needs, financial performance and rate impacts are important considerations.

Goals and targets that have been identified by the American Water Executive Leadership Team have been integrated into this document to provide guidance on the prioritization of capital project investments. Certain capital investments, it is stated, can effectively impact goals and targets and examples identified are:

- Plant improvements designed to meet water quality regulations minimize risk of notices of violation (NOV) and maximum contaminant level (MCL) violations;
- Projects to achieve energy efficiency which reduce the carbon footprint and improve operational efficiency;
- Replacement of deteriorated assets to reduce system outages and safety incidents to improve high customer satisfaction.

This last point is crucial to the subject of the pipe bridge failure and the resulting customer impacts.

The Guidance states that a 5-year look forward presents challenges for the Capital Investment Program (CIP) to meet existing needs with limited financial resources. Guidelines are provided in the document to optimize investment and prioritize projects.

Regarding the replacement of aging infrastructure, American Water notes that the industry as a whole faces significant capital investment needs to replace and expand aging infrastructure. The document contains the statement that, "Leadership recognizes that this replacement rate could impact their ability to provide long-term sustainable levels of service and to increase the replacement rate would make it difficult to maintain customer rates at affordable and cost competitive rates," and that achieving sustainability of the performance of AW assets is identified as a key long-term goal in asset strategy.

In consideration of limited funding available, the document stresses that the capital plan must prioritize projects according to the critical needs of the business. Guidance on indentifying critical needs for various purposes and a procedure on how to prioritize projects and some recommended priorities are given.

Projects are described as being prioritized as A, B or C .

Of specific interest to our investigation were "Priority A" projects which are described as essential or mandatory to:

- Meet legal obligations;
- Reduce high risk health and safety issues;
- *Address failed or imminently failing assets* (emphasis added);
- Address critical customer issues;
- Asset Investment Strategy Components.

The Strategy Components identified in the document include:

- Capacity and Growth;
- Efficiency;
- Regulatory Compliance and Water Quality Goals;
- Renewal of Business Support Assets;
- Renewal of Pipeline Network Assets;
- Renewal of Supply and Treatment Assets;
- Reliability and Quality of Service;
- Operational Risk Management

A comprehensive summary of each of these strategy components is contained in Appendix A of the Asset Investment Strategy Guidance for Business Planning document. The summary includes a discussion of scope, objectives, key points, and alignment with annual goals.

4.6.1.2 Capital Investment Management Planning

NJAW follows American Water's Capital Investment Management (CIM) Policy for capital investments. This policy is used to ensure that investment decisions are made that minimize cost to the customers while meeting American Water's goals of regulatory compliance, growth, infrastructure renewal and providing safe, reliable quality service.

The CIM Policy defines capital investment planning as consisting of three distinct phases:

- Planning - Sound engineering planning through the American Water's Comprehensive Planning Study (CPS) Program is identified as the primary driver for identifying capital project needs which needs to be in alignment with the Asset Investment Strategy with input for all appropriate functional areas. Details are contained in the Comprehensive Planning Practice (see below).
- Budgeting - Each subsidiary (e.g., NJAW) proposes a 5-year Capital Investment Plan. At this phase a bottom up capital asset plan is developed and identifies the level of spending. American Water's board must approve the overall business which includes the Capital Investment Plan. This is updated quarterly.

- Delivery - This phase addresses the general oversight of the capital program and the sign-off of the technical and functional aspects of individual projects that require approval during a given month and the ultimate approval of individual projects. This is done by cross functional committees at both the subsidiary and corporate levels. The CIM committees provide concurrence on project scope and schedule.
- Waiver - In an emergency situation capital expenditures without prior technical and functional sign-off and advice from the CIM Committees are acceptable where safety or acceptable service would be compromised. Thus, capital planning should consider whether any expenditures can be shifted from other projects where risks addressed by such projects are more tolerable or can be managed, reduced or otherwise mitigated by less intensive capital means.

4.6.1.3 Comprehensive Planning Process

NJAW's comprehensive planning process focuses on the need to provide safe, adequate and reliable service to its customers. The process provides an engineering analysis basis to assist management in the long-term planning process and operation of the Company. This process does not attempt to determine the remaining useful life of aging assets but it does take condition, maintenance and repair history, and original useful life into account. Within this process it is anticipated that additional expenditure may be necessary beyond those already indentified.

The comprehensive planning process supports American Water's CIM Policy by ensuring sound engineering planning is the primary driver for identifying specific capital project needs. The process outlines the tools and standards used to accomplish this goal. It also supports American Water's State Planning Study Program (PPR) which states that each subsidiary's engineering function is responsible for having a full understanding of the condition and performance of all systems under its jurisdiction and for identifying, prioritizing and completing critical planning work for systems in need of planning. In order to accomplish these goals, a program of planning work is developed for each subsidiary. The subsidiary's PPR identifies, budgets and prioritizes work to be completed over the next five to ten years by assessing the planning needs for each system as well as identifying other subsidiary planning studies.

Asset Planning staff, at both corporate and subsidiary levels, within the engineering function are responsible for assuring compliance with the process. It also states that all planning work should be done by NJAW engineering staff whenever possible. Consultants are to be used only when the workload cannot be accomplished by staff and when the expertise cannot be found within NJAW.

4.6.1.4 Capital Budgeting and Delivery Practice

The purpose of this practice is to ensure consistent capital governance procedures for budget preparation and delivery of the capital program. The following cross functional committees are identified as required to be in place for technical review and sign-off, advisement on project approvals, and general oversight of the capital program, and generally meet on a monthly basis:

- Operating Unit Functional Sign Off Committee;
- Operating Unit Capital Investment Management (CIM) Committee;
- Corporate Functional Sign Off Committee;
- Corporate Capital Investment Management (CIM) Committee.

4.6.1.5 CIM Project Re-forecasting Practice

This practice supports the Capital Investment Management Policy by identifying the specific steps and timing necessary for re-forecasting capital projects. The following individuals have organization responsibilities for this practice:

- Project Manager;
- Project Manager Supervisor (an NJAW employee who oversees the work performed by a project manager; this person does not necessarily need to be the project manager);
- Direct (administrative) Supervisor;
- Capital Program Lead (and other designated individuals on the Capital Program Team;)

- Manager - Utility Plant Accounting (and other designated individuals in UPA).

4.6.1.6 Project Prioritization Model

American Water uses an Excel-based model to provide consistency and objectivity to the process of prioritizing capital projects for capital investments. The model's protocols set evaluation criteria, descriptions and criteria weighting guidelines for capital project prioritization. Together with the CIM Policy and the Asset Investment Guidance, the model provides NJAW the basis whereby a project once identified as a high priority project such as the pipe bridge repair work can be fast tracked for completion

4.6.2 Asset Management

4.6.2.1 Asset Management Principles

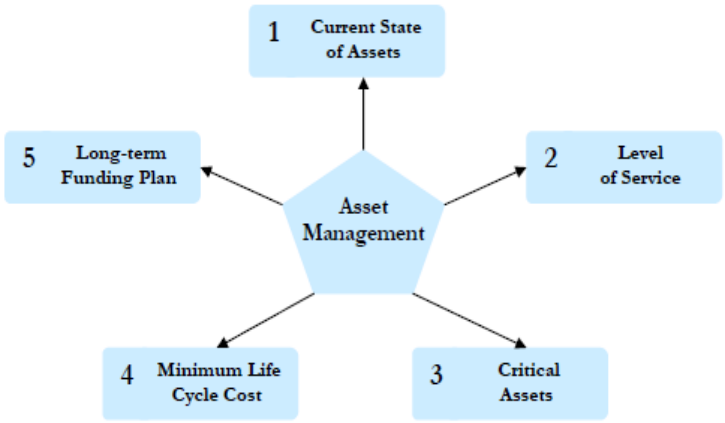
Over the past decade, the processes and practices of managing infrastructure assets has significantly matured. Beginning with industry guidance such as the *International Infrastructure Management Manual* (2002) and the *Asset Management Handbook* (2002), numerous guidance has been published on how to manage infrastructure to minimize lifecycle costs while maintain established levels of service at an acceptable level of risk.
The first formal specification for asset management, PAS 55, was issued in the United Kingdom in 2004, and updated several times since. *Implementing Asset Management-A Practical Guide* (2007) was jointly published by AMWA, NAWA and WEF, and the USEPA has issued guidance and tools to help utilities better manage their infrastructure assets. By 2014, the International Standards Organization is expected to issue their first standard on infrastructure asset management (ISO 55000).

Table 2 shows the 12 Key Concepts of Asset Management as included in *Implementing Asset Management-A Practical Guide.* Figure 6 shows the USEPA's framework of the Five Core Questions of an Asset Management.

TABLE 2
The 12 Key Concepts of Asset Management

Knowledge of:	• Levels of Service • Assets and their characteristics • Physical condition of assets • Performance of assets • Total cost of asset ownership
Ability to:	• Predict future demand • Assess asset risk • Identify and evaluate risk mitigation options • Prioritize options and fund within available budget • Optimize O&M activities • Effectively manage info & employ decision tools • Obtain & sustain organizational coordination and commitment

FIGURE 6
USEPA's Five Core Questions Framework



The intent of Asset Management is to ensure the long-term sustainability of the water utility. By helping a utility manager make better decisions on when it is most appropriate to repair, replace, or rehabilitate particular assets and by developing a long-term funding strategy, the utility can ensure its ability to deliver the required level of service perpetually.

From a conceptual standpoint, one of the essential elements of every asset management program is the ability to identify, evaluate, score, and prioritize assets on their basis of risk, where risk is the product of the consequences of an asset failure and the likelihood of the asset failing. In the absence of well-developed and carefully managed risk-based program for managing assets, the operational mode becomes one of being "reactive." The result is that future users are burdened with the cost or responsibility for the replacement of infrastructure that previous and current users have used. In addition, and perhaps even more important, is that assets considered high risk, based on either a high likelihood or consequence of failure, or both, may be overlooked among the vast infrastructure needs of a utility. Consequently, unforeseen catastrophic asset failures may occur, resulting in a loss of service to customers with very costly repairs required (often much more expensive than had the same repair been performed in a planned manner).

By following the principles of risk-based asset management, water utilities are able to identify those assets which demands proactive capital planning as well as response planning commensurate with the known conditions and specific site parameters that result in elevated risk to the utility and its customers, including those assets that are compromised from natural disasters and from adverse anthropogenic (human-related) events.

4.6.2.2 NJAW Asset Management Program

The NJAW asset management program includes both vertical (structures and equipment) and linear or horizontal (pipeline) assets. In general, NJAW follows a risk-based approach, evaluating both the likelihood and consequences of asset failure. NJAW uses a computerized maintenance and management system (CMMS) to track infrastructure assets, along with a Geographic Information System (GIS). NJAWC's asset management program compares favorably both to other New Jersey water purveyors and to other investor-owned water utilities nationally. Currently, CMMS and GIS are not totally integrated (referred to by NJAW as "islands of automation"). However, there are plans in the near future to complete the integration of these systems into the pending Enterprise Asset Management module, which is part of the ongoing SAP system implementation. The EAM module is expected to "go live" for NJAW in October 2013.

During an on-site interview with NJAW further details were presented of their asset management program in the following top-down structure:

1. Company Guiding Principles (proprietary and business confidential)
2. Asset Strategy
3. Prioritization Guidelines for Capital Investment

NJAW reported that there has always been equal priority afforded to both vertical and horizontal assets. In terms of invested value and present CIP project work, there is a 70/30 (linear/vertical) asset ratio. They believe this is reflected in NJAW's current and future strategic reinvestment planning. No data was requested by or provided to the SRM Team on historical and planned capital investment to confirm this commitment.

The process of identification, characterization, risk scoring and prioritization is a continuous process that includes a variety of NJAW senior-level managers within operations, engineering, communication, government affairs, and finance/rates. Each year a cross functional workshop is held in each Operating Area to evaluate the prioritized risk-based asset list and determine and memorialize those assets scheduled for planned improvements. In general, engineering has ownership of the entire process and is responsible for ensuring that planned improvements are fully implemented.

Additionally, there are critical asset review processes within Engineering that occur monthly under the guidance of Suzanne Chiavari, NJAW's Vice President of Engineering. NJAW did report that the failure of the pipe bridge has resulted in modifications within this process to avoid a similar occurrence in the future. As an example, NJAW has developed and implemented a plan to identify, inspect and evaluate all crossings (waterway and roadway),

particularly those that represent a high consequence of potential failure. NJAW also recognizes that any asset that is uniquely functional (such as the SRWTP pipe bridge) must have a uniquely identified characterization in the GIS and CMMS.

In general, work is separated into two categories:

1. Planned improvements
2. Emergency improvements

There is currently no category assigned to those assets that are classified as "imminent failure." In fact, upon review of all the data provided by NJAW prior, during, and after the on-site interviews including those opinions and statements shared by both senior-level management from NJAW and HMM only Mr. Jimenez described the condition of the pipe bridge, following Hurricane Irene, as being one of imminent failure in answer to a question the SRM Team posed to him via telephone interview.

In addition, remaining service life (RSL) is only defined by NJAW for a high-priority asset when it is approved and authorized as a capital improvement project. Conventional wisdom would lead any responsible asset manager to believe that RSL is difficult (if impossible) to define on an individual asset in the top-down AM. There is simply not enough desk-top, risk-based data to predict RSL. In this respect, when identifying the condition of each of their assets, NJAW should also develop an order-of-magnitude estimate of the RSL of each asset. Better and more informed understanding of the condition of all of the Company's conveyance assets will simply result in lower overall risk of their infrastructure and provide better response planning when an asset approaches Category A and even those representing "imminent failure" (i.e. zero Remaining Service Life (RLS)).

The NJAW asset management program is also well defined, and more importantly, integrated into a much broader and institutionally supported framework articulated in the Capital Investment Management (CIM) Policy described in greater detail in the previous section. At its heart, the CIM has a stated business objective that includes assurances that proper asset management will be implemented and maintained.

The objective of the CIM policy is to assure that capital investment decisions are made which efficiently utilize financial resources and minimize cost of service to the customer, while also assuring that the Company continues to maintain regulatory compliance, keeps pace with growth and infrastructure renewal, and provides safe, reliable, efficient, and quality service. One of the stated goals of the CIM requires that an ongoing, comprehensive engineering planning program be considered the primary tool for the evaluation and recommendation of capital investment needs.

Overall, the CIM, and the Asset Investment Strategy Guidance brings together a number of principles essential in the asset management process including the use of capital investment as a major driver in meeting its stated objectives but on the basis of standardized prioritization procedures.

It was noted, in particular, that in January, 2012 the Executive leadership issued a number of goals and targets for NJAW to fulfill its core vision, mission and values. One of these goals was to shift needs to identify and accept higher risks on deferred projects. However, it is clear that this executive goal had no impact on the pipe bridge project governance, funding or prioritization, considered by most at this time to be a high risk asset. The project moved through all NJAW processes without delay.

It was also noted that the Prioritization Guidelines for Capital Investment identify and segregate projects into three basic categories; A, B, and C. Projects in Category A , considered essential or mandatory, must meet one of the following criteria:

- Compliance with legal obligations;
- Reduce high risk health and safety issues;
- Address failed or imminently failing assets;
- Address critical customer issues.

Specifically, this also applies to the methodologies that AM follows for buried, linear assets. In an excerpt from American Water's Standard P01: 2012 Planning Criteria (for water systems), the following was noted:

Engineering Criteria

In planning the needed water facilities, accepted engineering standards and practices are utilized to evaluate facilities. Using these standards and practices, an assessment is made to determine if adequate capacity and an appropriate level of reliability are present for domestic, commercial, industrial usage, and fire protection needs.

Specific details regarding the planning criteria utilized are provided in the following subsections. Recommendations included in this Comprehensive Planning Study (the document sited above) address improvements that work towards meeting the planning criteria described above. In addition, recommendations are included in this report where structural or mechanical problems with existing facilities are evident.

It is beyond the scope of this Comprehensive Planning Study to attempt to identify the end of the useful life of each piece of American Water's equipment; for example, the many miles of pipeline within a distribution system. Also, capital expenditures will occur over time due to normal aging and operational wear on existing equipment, and to enhance system security. For this and various other reasons, it is expected that American Water may encounter additional capital expenditures beyond those identified in this Comprehensive Planning Study.

The section clearly allows for funding of exceptional circumstances such as those improvements required due to the elevated nature of risk associated with a potential and imminent failure of a particular asset.

SECTION 5

Conclusions

In response to NJBPU's request for a critique of each of the assessments that the SRM Team conducted, the following conclusions were formulated:

1. Assess the Company's historic operation and maintenance (O&M) practices (emphasis on inspections) with respect to the SRWTP Pipe Bridge and appurtenant piping, including any inspection logs/records since 2000.

- NJAW did not have the pipe bridge in its asset database. Admittedly the bridge itself was a unique asset; still it was a NJAW asset with unique O&M and inspection requirements. The only related documentation of its existence was a node-to-node line segment in the GIS showing the approximate location of the pipelines it supported. It was also referenced in NJAW's 1993 Monmouth County Planning Study but only with regard to its role in supporting the raw and finished water pipelines, but never as an independent asset which if not replaced in planned pipeline improvements still required attention. Until the failure of the pipe bridge in 2012, there were no O&M plans or documents describing the pipe bridge or the pipes, their physical attributes or their condition. There were no records of any maintenance done on the pipe bridge structure or on the three pipelines supported by the bridge.
- The SRWTP pipe bridge was only inspected once in a forty year period, in 1991, 20-years after its construction. Although there is no standard inspection requirement for a bridge used in this application, highway bridge standards and associated inspection frequencies (e.g. five year inspection intervals) could have been applied given the importance of the asset. As a result there was a lack of historic inspection data that could have been used in conjunction with the post-Irene inspection and survey data, and the 1991 Killam report, to compare and assess the condition of the bridge after Hurricane Irene.
- Evidence of mudline recession in the Swimming River directly below the bridge was noted as early as 1991 and subsequent evidence of scour was found in a 2011 post- Hurricane Irene inspection. Although this information was available, no recommendations were made to restore the receding mud line. Riprap or other suitable material could have been recommended to arrest the scour damage and improve the embedment of the piles.

2. Review the circumstances surrounding the bridge collapse at New Jersey American's Swimming River Treatment Plant on June 29, 2012, and critique the Company's restoration efforts after the collapse, including the deployment of resources to restore operations, service to customers and the Company's communications with government officials and customers.

- The collapse of the bridge and failure of the three pipelines was noticed in real-time by the SWRTP operations staff. Within minutes of the collapse, NJAW operations and maintenance staff implemented an Event Management Plan in accordance with previously prepared procedures to be put into place should an emergency situation such as this were to occur. As a result, NJAW was able to follow prescribed steps and reconfigure their system to divert water from other parts of their system into the water deprived Middletown Gradient in a very short period time. NJAW was therefore prepared and able to quickly mitigate the potential effects of the severed pipes.
- After the bridge collapsed, NJAW's trained Event Management Team was immediately mobilized and members began following the prescribed activities defined in American Water's Incident and Event Management Practices Document. The team gathered information and evaluated the extent of the incident, assessed risk, initiated and maintained an event action log and plan, coordinated restoration efforts , deployed the proper resources, and implemented an effective communication plan with internal and external stakeholders including the BPU, NJDEP, media, OEM, customers and government officials. They also utilized social media as a means to provide information updates to all affected parties.

- NJAW's activities in the restoration efforts were noteworthy. Under the direction of Event Management Team, staff isolated the severed pipelines, reconfigured flow to minimize pressure loss based predetermined contingency plans (hydraulic modeling) mobilized and installed portable pumping equipment, notified wholesale customers to curtail usage, gave out bottle water and worked with vendors and an emergency contractor to rapidly procure pipe and other materials to install bypass pipelines around the severed mains. The net result of these activities was three days after the collapse the boil water advisory was lifted and seven days later customers were back to full service. These are significant accomplishments given the extent of the damage and a testament to NJAW emergency planning, leadership and staff.

3. Review and critique the Company's efforts post-Hurricane Irene related to restoring service at the Swimming River treatment plant, including the deployment of resources to restore operations, the restoration of service to customers and the Company's communications with government officials and customers.

- Two days prior to the Hurricane's landfall in New Jersey, NJAW began communicating with customers informing them of what they could do to prepare for a possible loss of water. NJAW assured customers that should their service be interrupted due to the impacts of the hurricane they would restore service as soon as possible. NJAW's Event Management Team was mobilized to prepare for the impact of the Hurricane.
- Once the Hurricane hit, it caused numerous problems in many of NJAW service areas in the state including: flooding at the Canoe Brook Water Treatment Plant which resulted in a loss of supply; flooding and loss of power at the Raritan-Milstone WTP; and widespread flooding, power outages and storm damage to many of its production facilities. The SRWTP pipe bridge was under water due to flooding and elevated levels of the Swimming River downstream of the spillway but there was no loss of operation at the treatment plant and no interruption of service to customers in the SRWTP service area. The preemptive communication actions taken by the NJAW Event Management team were effective and NJAW demonstrated a good level of competency in its preparation and response to this event.

4. Review of the post-Hurricane Irene inspection that determined that the SRWTP pipe bridge was fit for continued use.

- The SRWTP pipe bridge was submerged in the runoff water from the reservoir spillway during the Hurricane. Once the water receded and the pipe bridge was exposed, BCTS performed an inspection of the bridge and another shortly thereafter, subcontracting to commercial divers to perform an underwater inspection of the pipe bridge structure. The Preliminary Inspection Report, prepared by BCTS and circulated to NJAW and HMM on September 23, 2011, confirmed that one of the piles had "evidently" failed and another pile had apparently failed, with two other piles exhibiting significant damage. The report went on to recommend repairs to four partially or completely failed piles. The report was provided to HMM for use by HMM in preparing a more detailed structural assessment and repair recommendations.
- Subsequently inspections were also conducted by HMM and WJE. However, no one raised the damage assessment to a condition of imminent failure and as a result the bridge was left in service pending repairs. NJAW did not request nor did HMM (as NJAW's engineer-of-record) recommend, a more detailed professional forensic evaluation of the pipe bridge be conducted by a firm experienced in maritime structures, as was done after the collapsed. Bringing in a firm with this specialized expertise early-on in the evaluation process may have helped identify a condition of imminent danger. If such a firm had been brought in, and had that firm identified a condition of imminent danger, an emergency could have been declared by NJAW, an emergency bypass constructed, and repair work expedited. Had an emergency been declared, and an emergency bypass been constructed, the disruption in water service experienced by customer may have been avoided, and repairs may have been made to the pipe bridge prior to a collapse.

5. Review the impact of Hurricane Irene on the bridge and related piping and the Company's plans and projects post-Irene to: assess any damage to the SRWTP pipe bridge assets; assess the condition of those assets; inspect and recommend repairs to those assets; develop a plan to implement and recommend repairs

determined to be necessary; and the extent to which an effective interim monitoring protocol was established and maintained

- For the time period of Hurricane Irene (late August, 2011) until January, 2012, the condition of the SRWTP pipe bridge's supporting piles were investigated by BCTS, an underwater inspection team from TNJ Marine, and the consulting engineering firms of HMM and WJE; and a survey was done by the Kresson surveying firm, the results of which were compared to the 1991 Killam report survey data. The results of the inspections and assessments conducted by these parties involved in the assessment of the structural integrity of the pipe bridge in the aftermath of Hurricane Irene were in agreement that the piles supporting the bridge were in need of repair and the pipe bridge structure was vulnerable to failure however, none of the assessments or inspection reports said the condition of the bridge was one of "imminent failure." Given this information and the general consensus on the condition that the bridge had been damaged, but was still standing and apparently stable, no one offered an engineering judgment characterizing the condition or status of the pipe bridge as one of "imminent danger" or an "emergency" in order to expedite repair work.
- The September 2011, post-Hurricane Irene underwater inspection was performed with commercial divers who were not licensed professional engineers. These individuals, although trained to observe and verbally report on underwater findings, are not trained to assess the structural integrity or safety of a structure. Bringing in a firm experienced in evaluating maritime structures early on in the structural evaluation could have provided valuable input in determining the risk of failure of the bridge; HMM did not recommend bringing in such a firm.
- Based on the inspections performed, and the BCTS report which included various piles described as failed and damaged piles, staff did know that there was at least the potential for the pipe bridge to fail in another storm event. As a result NJAW had an Event Management plan prepared that could be utilized in the event of a collapse and loss of the pipelines. This detailed plan when coupled with the alternative hydraulic configuration models that were run post- Hurricane Irene provided NJAW with specific guidance should the pipe bridge fail and interrupt flow through the three pipelines.
- Immediately after the Hurricane induced waters receded and the pipe bridge was again exposed, NJAW moved quickly in the first few days and brought in the BCTS structural engineer to inspect the site and perform investigations. Supplementary inspections were performed over the next few weeks which led BCTS to make some initial recommendations to NJAW. The recommendations were to have an alternative analysis done for repair work aimed at either stabilizing the pipes and the pipe bridge structure which they had deemed to be damaged or to replace the pipe bridge entirely.

  The BCTS Preliminary Inspection Report was completed on September 23, 2011 and presented on September 28, 2011, HMM's draft Inspection and Interim Structural Repairs Report was submitted on October 14, 2011. The final HMM report was provided on January 12, 2012.

  In total it took nearly four months from Hurricane Irene before a formal task order was signed for HMM to begin the design for Phase I repairs, another three before a 60% design submittal, nearly two more months before the 90% design meeting and another month before there was a Phase 1 award to a contractor and receipt of a LURP permit (ten months after Hurricane Irene). Adding in time to get signed contracts, a notice to proceed issued to the contractor, and the estimated time of construction and the earliest repairs would have been substantially complete is estimated to have been August 1, 2012. Given the importance of this work and subsequent failure of the bridge, these projects could have been given the highest priority with a hard fast deadline for completion which may have averted the loss of service to customers. While NJAW internal governance documents included projected in service dates for the repair project, no such urgent deadline was imposed or tracked for the repair project work.
- As engineer of record, HMM's role in this project included several critical tasks, ranging from the initial damage assessment, repair recommendations, permitting advice (need, timing, preparation, interface with DEP, follow up on processing), construction timelines and deadlines, identification of critical paths and

potential roadblocks, project design, preparation of construction specifications and task sequences, identification of other potential construction issues such as overhead power lines, etc.

6. Review the Company's governance related to prioritization of capital projects that were identified to complete repairs to the pipe bridge assets after Hurricane Irene, and assess whether sufficient controls were in place to provide budgeted funds and effective project timing.

- Based on a review of strategy, policy and practice documents, and from our interviews with individuals at various levels of the organization, it is evident that the Company has developed a comprehensive and robust planning, budgeting and delivery platform for capital investments and has the governance in place to support the effective implementation of its capital investment program. With regard to the capital repair projects identified for the pipe bridge after collapse, engineering project managers and supervisors utilized this system to have funds appropriated for the repair work in ample time to complete the work.
- A detailed review of Appendix A of the Company's Asset Investment Strategy document has led the SRM Team to conclude that SRWTP pipe bridge and pipelines, which were identified by NJAW as critical assets, could have had reinforcement or replacement projects identified earlier by NJAW, and those projects could have been designated as a high priority projects under the then-applicable investment strategy component (under the current plan, for "customer focus") even considering the pre- Irene condition of the pipe bridge. This is because it is a single source of raw water supply to the SRWTP and carries two critical finished water supply lines to a large customer service area and if lost could have "significant long term adverse impacts on the company's reputation." Although the raw water pipeline did have a lesser priority rating and a project was to be planned for the future, prudent planning should have identified [projects to mitigate] the continued reliance on a critical asset in the nature of the pipe bridge.

SECTION 6

Recommendations

Recommendations:

1. **Inspection O&M History of SRWTP Pipe Bridge and Piping (Historic O&M Practices)**

   Enhance existing asset risk register for all high-consequence assets – It is recommended that NJAW consider a system-wide audit and review of potential data gaps or shortfalls in specific assets that represent those where the "consequence of failure" is highest (such as stream, river, and highway crossings that represent large service areas). Once these data gaps and shortfalls have been identified, a strategic plan should be developed and endorsed by NJAW leadership to carry out full and detailed assessments of each asset in order to quantify and characterize the relative risk scores.

   Create Special Risk Categorization (for assets deemed to be in imminent failure) – Current inspection protocols do not allow for a category that is elevated to "imminent failure". The existing asset register should accommodate a category for an asset that reaches this elevated level based on field inspections and further assessments by a qualified consultant with expertise in the particular asset, when such an assessment is appropriate. Those assets that are considered in a state of "imminent failure" that also are classified as highest consequence of failure should be fast-tracked for both immediate stabilization and permanent renewal or replacement. For assets considered unique in their function, NJAW should retain the technical support of an independent consultant with expertise in the particular asset.

   Develop Inspection Protocol of Pipeline Bridges and Similar Assets - All bridge structures (both owned by NJAW or others) that carry water mains should be inspected on a regular basis. If the asset has a functional purpose within the service area of the NJAW but is not owned and maintained by the NJAW, arrangements through instruments such as inter-municipal agreements or other binding contracts should be negotiated and maintained. Inspections should be performed by licensed Professional Engineers who are experienced in inspecting similar structures. This would require all visible above ground components be inspected every two years and all underwater bridge components be inspected every five years. If NJAW has a water main on a bridge structure owned by others, it should ensure that is has appropriate access agreements in place to ensure that the appropriate inspections can take place at the appropriate interval.
   Implement Scour Inspection Program (5-year cycle) - A Scour Inspection should be performed as an integral part of the underwater inspection and should be performed at least once every five years. A Scour Inspection would document the existing mud-line elevation at every Submerged Structural Unit
   herein defined as any asset that located below a pool level such as a river, stream, or reservoir. Such information should be compared with the previous data to determine if submerged portions of foundations are being undermined.
   Perform Routine Soils Investigation Prior to Construction of Pile Supported Structures - A soils investigation is routinely performed for NJAW projects prior to the construction of any pile supported structure. When scour is noted, it is imperative that the remaining soil be investigated for load capacity based upon the actual embedment length of the pile.

2. **Post-Hurricane Response Planning (Citations from AAR)**

   In general, NJAW has endeavored to initiate the highest priority recommendations cited in the AAR. Some of the citations were already being managed through emergency contracts and master service agreements already in place. We believe that NJAW has followed its best-practices that were already in place before Hurricane Irene and they should continue to complete and implements its AAR recommendations. In addition, though, we have the following additional recommendations:

   Improved Equipment Inventory – As indicated in its AAR draft recommendations, NJAW should evaluate and improve equipment and supply-chain inventories for event response. NJAWC has a pre-qualified vendor list that includes major vendors such as US Pipe, JFC, HMM, [list]; the pre-qualified vendor list should be

enhanced to include a specific equipment vendor list. A specific vendor equipment list should be maintained so that supplies are available, in addition to the enhanced inventories maintained by NJAW. NJAW should also consider enhancing its use of emergency contracts to ensure product availability when vendors are resource challenged.

Pre-Qualified Vendor List – NJAW has a pre-qualified vendor list (a best practice) that includes emergency services contracts with major vendors, as noted in the previous recommendation. The Company should consider expanding its pre-qualified list of vendors to including more equipment suppliers, consultants, and contractors to provide on-call services and support to quickly mitigate emergency situations. This is especially important, where practical, for those critical assets that are classified as "high consequence of failure" and are uniquely suited for the expert to evaluate and quickly mitigate in order to avoid its failure and catastrophic consequence. Case-in-point is the SRWTP pipe bridge which represented an number of asset types combined into a single asset feature.

3. Post- Bridge Collapse Response (Citations from AAR)

Continuation of AAR Recommendations – NJAW has initiated recommendations outlined in the AAR. It is recommended that NJAW continue and complete all recommendations in the AAR.

Enhanced Training – NJAW should consider expanding OEM drills and training. Specifically there is a need to improve or expand NJAW employee training necessary to know and understand their respective role in Event Management Practices and how Incident Command Management Practices are to be implemented.

Call Structure – NJAW should create a more refined event management call structure to ensure timely and efficient communication with the event management leadership team.

Bypass and Isolation Strategies – Specific bypass strategies or isolation plans (where cost-effective) should be developed for all high-priority assets as part of NJAW's Contingency Planning. Best case analysis should be used to determine the appropriate plan. Bypass strategies should include well-developed plans that identify equipment, resources, costs, and implementation.

Boil Water Advisory and Order Protocol – It is recommended that NJAW develop a written protocol that would be incorporated into the Event Management Practices that would provide useful guidance in determining how, where, and when an advisory or order is required.

Regulated Information – Procedures are needed by NJAW to better manage the type and content of information requested from and subsequently shared by the Command Post and the EOC with key external stakeholders. Reference, again, is made to the current AAR and its full implementation by NJAW.

4. Initial Post-Hurricane Pipe Bridge Inspection

Management of High-Risk Assets – Despite such situations being rare (and, in this case, involving a unique asset), in consideration of those assets that are categorized by NJAW as having a condition elevated internally or by an outside forensic expert as being in a state of "imminent failure", "no remaining service life", or "likely to fail" (such as if the SRWTP Pipe Bridge had been identified in this way) NJAW should make necessary changes within the Company's Asset Strategy and Prioritization Guidelines to accommodate such elevated conditions, perhaps into a more formal process for identifying and managing emergency projects and other "emergency improvements" to ensure the appropriate priority is assigned promptly. Rehabilitation or replacement, including temporary measures to protect the functional performance, of that asset would then move quickly irrespective of financial, regulatory, or environmental constraints.

5. Post-Hurricane Pipe Bridge Repair and Rehabilitation Plan

Establish Permit Application Protocols Prior to Design – NJAW should require written guidance on permits from consulting engineers, such as whether or not permits are required, what the permit application requirements are, what the permit restrictions are likely to be; and require documented support for the consultant's expertise with a given permit application; and NJAW should review and understand all required permits that may be necessary to perform asset repair and rehabilitation work in various locations.

Additionally, the investigative process for determining which permits are required for each given item of work should be determined early in the design process. Also, emergency work, if possibly executed in the absence of a permit, must be identified as soon as possible.

Event management handbook – NJAW currently maintains a variety of emergency response plans. NJAW should consider the need to improve and consolidate these plans, with particular emphasis placed on the tracking and maintenance of these plans. In addition, NJAW should create an Event Management Handbook that would include critical information designed for responders who are not familiar with the actual asset systems.

6. Governance Associated with Post-Hurricane CIP and Funding

Create, Fund and Appointment High-Risk Asset Manager - NJAW should consider the creation of a role that would include responsibility for assets that have been elevated to a high-risk status (based on NJAW's current and enhanced system of scoring assets based on likelihood and consequence of failure) such as the pipe bridge following Hurricane Irene. Under the oversight of this manager, an expedited process of moving from the initial elevated risk characterization (such as "imminent failure") through repair, rehabilitation or replacement would be executed with precision and an unimpeded schedule.

On-Going Enhancement of Training Manuals – NJAW must continually work of updating SOPs, emergency response planning and documentation, system redundancy, etc. as a requisite to effectively manage future events. An outside consultant may be considered as a resource to perform a full audit of these documents for improvement.

Appendix A

The SRM Team reviewed NJAW's organizational structure, reviewed job descriptions and responsibilities and interviewed key individuals who played significant roles in the Hurricane Irene and Post-Hurricane Events.

Copies of the Organizational Charts containing most of the individuals interviewed and their reporting hierarchies are attached in Appendix B.

The following individuals from NJAW and Hatch Mott McDonald (HMM) were either interviewed, participated in meetings conducted by the SRM Team:

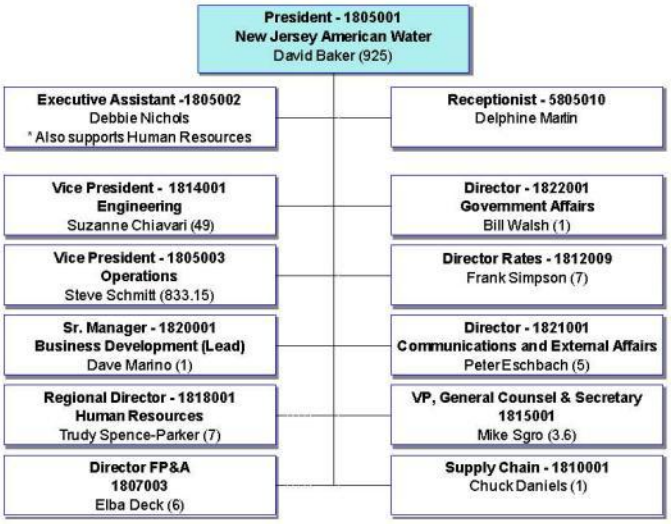
Interview Participant	Title	Affiliation
David Baker	President	NJAW
John Bigelow	Past-President	NJAW
Gary Naumick	Senior Director - Engineering	AW Corp
Suzanne Chiavari	Vice President – Engineering	NJAW
Steve Schmitt	Vice President – Operations	NJAW
Steve Tambini (via telephone)	Past Vice President – Operations	NJAW
Peter Eschback	Director Communication and External Affairs	NJAW
Mike Sgro	Vice President, General Counsel and Secretary	NJAW
Robert Brabston	Corporate Counsel	NJAW
Peter Keenan	Director of Engineering – Technical Services	AW Corp
Javier Jimenez (via telephone)	Design Engineer, Structural	AW Corp
Joe Dugandzic	Past Engineering Manager, Project Delivery	NJAW
Frank Cook	Engineering Manager, Capital Program	NJAW
Vince Monaco	Engineering manager, Asset Planning	NJAW
Ken Seelig	Senior Planning Engineer	NJAW
Eric Hahn	Senior Project Manager/Engineer	NJAW
Adam Kane	Staff Engineer	NJAW
Kevin Kirwan	Senior Director, Field Operations South	NJAW
Kevin Keane	CN-MN Manager	NJAW
Bob Damoci	CN-OC Superintendent	NJAW
Bob Schaefer	Senior Director, Production	NJAW
Juan Donoso	Production Manager, Costal North	NJAW
Patty Ramsden	Operations Supervisor	NJAW
Brian Weir	Operations Supervisor	NJAW
Michael Gennaro	Senior Vice President, Associate General Counsel	HMM
Paul Hedli	Vice President, Manager Structural Engineering	HMM
Michael Altland	Vice President	HMM

Appendix B

AMERICAN WATER

New Jersey American Water

State
Service Company

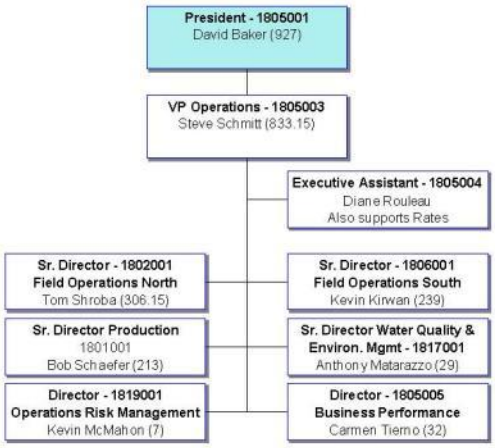


* Final headcount is expressed in a whole number and is aligned with the 2012 Business Plan and 2012 Organizational Streamlining Results

AMERICAN WATER

New Jersey American Water
Operations Management

State
Service Company

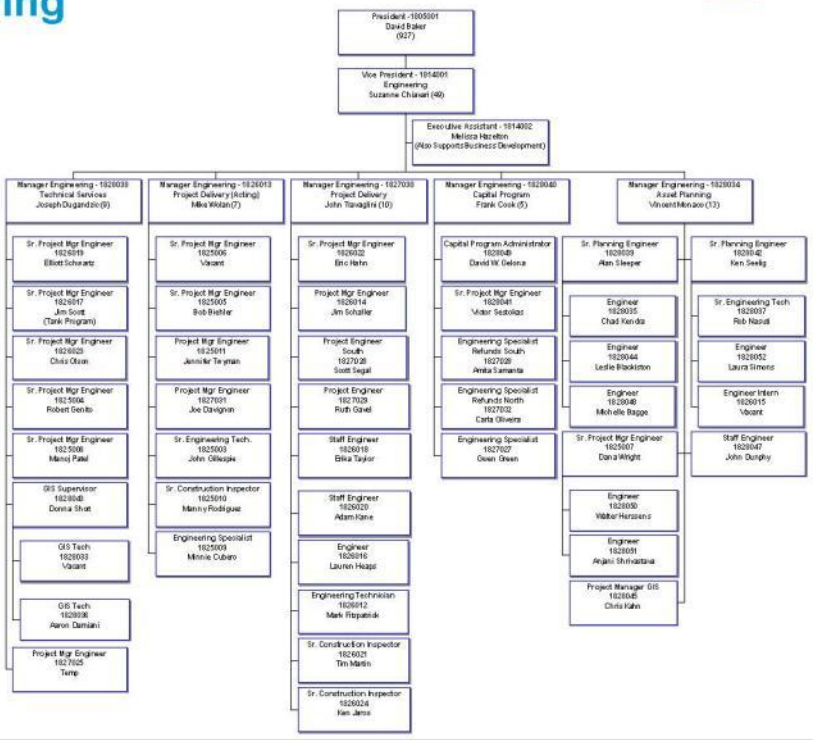


** Operations Risk Management includes 1 from Security
*** 2 Maintenance included in total headcount for VP Operations

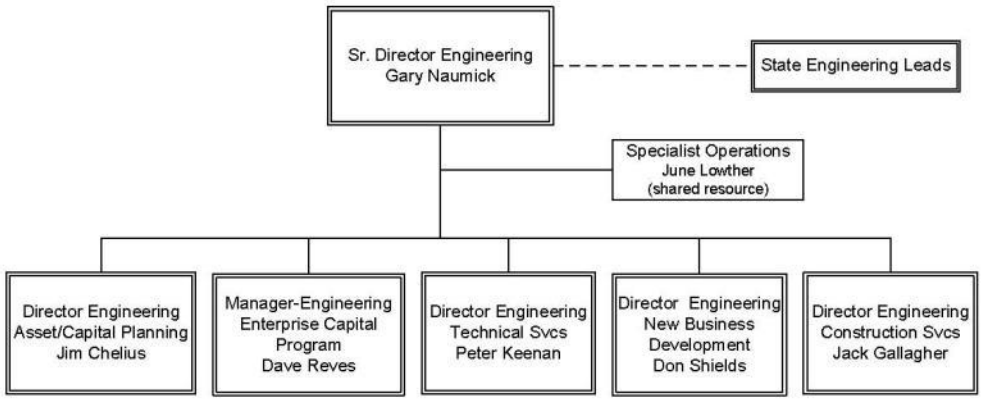
AMERICAN WATER

New Jersey American Water Engineering

State
Service Company

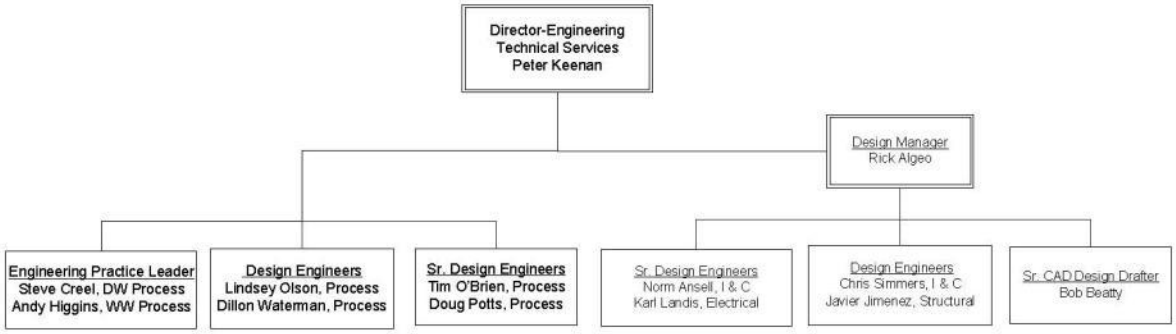


Business Center
Engineering



AMERICAN WATER

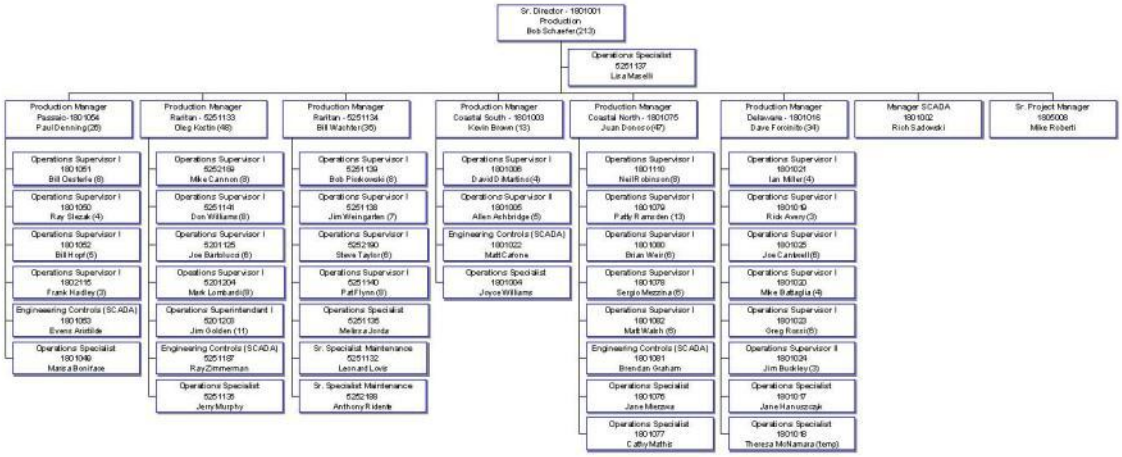
Business Center
Technical Services



AMERICAN WATER

New Jersey American Water Production

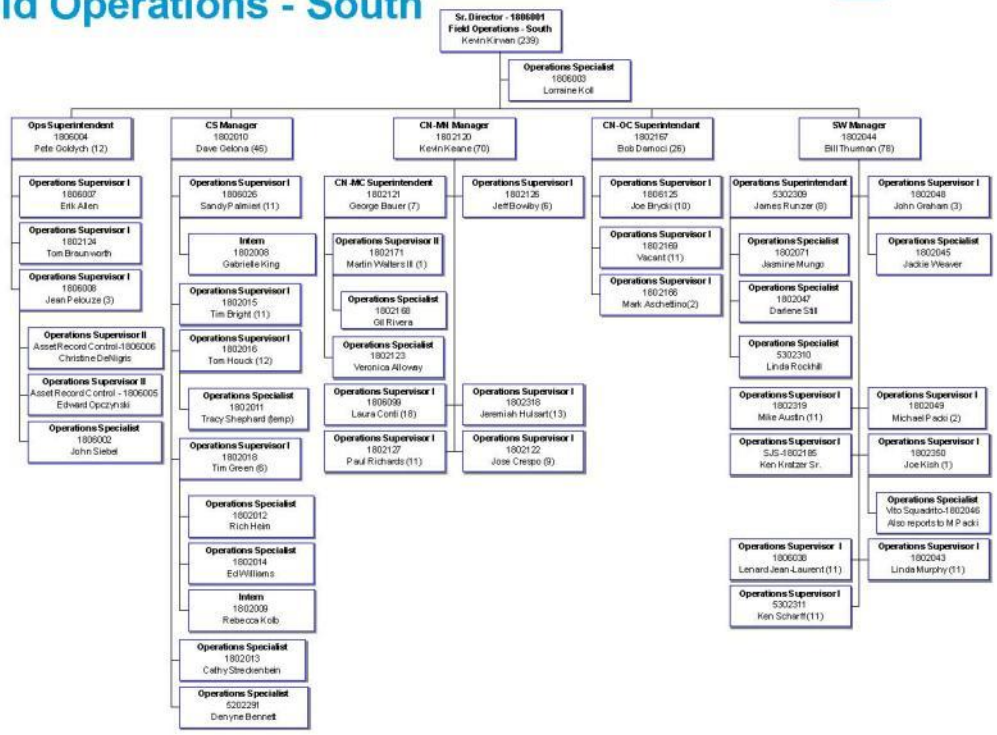
State
Service Company



AMERICAN WATER

New Jersey American Water
Field Operations - South

State
Service Company



Appendix C

Swimming River Pipeline Bridge – August 2012. Note collapsed central portion

Collapsed portion of Swimming River Pipeline Bridge – View looking South. Note Swimming River Road Bridge over Swimming River and also emergency bypass lines installed on bridge and shoulder of Swimming River Road.

Pile Cap 6B - Typical pile bent with concrete pile cap. Note concrete cross bracing on timber piles and vertical steel channel on edge of pile cap

Timber Pile 5A East - Typical failed pile

Failed Piles 6A East and 6A West (Foreground). Remaining Pile Bent 6B (Background).
Steel channel used to mount timber siding seen in foreground.
Channel is still attached to submerged concrete pile cap.