Ensuring Water Supply for the Future in SE NC

By Tony Boahn, PE, Vice President and Regional Manager, McKim & Creed, Inc.

If a restaurant manager learns that her customers' demand for drinks is going to nearly triple in the next 40 or so days, she immediately starts formulating a plan to meet that need.

Likewise, if a water utility learns that its customers' demand for water is going to nearly triple in the next 40 or so years, a detailed planning process is necessary to ensure that water supply needs can be met.

That's the situation faced by three water utilities in southeastern North Carolina. The Cape Fear Public Utility Authority (CFPUA) provides high-quality water to the City of Wilmington and New Hanover County, likewise Brunswick County – the fastest growing county in the state – supplies high quality water to its residents. The Lower Cape Fear Water and Sewer Authority (LCFWSA) furnishes regional raw water supply services to local governments and industries within a five-county area. Its primary customers include CFPUA, Brunswick County, and Pender County.

Together, the three utilities performed a raw water supply analysis that projected demands in 10-year increments. The analysis began with actual raw water usage in 2015 and forecasted needs until 2062. The extrapolated data indicated that raw water demands in southeast North Carolina will increase 190% over the next four decades. Usage in 2015 was 33.2 mgd; in 2062, due to population growth, raw water demand in these service areas is projected to reach 96 mgd. In addition, estimates indicated that LCFWSA could exceed its raw water transmission capacity within the next 5 to 7 years.

So, like the restaurant manager, CFPUA, Brunswick County, and the LCFWSA began a comprehensive planning process to develop a dependable and long-term raw water supply for the next 40 or so years.

SOUTHEAST NC RAW WATER RESOURCES

CFPUA and LCFWSA own and operate separate raw water systems that withdraw and convey raw water from the Cape Fear River above Lock & Dam No. 1.

The CFPUA raw water system consists of an intake canal, a raw water pumping station, and a raw water transmission main that supplies approximately 10 mgd to CFPUA's treatment plant. The LCFWSA's Kings Bluff Raw Water Supply system comprises the Kings Bluff Raw Water Pump Station, parallel and screened intakes, 24 miles of raw water transmission main, an intermediate booster pump station, and a ground storage tank.

The current capacity of LCFWSA's Kings Bluff facility is limited to approximately 48 mgd. This restriction is caused by the existing 14-mile, prestressed concrete cylinder pipe (PCCP) transmission main, which conveys raw water from the Kings Bluff pump station to the ground tank located near Brunswick County's Northwest Water Treatment Plant.

Together, the three partners – CFPUA, LCFWSA, and Brunswick County – determined that a proactive planning approach was necessary to ensure that future raw water supply needs were met. And they understood that taking a regional approach would be beneficial and cost effective for all their customers. Their proposed solution was to design and build a parallel raw water transmission main for the Kings Bluff system. This scenario afforded an effective means of expanding raw water transmission capacity; supporting regional growth for Brunswick County, LCFWSA, and CFPUA customers; and providing redundancy and reliability. This last benefit was a particular concern, in light of Hurricane Matthew.

A RAW WATER EMERGENCY

In October 2016, Hurricane Matthew dumped 8 in. of rain on the Cape Fear Region in just 24 hours. When the Cape Fear River crested at 28 ft. the following week, LCFWSA's raw water main ruptured.

MATERIAL	COMMERCIAL AVAILABILITY	AVAILABLE IN REQUIRED PIPE DIAMETERS	SIGNIFICANT INSTALLATION HISTORY	RECOMMENDED OR FEASIBLE
DIP	✓	✓	✓	✓
STEEL	✓	✓	✓	✓
PCCP	✓	✓	✓	✓
BAR WRAPPED CP	✗	✓	✓	✗
PVC	✗	✗	✗	✗
HDPE	✓	✗	✗	✗

The LCFWSA's Kings Bluff Raw Water Supply system is composed of the Kings Bluff Raw Water Pump Station, parallel screened intakes, a raw water transmission main, an intermediate booster pump station, and a ground storage tank. As a primary supplier of raw water to southeast North Carolina, the LCFWSA's Kings Bluff system serves Brunswick County, CFPUA, Pender County, and two industries located on the US 421 corridor in New Hanover County.

Each day the pipeline remained compromised, 12.5 million gallons of raw water spilled through the football-sized hole. There was no parallel or redundant main to maintain a constant supply of water flowing to the treatment plants.

The failure occurred in a low topographical area that has limited drainage and is prone to flooding. It was surmised that the flooded conditions and the significant impacts attributed to the hurricane undermined the pipe bedding and foundation, causing settlement of the pipe, separation of the pipe joints, and, ultimately, failure of the pipeline.

A multi-organizational effort by LCFWSA, Brunswick County, and CFPUA was launched to repair and restore the pipeline.

The first repair effort was a repair/clamp, which would have allowed raw water to flow to utilities while a bypass was being constructed. Unfortunately, the clamp was not effective, so the following day the team began working to establish a temporary bypass. Pipes and materials were flown and trucked in from all parts of the country to expedite construction.

The bypass pipe was activated on October 29, and the repaired pipe was brought online on November 28. From a positive aspect, the pipe never completely failed, so limited service was available throughout the repair. There was no damage to homes or businesses, the failure did not occur during tourist season, and there was excellent multi-governmental cooperation. Even so, the crisis magnified the need for redundancy.

A REGIONAL SOLUTION

In the spring of 2017, the partners began implementing their plan to increase raw water supply capacity. CFPUA is managing the project with input from LCFWSA and Brunswick County. McKim & Creed, Inc. is responsible for design and permitting.

The new transmission main will originate at the Kings Bluff Raw Water Pump Station and terminate at the ground tank. The pipeline will be installed in LCFWSA's 75-ft right of way and will run parallel to the existing raw water main.

"Designing and building this parallel raw water main is an important step for CFPUA and the region. It will provide additional water capacity and system reliability through a regional approach. It is consistent with CFPUA's mission to continue to supply our customers with a plentiful supply of water now and in the future," stated Carel Vandermeyden, PE, CFPUA's director of engineering.

To get the project moving forward, the team first determined the most cost-effective pipe diameter and material(s) to meet the long-term system capacity goal of 96 mgd.

ANALYZING MATERIAL, CAPACITY AND SIZING

The team analyzed six different pipe materials – ductile iron (DIP), steel, prestressed concrete cylinder (PCCP), bar wrapped concrete cylinder (bar wrapped CP), polyvinyl chloride (PVC), and high-density polyethylene (HDPE) – at three different diameters: 48, 54, and 60 in. The basis of comparison for each pipe material included a pipe pressure class rating of 150 psi with a minimum 100 psi surge allowance. Each material was evaluated for standards, pipe joints and connections, service life, installation considerations, maintenance and repair, and cost.

Next, a hydraulic model was developed to compare the identified pipe diameters for feasibility in conveying 96 mgd from the Kings Bluff system in parallel with the existing PCCP raw water main. The maximum allowable working pressure for the existing PCCP was determined to be 104 psi; this was used as the maximum threshold for operation in the model.

The pipe configurations were analyzed for two primary scenarios:

- Normal, parallel operation of the existing and proposed pipes
- Incorporation of a control valve to maintain the 104-psi threshold pressure in the existing pipe while forcing a higher flow/pressure through the proposed pipe

In addition to pipe material and diameter, the team assessed corrosion control,

The current capacity of the LCFWSA Kings Bluff facility is limited by the existing prestressed concrete cylinder pipe (PCCP) transmission main, which conveys raw water from the Kings Bluff pump station to this ground tank located near Brunswick County's Northwest Water Treatment Plant.

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FINAL RECOMMENDATIONS

Based on the capacity goal, construction costs, life cycle analysis, and non-economic factors, CFPUA, LCFWSA, and Brunswick County opted to construct a 14 mi., 54 in. steel raw water main, with the option to bid ductile iron as an alternative pipe material. Each of the partners will have the capacity they need for their customers for the next 40-plus years and will meet the 96-mgd capacity goal.

As of the writing of this article, design of the 54 in. steel raw water main is at 60%. The team anticipates advertising for construction bids in the third quarter of 2019, with construction completion slated for the end of 2021. The opinion on probable construction cost is $65 million.

Severe flooding associated with Hurricane Matthew caused the raw water main to rupture. This magnified the need for redundancy, which will be provided by the new parallel raw water main. In addition, the new pipeline will meet capacity goals of 96 mgd.

"The Lower Cape Fear Water and Sewer Authority was incorporated in May of 1970 to provide a regional approach to surface water requirements into the future," said LCFWSA Executive Director Don Betz. "A surface water transmission main was completed in the early 1990s and has provided a cost-effective supply. The current design process and future construction of a 14-mile parallel pipeline in the original right of way illustrates the continuing commitment of its regional members to continue to deliver a long-term, dependable supply to a growing regional economy."

Added John Nichols, PE, CPESC, Brunswick County director of public utilities: "Brunswick County is very excited to be moving forward with design of the Cape Fear parallel raw water main project. The project will have significant benefits to the Brunswick County water system, its customers, our wholesale customers, and to the utilities and people in southeast North Carolina. The project provides needed redundancy as well as additional water capacity for the entire region. For water users in Brunswick County, the project ensures an adequate raw water supply for decades to come. The project is a good example of cooperation among multiple utilities. It also demonstrates the benefits of a regional approach for each utility and to the customers that are served by each utility."

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ABOUT THE AUTHOR

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