Rehabilitation of Glenville Lake Dam –
Preserving Water Supply Infrastructure

Danielle K. Neamtu
Project Team

Owner – Public Works Commission of Fayetteville
• Joseph E. Glass, P.E. (Water Resources Engineering Manager)
• Chris Smith (Water Treatment Facilities)
• Chad Ham (Water Resources Environmental Program Manager)

Engineer – CDM Smith, Inc.
• Steve Whiteside, P.E. (Lead Practitioner)
• Danielle Neamtu, P.E. (EOR – Civil)
• Justin Boggs, P.E. (EOR-Structural)
• Richard Semo (Resident Project Representative)

Contractor – Crowder Construction
Outline

- Background
- Design and Permitting
- Construction
- Lessons Learned
- Post-Construction Performance
Background
Background

• Glenville Lake Dam is located on Little Cross Creek at the Glenville Water Treatment Plant in Fayetteville, North Carolina
Background

- Glenville Lake is one of four dams on Little Cross Creek owned and maintained by the Public Works Commission of the City of Fayetteville (FPWC)

- Glenville Lake is one of two water sources for FPWC; the other source is an intake on the Cape Fear River
Historic Flooding

Three of the five major historic North Carolina floods have impacted Fayetteville

- Okeechobee Hurricane of 1928
- Homestead Hurricane of 1945
- Hurricane Floyd 1999

Flooding in Fayetteville, NC 1945. Source: Fayetteville Observer, photo from The Bill Belch Collection
Historic Flooding

• Most significant flood in Fayetteville, North Carolina since 1945 was the September 15, 1989 storm. Over 7 inches of rain fell in 6 hours due to cluster of thunderstorm events.
Dam Features

- Earth embankment dam with length of 850 feet and height of 21.5 feet was constructed circa 1909 with 40-foot-wide concrete ogee principal spillway.
- Impoundment capacity at normal pool is 230.5 acre-feet and drainage area inclusive of upstream lakes is approximately 22 square miles.
Design and Permitting
Design and Permitting - Preliminary Design

• **Inspection**
  - Heavy Vegetation/Steepness of Upstream Slopes
  - Steepness of Downstream Slope, right of spillway and potential soft/wet areas downstream of toe
  - Spillway Concrete Deterioration

• **Survey**

• **Geotechnical Investigation**
  - 5 geotechnical borings completed as piezometers for long-term monitoring
Principal Spillway and Auxiliary Bottom Drain
Design and Permitting - Re-inspection

- Deterioration and Potential leaks noted
- Lake drawn down for inspection of spillway
  - Low-level Outlet
  - Spillway Concrete Deterioration
Design and Permitting - Re-inspection

- Concrete Coring
- Loss of Sand Core
- Spillway Replacement Recommended
Design and Permitting – Spillway Replacement

- Classified as Small High Hazard Dam, Design Storm = 1/3 Probable Maximum Precipitation (9.98 inches in 6 hours)
- New H/H Models developed for both upstream and downstream of the dam and demonstrated the following:
  - Existing spillway undersized
  - New spillway could not have upstream or downstream impacts to 100-year flood levels (FEMA No-rise)
  - Additional spillway capacity achieved by adding secondary weir to pass flows above the 100-year
  - Dam crest elevation was raised to reduce the potential for overtopping during the design storm event
Design and Permitting - Final Design Features

- Replace Existing Spillway with New Concrete Straight-drop spillway
- Maintain normal pool with lower weirs and provide additional capacity above 100-year storm event with upper weir
- Flatten Upstream to 2.25H:1V and stabilize with articulating concrete blocks
- Flatten Downstream Slopes to 3H:1V
- Raise dam crest with parapet wall and earth to provide freeboard during the design storm event (1/3 PMP)
Design and Permitting – Straight-Drop Spillway

• **Spillway has weirs on 3 sides**
  • Side Weirs: Normal Flow
  • Front Weir: >100-YR Storm Event
Design and Permitting – Uplift and Underdrain

• Underdrain System to Reduce Uplift Pressure
Design and Permitting – Other Design Details

- **Downstream Wall Drains**

- **Battered Walls** – provide better compaction of soils against wall
Design and Permitting – Other Design Details

- Wall Extensions – to separate the weir nappe and reduce potential for vibration of the structure
Design and Permitting – Other Design Details

- Rounded Weir Crests – lowered the WSE at 1/3-PMP

- Baffle Blocks
Construction
Construction

- **Contractor:** Crowder Construction Company
- **Construction Schedule:**
  - Start: August 2014
  - Complete: April 2016
Construction

Lake Dewatering

Rehabilitation of Upstream Slope
Construction - Sediment Removal and Subgrade
Construction - Sediment Removal and Subgrade
Construction - Sediment Removal and Subgrade
Construction - Sediment Removal and Subgrade
Construction – Earth Berm

- Keyway added below earth berm
- Intake to remain in place
Construction - Diversion Pipes

- Pipe Cradle and Filter Diaphragms
- Twin 48-inch Diversion Pipes
Construction - Geomembrane

- Supersacks with Geomembrane
- Rehabilitation of Upstream Slope
Construction – Spillway Demolition
Construction – Spillway Demolition and Excavation
Construction – Spillway Excavation and Slab Preparation
Construction – Downstream Cut-off Wall
Construction - Slab

- Upper Slab
- Lower Slab
Construction – Spillway Construction
Construction - Rainfall
Construction – Major Storm Event

- Thursday, October 1, – 3/8 inch of rain overnight, lake levels El. 102, drizzle
- Friday, October 2, 7AM – 3/4 inch of rain overnight, lake levels at El. 104, light rain
- Friday, October 2, 1PM – 5/8 inch of rain since 7AM, lake levels at El. 104, light rain
- Friday, October 2, 8PM – 2 inches of rain since 7AM, lake levels at El. 104, steady rain
- Friday, October 2, 11PM – 2-7/8 inches of rain since 7AM, lake levels at El. 105, steady rain
- Saturday, October 3, 7AM – 2-1/2 inches of rain overnight, lake levels at El. 113, light rain
Construction – Major Storm Event

• Peak lake level El. 114, 3 feet below cofferdam crest
Construction – Mitigation Measures Implemented: Waters Recede
Construction – Mitigation Measures Implemented: Waters Recede
Construction – Spillway Construction Completion
Construction – Diversion Pipe

- Diversion Pipe Removal and Backfilling Around Spillway
Construction – Upstream Slope

- Upstream Slope Stabilization with Articulating Concrete Blocks
Construction – Parapet Wall Construction
Construction – Parapet Wall Construction
Construction Completion April 2016
Construction Completion April 2016

Parapet Wall and ACB

Straight-Drop Spillway
Post-Construction Performance

- **Hurricane Matthew, October 7 through 8, 2016**
  - 15 inches of rain fell in the project area in less than 24 hours
  - Severe flooding and failure of several dams and levees occurred across all of eastern North Carolina
100-year spillway engaged
View from the Crest – Upstream and Downstream
Post-Storm - Sunday October 9, 2016, 9 AM
Thank You

Danielle Neamtu | NeamtuDK@cdmsmith.com