Overcoming Numerous Challenges to Achieve a Reliable Water Supply

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PENNSYLVANIA AWWA – ANNUAL CONFERENCE
April 18, 2019
Outline

- Project background
- Site selection
- Design concepts
- Permitting challenges
- Design & construction challenges
- Results and summary
Project Background

Ellwood City

40 miles

Pittsburgh
Project Background
Project Background

- Existing Ellwood City WTP
  - Built in 1909 east of Ellwood City
  - Source – Slippery Rock Creek
  - Capacity 5.2 mgd
  - Owned and operated by Pennsylvania American Water
Project Background

• Existing plant issues
  – Very poor condition
  – Marginal ability to meet new regulations
  – Reliance on single source – Slippery Rock Creek
  – Requests received for up to additional 4 mgd
    • Limited room on site for expansion
    • Poorly situated relative to new customers
    • Slippery Rock Creek supply is limited
Project Background

- Decision
  - Build new plant west of town
  - Accessible to larger Beaver River with adequate supply
  - Closer to new customers
  - Site and source suitable for 8 mgd and expandable to 16 mgd.
Project Background

- Site selection conducted by PAW in 2014
- Various sites west of town examined
- While studies were proceeding ....
Charleston WV

January 2014

Elk River
Lynchburg VA

April 2014

James River
Project Background

• New criteria – find site with two independent sources
• Motivated decision for site near confluence of Beaver River and Connoquenessing Creek
• Both new sources able to support system demands independently
• Annual 7-day minimum flow:
  – Beaver River – 61 mgd
  – Connoquenessing Creek – 33 mgd

• *The right decision does not always lead to the easiest solutions*
Project Background

New Site

Existing WTP

Excellence Delivered As Promised
Project Background

- In 2015 Gannett Fleming was retained to assist Pennsylvania American Water with completion of the **raw water facilities**.
- This presentation addresses this aspect of the project
- Preliminary design completed in 2015
- Final design completed in 2016
- Construction begun in spring of 2017
Intake Site Selection

Beaver River

Connoquenessing Creek
Intake Site Selection

Selected site provided access to two supplies but:
- Required numerous physical challenges
- Involved many stakeholders, permits and approvals
Intake Site Selection

- Two intakes would be connected to a single raw water pump station (RWPS)
- RWPS must be on plant site - no vehicle access available to river
- Intakes designed for 16 mgd so PAW would not have to go back to either intake for expansion
Intake Design Concept

- **Beaver River Intake**
  - Survey found site with 8-ft minimum depth
  - Designed for 16 mgd full barrel Wedgewire screens
    - Two 33” diameter, 112” length
    - One 24” diameter raw water main
Intake Design Concept

- Connoquenessing Creek Intake
  - Survey found site with 3.5-ft minimum depth
  - Designed for 16 mgd half barrel WedgeWire screens
    - Four 18” radius, 110” length
    - Two 24” diameter raw water mains
RWPS Design Concept

- Raw Water Pump Station
  - Deep dry-well caisson pumps
    - Three vertical turbine pumps and space for a 4th pump
    - Each 5.34 mgd at 204’ TDH
    - 300 HP premium efficiency motors
  - Sodium permanganate feed for oxidation and mussel control
  - Two intake screen airburst systems
Permitting

- Might be a textbook case for permitting in Pennsylvania.
- Permits and approvals included:
  - Two new PADEP water allocation permits
  - Two new PADEP new-source permits
  - Navigation impact avoidance on the Beaver River
  - Three major railroad crossings (CSX and Norfolk Southern)
    - And two sidings
  - Power transmission main right-of-way crossings
  - Steep topography
Permitting

- Permits and approvals continued:
  - Potential underground mining
  - *Likely archaeological sites*
  - State road crossing and access
  - Local road crossing and access
  - Two stream obstruction and encroachment permits
  - *Endangered species survey*
  - Strict fish protection requirements
Permitting

- Railroad crossings added major effort, costs and delays
- Resulted in design changes and construction delays and added costs
Permitting

• Phase I archaeological survey got hits
  – Decision made to micro-tunnel to avoid critical areas
• Endangered species – found Indiana bat habitat,
  – Required construction schedule adjustments

Area 2 near Connoquenessing Intake
Permitting

- New source permitting
  - Required extensive 3+ year sampling program
  - Samples required at **exact** location and depth of intake (in the stream)
  - Sites were not easily accessible
  - Designed and constructed pumping system
New Source Permitting – Sample Pump and Box
New Source Permitting – Sample List

- Parasites - Cryptosporidium
- Turbidity
- Water Temperature
- pH
- Volatile Organic Chemicals (21)
- Synthetic Organic Chemicals (30)
- Inorganic Chemicals (16)
- Radionuclides (4)
- Secondary Contaminants (16)
- Microbiological Contaminants (LT2)
- Total Coliform Bacteria
- E. Coli
## New Source Permitting - Sampling Plan

### Contaminant List

<table>
<thead>
<tr>
<th>Contaminant Group</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parasites</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Turbidity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each Source</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAW WTP Lab</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td><strong>Total Coliform Bacteria</strong></td>
<td>Freedom Associates, Inc.</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>E. Coli</strong></td>
<td>Freedom Associates, Inc.</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Water Temperature</strong></td>
<td>Field Measurement by Sampler</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>PAW WTP Lab</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td><strong>Volatile Organic Chemicals</strong></td>
<td>Belleville Lab or Microbac</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>21 Separate Compounds</td>
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<td></td>
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<tr>
<td><strong>Synthetic Organic Chemicals</strong></td>
<td>Belleville Lab or Microbac</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>30 Separate Compounds</td>
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<tr>
<td><strong>Inorganic Chemicals</strong></td>
<td>Belleville Lab or Microbac</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>16 Separate Compounds</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Including Asbestos</strong></td>
<td>External Lab or Microbac</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td><strong>RadioNuclides</strong></td>
<td>External Lab or Microbac</td>
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<td>X</td>
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<tr>
<td>4 Separate Compounds</td>
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<tr>
<td><strong>Secondary Contaminants</strong></td>
<td>Belleville/External Lab/Microbac</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>16 Separate Tests</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td><strong>pH (Captured in LT2 Sampling)</strong></td>
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<tr>
<td><strong>Microbiological Contaminants</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Coliform Bacteria (Included in LT2 Sampling)</strong></td>
<td>* Enumeration</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>E. Coli (included in LT2 Sampling)</strong></td>
<td>* Enumeration</td>
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</tbody>
</table>

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* Sampling was initiated April 2015. A boat was used to collect samples from the proposed intake locations using the "Alternate Sampling Procedures" until the approved sample intake arrangement was installed in November 2015.

* Includes Matrix Spikes.

* Informational Samples will be collected monthly, beginning January 2015, to better characterize the raw water quality for WTP process design purposes. Samples will be analyzed for parameters shown on Attachment D.

Note: Informational samples are not unique to the New Source Permitting Sampling. Sampling may be terminated earlier than indicated and may be continued for a longer duration. Sample analyses may be added or deleted from the Informational Samples. Informational sample data will be included with the PWS application.

Where Informational sample analyses duplicate analyses to be performed as part of standard new source sampling, parameters will not be analyzed in duplicate.

* Laboratories subject to change. Certified laboratories will perform analyses other than required field measurements.

* A new source sample set was collected during January 2016, prior to PADEP approval of the sampling plan. PADEP approved new source sampling to be initiated February 2016.
New Source Permitting - Connoquenessing Creek

Temporary Raw Water Sample Station Location

From North Bank Looking Downstream
New Source Permitting - Beaver River

Streambank sample line to sample box

Sample line out to intake and pump
New Source Permitting

- System really worked well until it came time to start construction of actual intake
- No major issues found with water quality
- LT2 sampling supported Bin 4 classification
Design Challenges

- WTP and original RWPS sites separated by NS and two Siding Tracks.
- NS granted approval for 5 large diameter jack and bore utility crossings
  **but**
- Rejected approval of a permanent at-grade crossing.
Design Challenges

- **Resolution** –
- Shift the RPWS to the WTP site
- Resulting in:
  - 20 feet deeper caisson and
  - 270’ longer tunneling at the base of the caisson.
Design Challenges

• Redesign of RWPS to attach to the WTP’s High Service Pump Station
• **Resolution** –
• Modify and merge the design of two consultants (GF and BH) to a unified structural design
• Prepare a common set of merged construction documents.

Raw water pump station shaft and completed walls.
Design Challenges

- Inability to obtain a WTP outfall discharge permit on the WTP site
- PADEP wanted the outfall directly to the Beaver River.
Design Challenges

• **Resolution –**
• Routed the 24” outfall line:
  – to the RWPS
  – vertically down the caisson shaft
  – through the RWPS tunneling
  – to a new Outfall Structure downstream of the Beaver River Intake
Design Challenges

• Tunneling from the RWPS caisson to the west side of Beaver River carrying many utilities
  – Gravity flow raw water supplies from creek and river
  – High pressure finished water line from the WTP to the distribution system
  – WTP outfall line
  – Chemical feed lines
  – Sample Lines
  – Air Burst Supply Line to Intake arrays
Design Challenges

Resolution –
Provide two tunnels, 60” and 75”, rather than one large tunnel to provide redundancy in the event of any utility issues
Design Challenges

• Phase 1 archaeological survey found resources near the Connoquenessing Intake
• Phase 2 study recommended
• Potential project delay of years
Design Challenges

Resolution –
• Micro-tunnel under NS railroad tracts to a cleared area fronting the creek intake array
• 500 feet of 75” micro-tunneled casing
Construction

• Construction began spring of 2017
• Contractor and Subcontractor:
  – Reynolds Construction LLC,
  – Mascaro Construction Company LP
• Cost: $80 million
Construction Challenges

• Twin tunnels at the base of caisson to west side of Beaver River cross very active CSX railroad track.
• CSX denied temporary at-grade crossing during construction
• Imposed severe construction requirements on the micro-tunneling
Construction Challenges

- **Resolution** –
  - Reynolds and micro-tunneling sub met CSX requirements.
  - PAW paid for full time CSX inspection service.
  - Reynolds developed alternate plan for retrieval of micro-tunneling equipment at the two retrieval pits on the west side of Beaver River.

![Installing pipe in tunnel No 1](image_url)
Construction Challenges

• At alternate means for access to west side of Beaver River was needed
• Original plan was use of stacked box culverts to pass Beaver River waters and top used as a drivable bridge
• Hydraulic modeling showed frequency culverts would be topped in normal construction year from rainfall events
• Delivery times for culverts was too long
• Reynolds decided risk was not acceptable
Construction Challenges

- **Resolution** –
- Construct a floating bridge to access the west side of the Beaver River
Construction Challenges

- The east side of the Beaver River has an active NS track and railroad bridge crossing
- NS initial would not allow an at-grade crossing and
- Later rejected a temporary construction crossing under the railroad bridge.
Construction Challenges

- **Resolution** –
  - NS ultimately agreed to a temporary at-grade crossing of its tracks
  - NS full time inspection was required throughout the construction period.
Construction Challenges

- Historic rainfall for Ellwood City for 2018 construction year:
- Wettest year on record (58 inches versus 38.1 normal)
- Multiple flooding events at Beaver River during construction
  - Flooding of micro-tunnel launch and receiving pits.
  - Flooding of RWPS caisson from back flow from receiving pits.
  - Flooding of sheeted excavation pit for River and Creek intake array.
  - Loss of floating bridge.
  - Submergence of construction materials/equipment.
  - Flooding of sheeting for concrete encased utility crossing of Beaver River.
Construction Challenges

West side of Beaver River Sept 2018

East side of Beaver River Sept 2018
Construction Challenges

- Resolution –
- Extended work hours and work week to make up timing when possible

Flooding at Tunnel #2 launch pit and Connoquenessing Intake
Recent Photo – Raw Water Pump Station
Recent Photo - Connoquenessing Intake Screens
Recent Photo – Connoquenessing Transition Chamber
Site Photos

- Water and Wastewater Digest named Ellwood City WTP #1 Top Project for 2018
Summary and Lessons Learned

- Site selection and conceptual design must consider all potential design, construction and operational issues when ranking sites.
- A goal of redundant supplies must consider each design element to insure N + 1 design throughout.
- Do not underestimate the cost of dealing with railroads in time, money and patience.
- New source development must consider the extensive and lengthy sampling requirements.
- The much higher risk of archaeological issues along rivers and creek must also be considered in site selection and project planning.
Acknowledgements

• Scott Thomas - Project Manager for Pennsylvania American Water and the rest of the PAW staff
• Reynolds Construction LLC, and Mascaro Construction Company LP for many of the photos shown
• Everyone from the regulatory agencies that worked with us.
• Gannett Fleming and Buchart Horn Design Teams on the collaborative design.
Thank You

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