Overcoming Numerous Challenges to Achieve a Reliable Water Supply

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PENNSYLVANIA AWWA – ANNUAL CONFERENCE
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Outline

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

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Project Background

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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

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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

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Lynchburg VA

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Toledo OH

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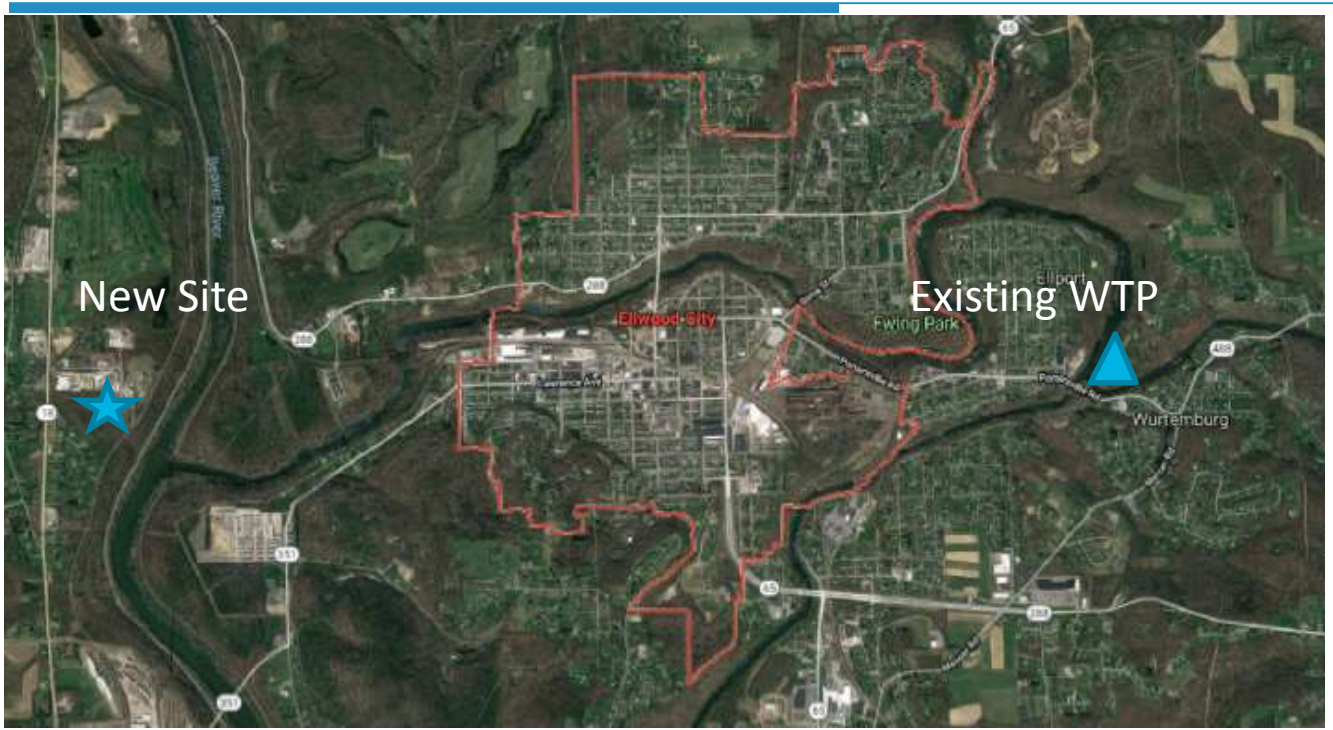
Project Background

- 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



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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

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Intake Site Selection

Selected site provided access to two supplies but:

-Required numerous physical challenges

-Involved many stakeholders, permits and approvals

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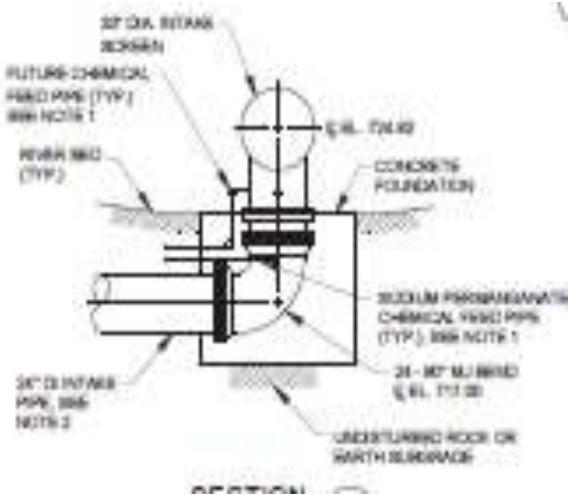
Intake Site Selection

- 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



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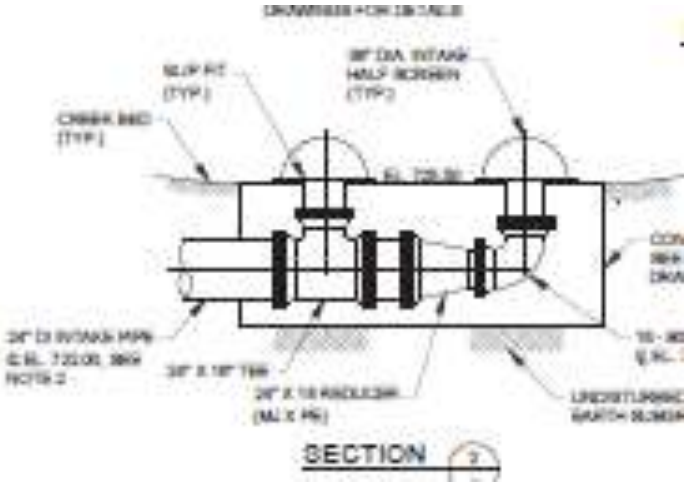
Intake Design Concept

- 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



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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

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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

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Permitting

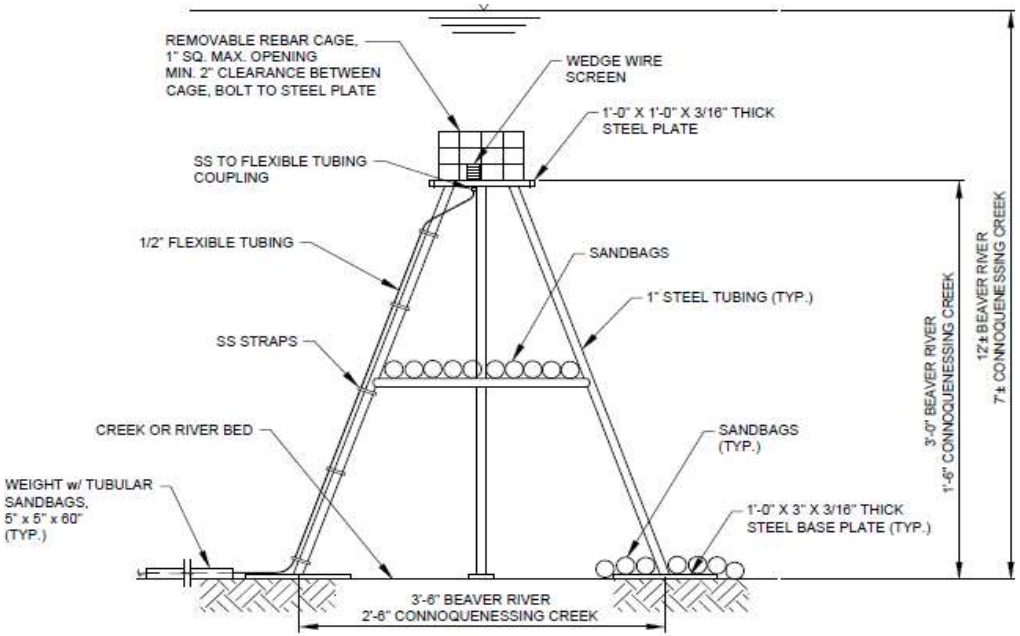
- Phase I archaeological survey got hits
  - Decision made to micro-tunnel to avoid critical areas
- Endangered species – found Indiana bat habitat,
  - Required construction schedule adjustments

Area 2 near Connoquenessing Intake

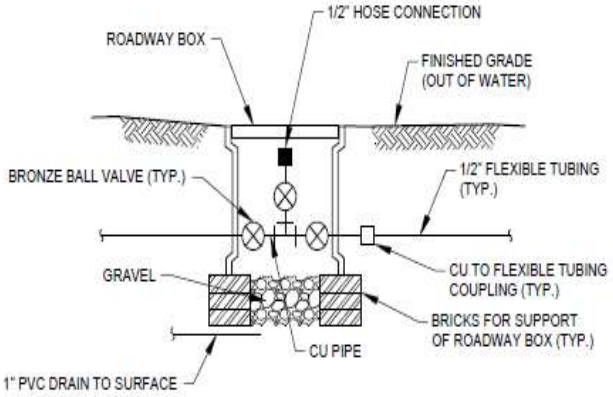
Permitting

- 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



ELEVATION



VALVE/SAMPLE BOX DETAIL A

NO SCALE

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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

2015 2016 2017 2018

Pennsylvania American Water Company - Ellwood City New Source Sampling Plan

Sampling will be Coordinated by Kristy Donaldson, WQ Supervisor, NW PA

		2015[1]									2016												2017											
Contaminant Group	Lab[4]	4/28/2015[2]	5/26/2015	6/22/2015	7/27/2015	8/24/2015	9/28/2015	10/26/2015	11/23/2015	12/28/2015	2/25/2016[2]	2/22/2016[5]	3/28/2016	4/25/2016	5/23/2016	6/27/2016	7/25/2016	8/22/2016	9/26/2016	10/24/2016	11/28/2016	12/26/2016	1/23/2017	2/27/2017	3/27/2017	4/24/2017	5/22/2017	6/26/2017	7/24/2017	8/28/2017	9/25/2017[2]	10/23/2017	11/27/2017	12/26/2017
Parasites - *Cryptosporidium*	External - Eurofins	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Turbidity - Each Source	PAW WTP Lab	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Total Coliform Bacteria	Freedom Associates, Inc.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
E. Coli	Freedom Associates, Inc.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Water Temperature	Field Measurement by Sampler	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	PAW WTP Lab	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Informational Sample Set[3]	Belleville Lab or Microbac										X	X	X	X	X	X	X	X	X															
Volatile Organic Chemicals	Belleville Lab or Microbac										X	X			X			X																
21 Separate Compounds																																		
Synthetic Organic Chemicals	Belleville Lab or Microbac										X	X			X			X																
30 Separate Compounds																																		
Inorganic Chemicals	Belleville Lab or Microbac										X	X			X			X																
16 Separate Compounds																																		
Including Asbestos	External Lab or Microbac																																	
RadioNuclides	External Lab or Microbac										X	X			X			X																
4 Separate Compounds																																		
Secondary Contaminants	Belleville/External Lab/Microbac										X	X			X			X																
16 Separate Tests																																		
pH (Captured in LT2 Sampling)																																		
Microbiological Contaminants																																		
Total Coliform Bacteria (Included in LT2 Sampling) - Enumeration																																		
E. Coli (included in LT2 Sampling) - Enumeration																																		

[1] 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.

[2] Includes Matrix Spikes.

[3] 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 that Informational samples are not a requirements for New Source 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.

[4] Laboratory subject to change. Certified laboratories will perform analyses other than required field measurements.

[5] 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.

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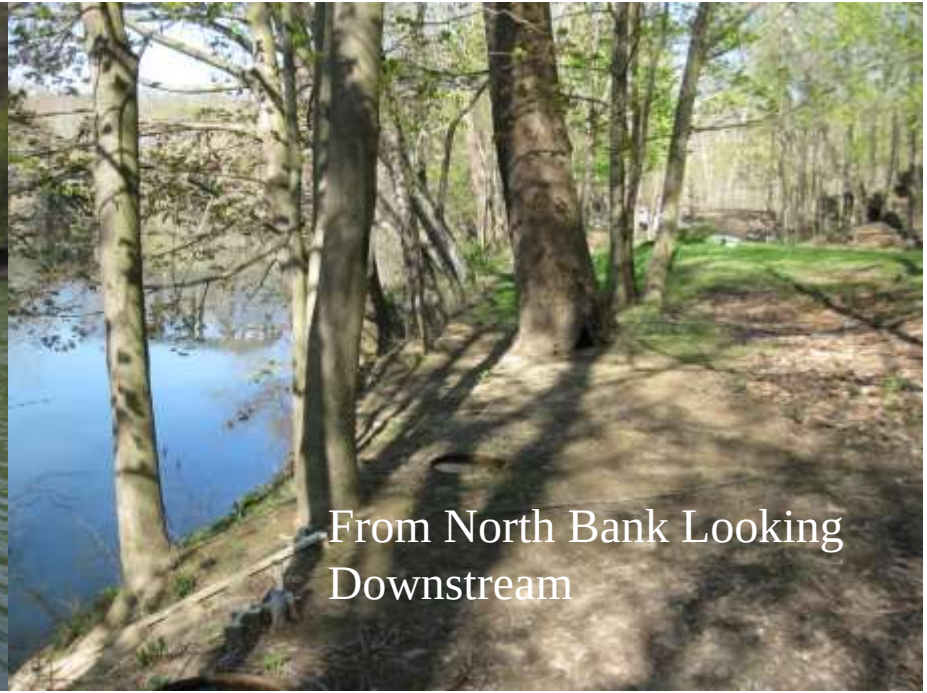
New Source Permitting - Connoquenessing Creek



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New Source Permitting - Beaver River

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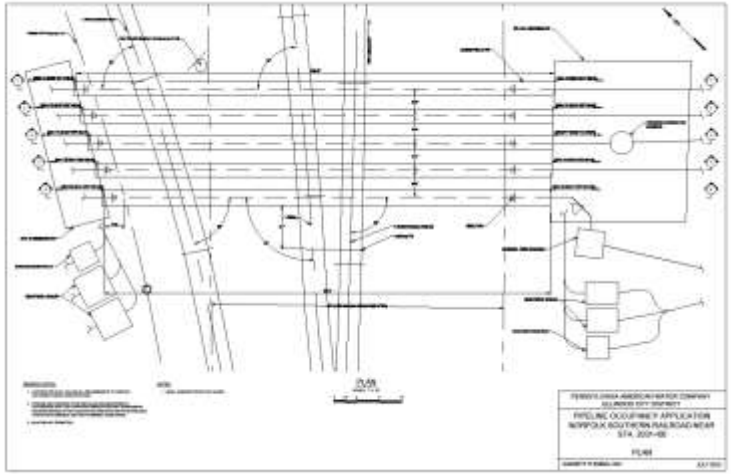
New Source Permitting

- 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.



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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.

Final Caisson Wall Pour

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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.

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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

Tunnel No 2 receiving pit

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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

Piping coming into shaft from caisson

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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

Prepping MTBM to start tunneling

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Construction

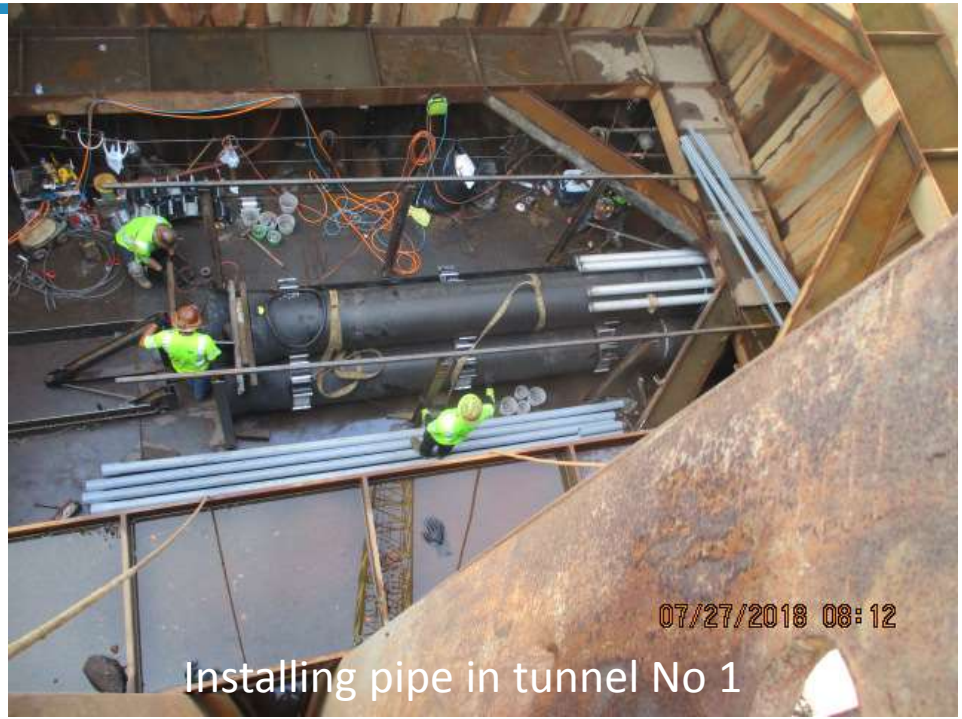
- Construction began spring of 2017
- Contractor and Subcontractor:
  - Reynolds Construction LLC,
  - Mascaro Construction Company LP
- Cost: $80 million

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

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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

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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.

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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

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Construction Challenges

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

Flooding at Tunnel #2 launch pit and Connoquenessing Intake

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Recent Photo – Raw Water Pump Station

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Recent Photo - Connoquenessing Intake Screens

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Recent Photo – Connoquenessing Transition Chamber

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Site Photos

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

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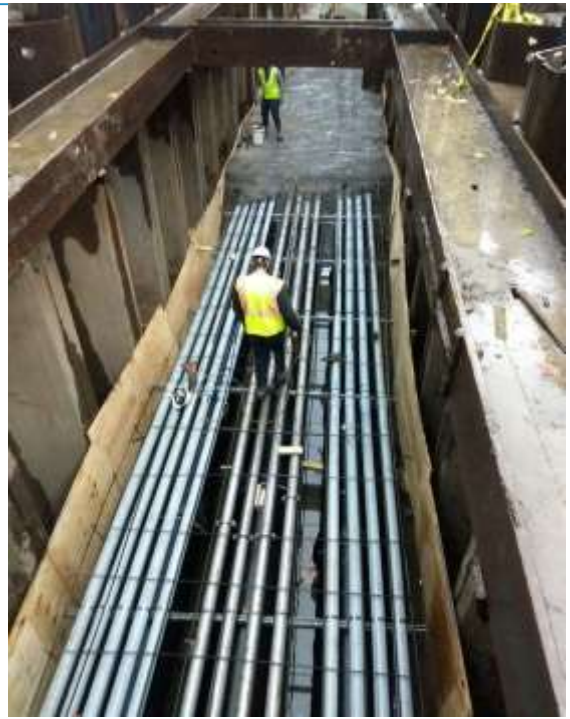
Summary and Lessons Learned

- 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.



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Thank You

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