Tunneling to Meet the Speed of Economic Development

The Blacklick Creek Sanitary Interceptor Sewer (BCSIS)

Presenters:
Nick Domenick, PE – City of Columbus
Michael Garnes, PE - EMH&T

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EDUCATION. PRESERVATION. DEDICATED TO YOUR WATER ENVIRONMENT.

Ohio Water Environment Association
Collection Systems Specialty Workshop
May 17th, 2018

AGENDA

1. Project Background
2. Key Design Constraints and Final Design Components
3. Construction
4. Current Project Status

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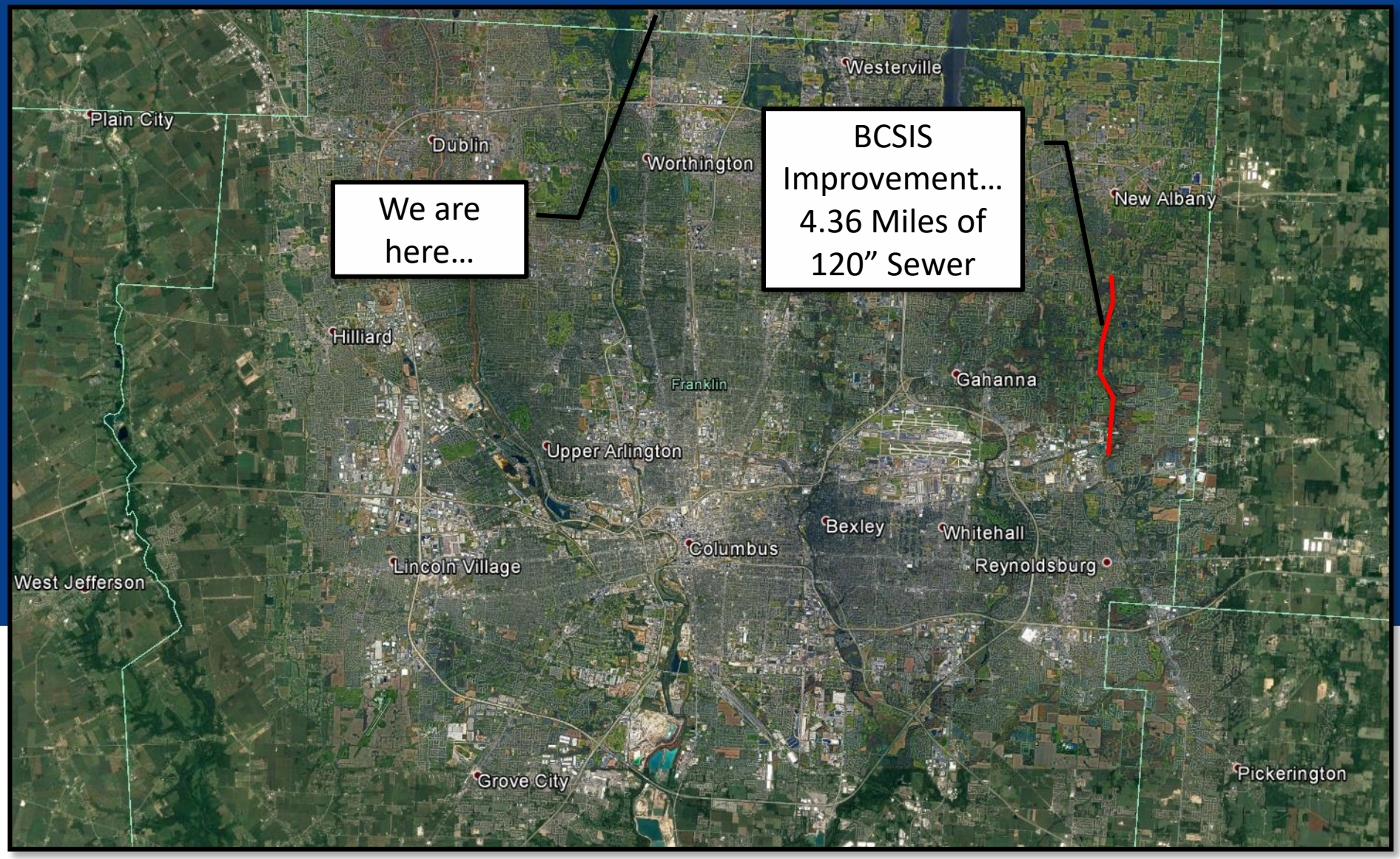
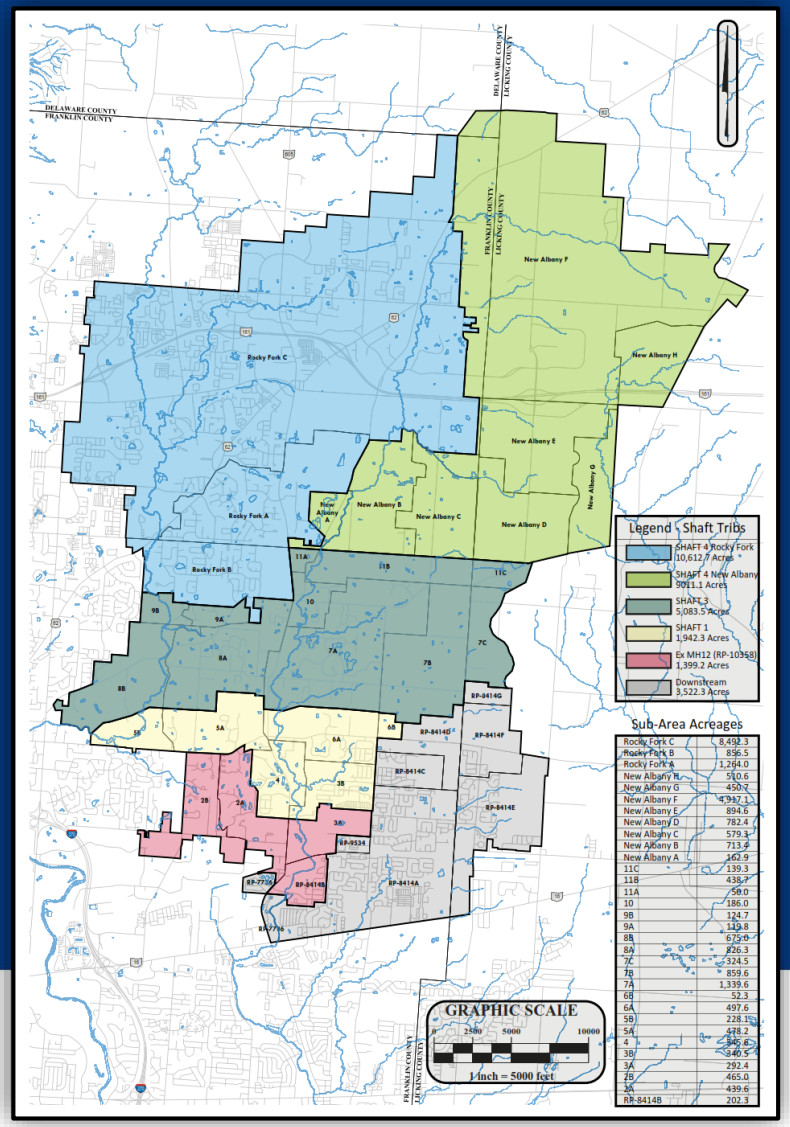
Perspective – Where we are….



Purpose

Need for Investment/Project

- ❑ Multi-Jurisdictional
  - Agreement between Columbus & Local Communities (JWSD and New Albany)
- ❑ Support Comprehensive Plans for Jefferson Township, New Albany and City of Columbus within the Blacklick Tributary Area
- ❑ Service Area
  - 28,000 Acre Tributary Area
    - Blacklick Creek Sewershed (10,600 Ac)
    - Rocky Fork Sewershed (17,200 Ac)



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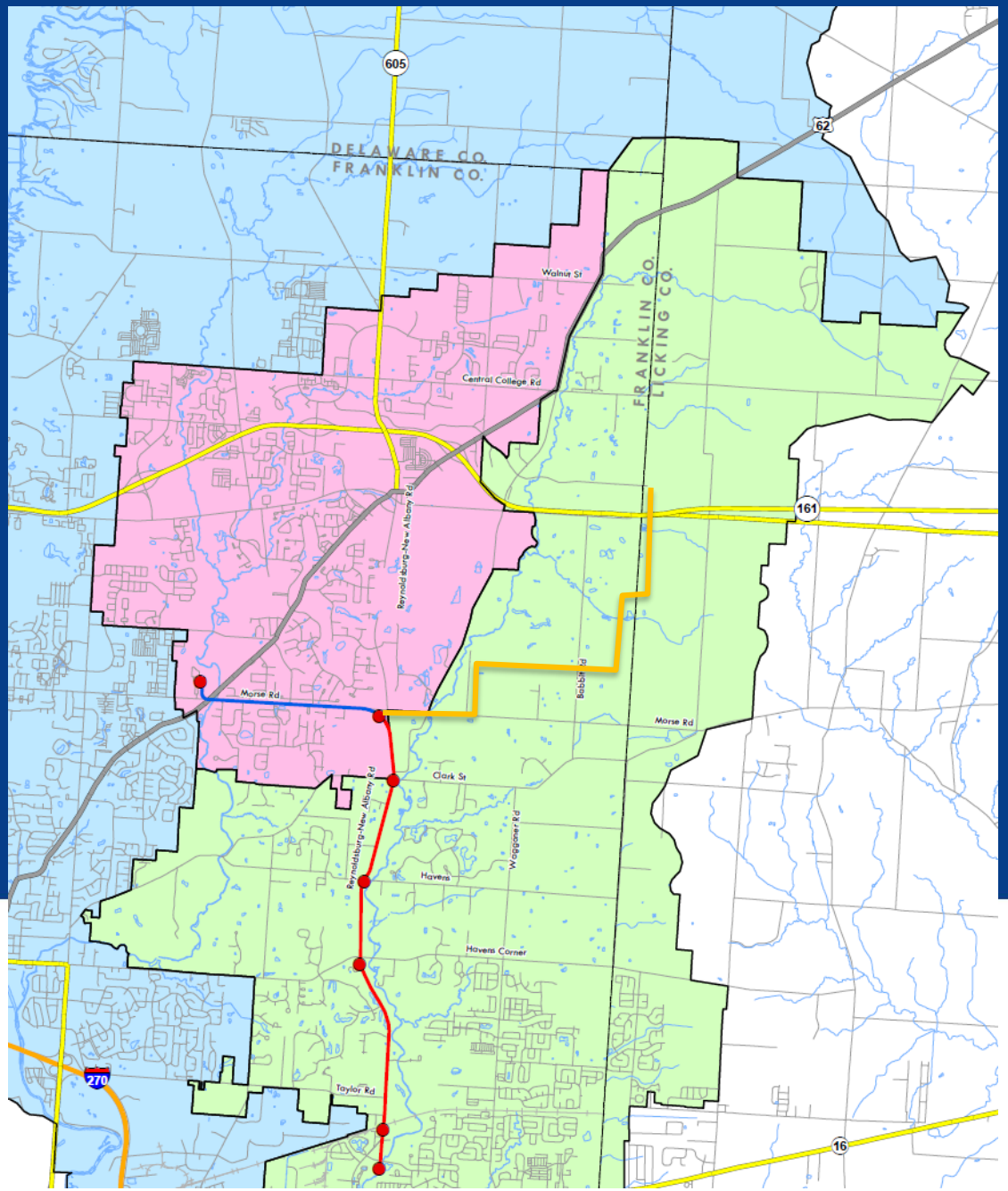
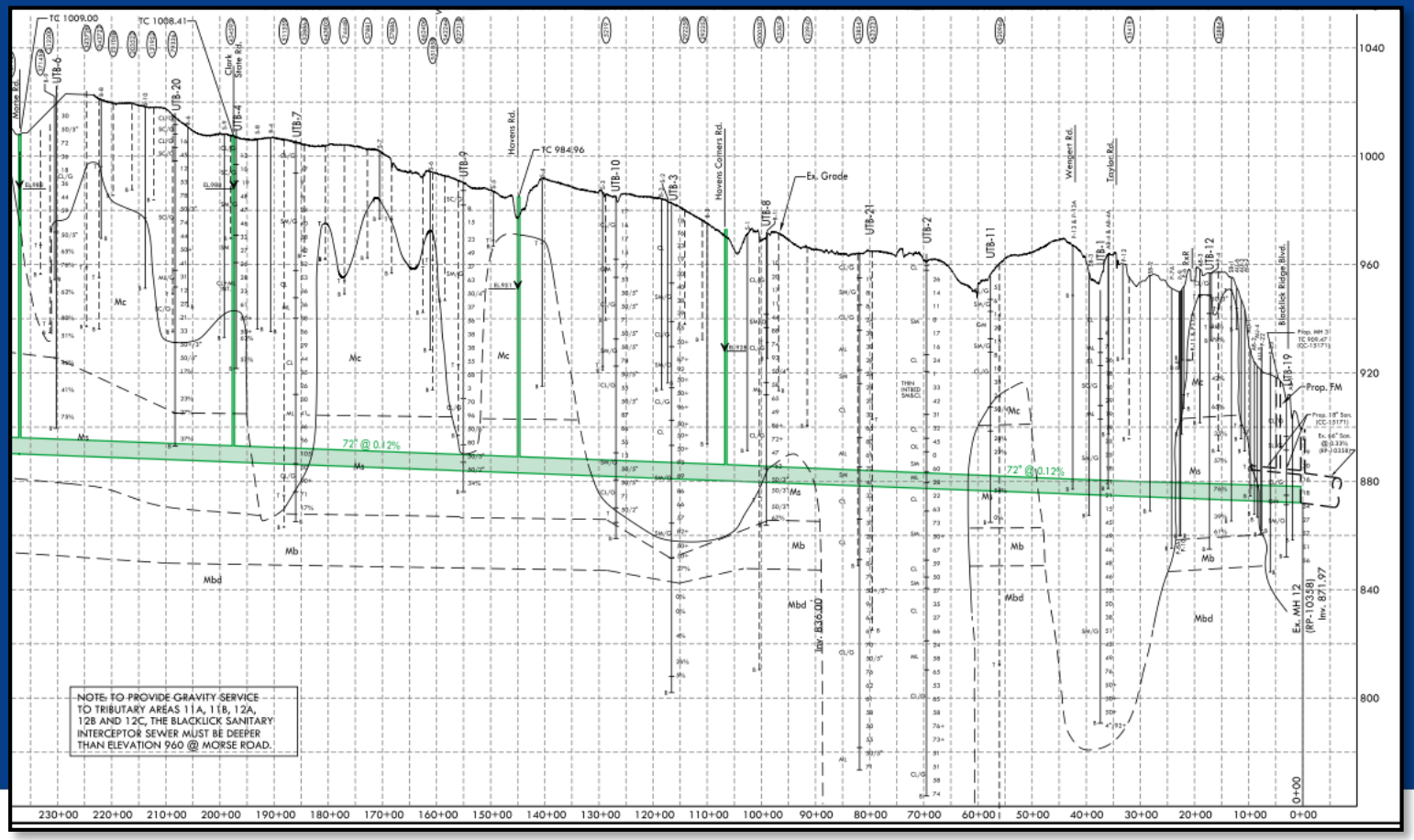
Operational Flexibility

- Service
  - Blacklick Sewershed
    - BCSIS
    - BCTS
  - Rocky Fork Diversion
    - Big Walnut Sewershed
    - Divert flow to support growth



Key Design Considerations



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What are our Design Constraints?

- Schedule – City had commitment to contract communities
- Subsurface Conditions
  - Geology – Understand “complex” subsurface within glaciated till plain; Bedrock Lithology and Buried Valleys
  - Hydrogeology – Protection of Groundwater and Private Wells
- Alignment
    - Land Acquisition
    - Serviceability – Contracted Connection Points for New Albany and Jefferson Water and Sewer District
- Constructability/Risk Management – Microtunnel, TBM, EPBM, shafts,
- Impacts to Area – Maintenance of traffic, construction area aesthetics,…
- Cost

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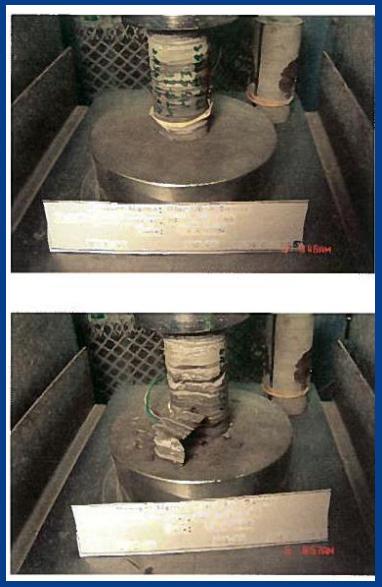
Geotechnical Investigation

- 107 Geotechnical Borings
- Vertical ft drilled = 12,025 ft/2.34 miles
- 42 Monitoring Wells total
- 12 soil to rock transitions
- 907 Total Tests - 522 Soil Tests + 385 Rock tests
- Geophysics at locations of Transition Zones



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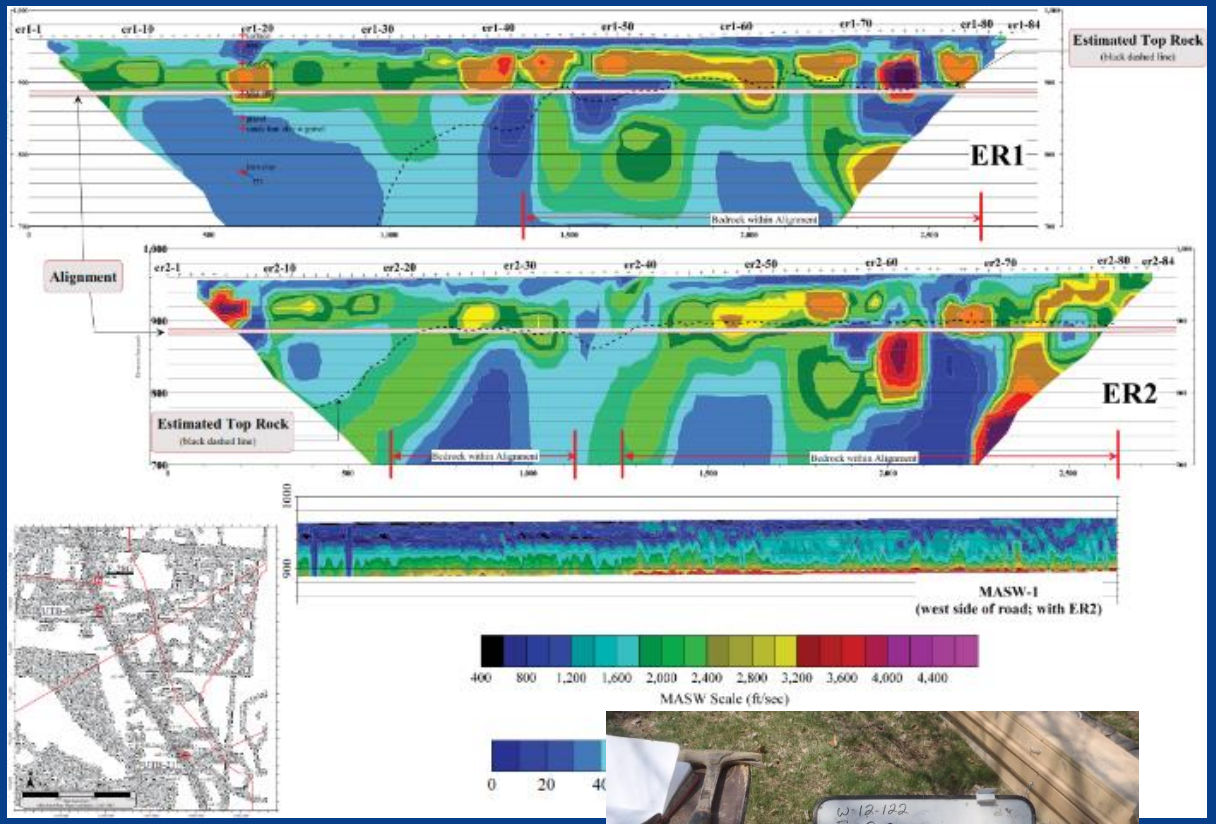
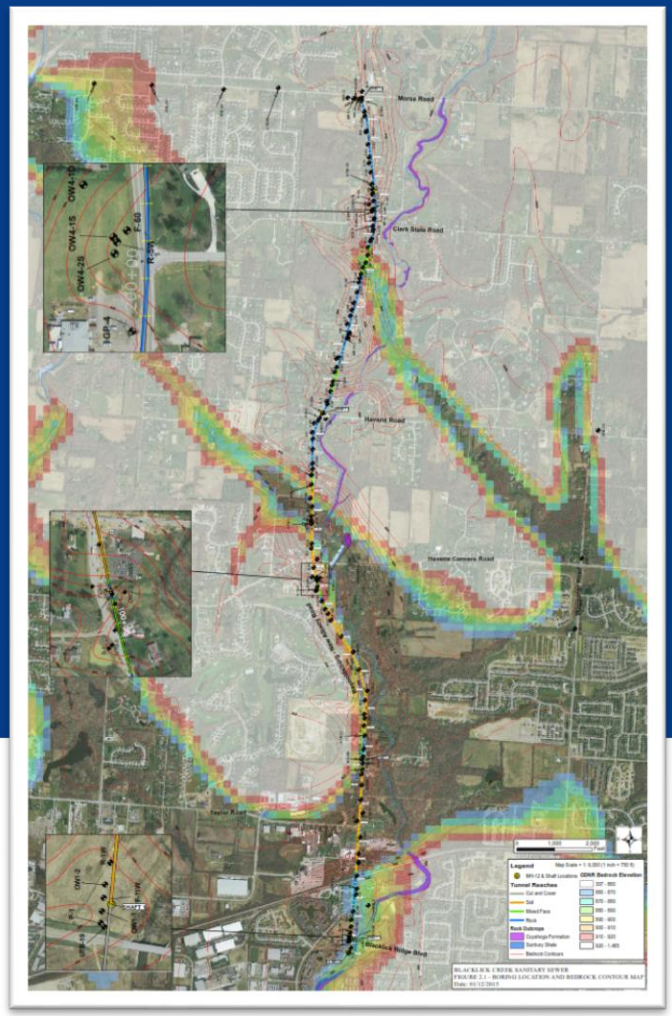
Geology of Project Corridor





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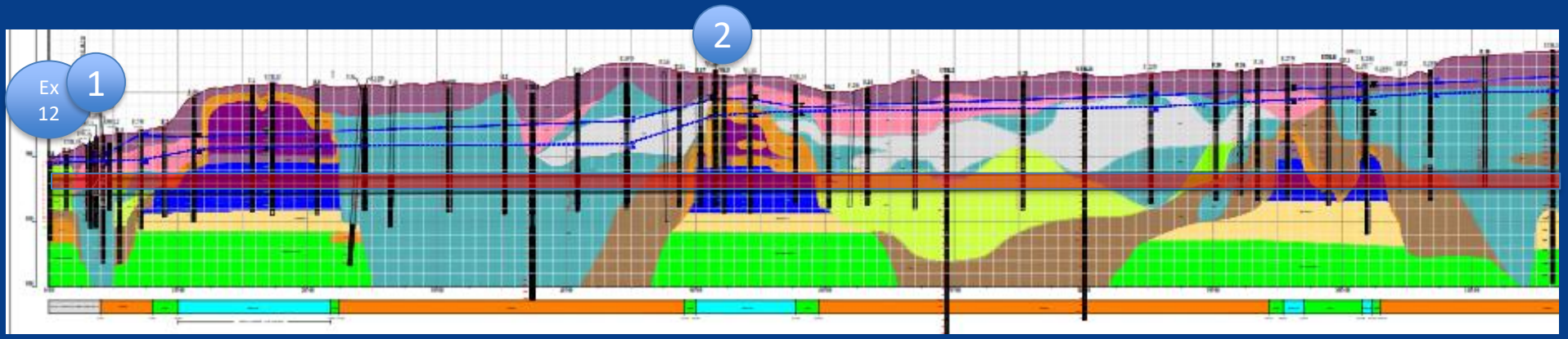

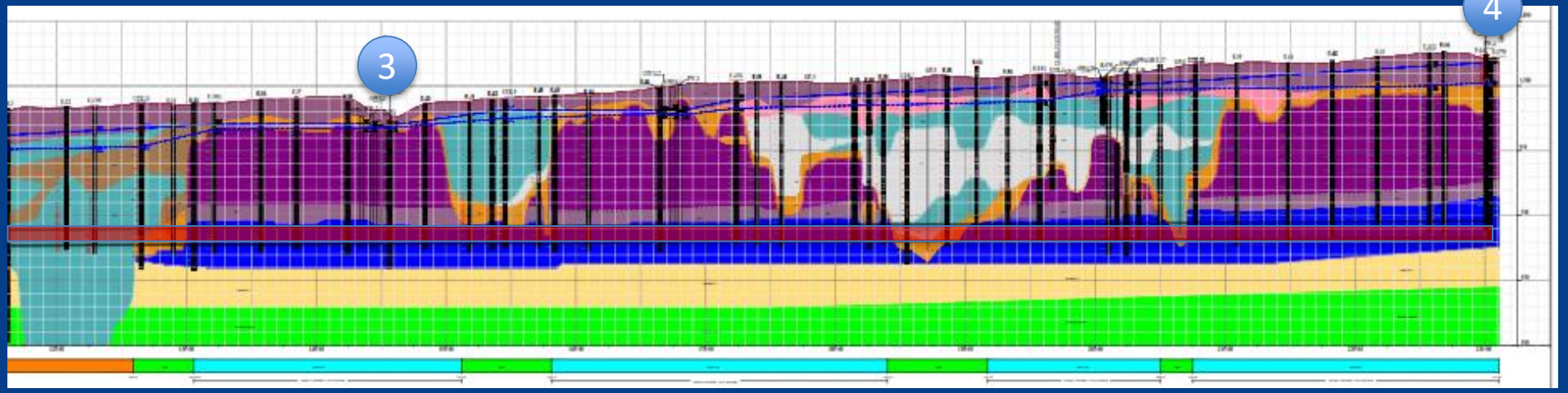

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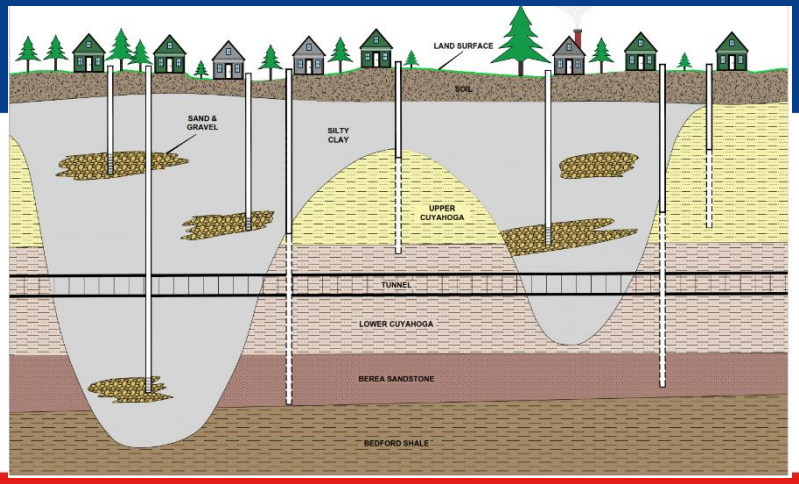
Subsurface Conditions

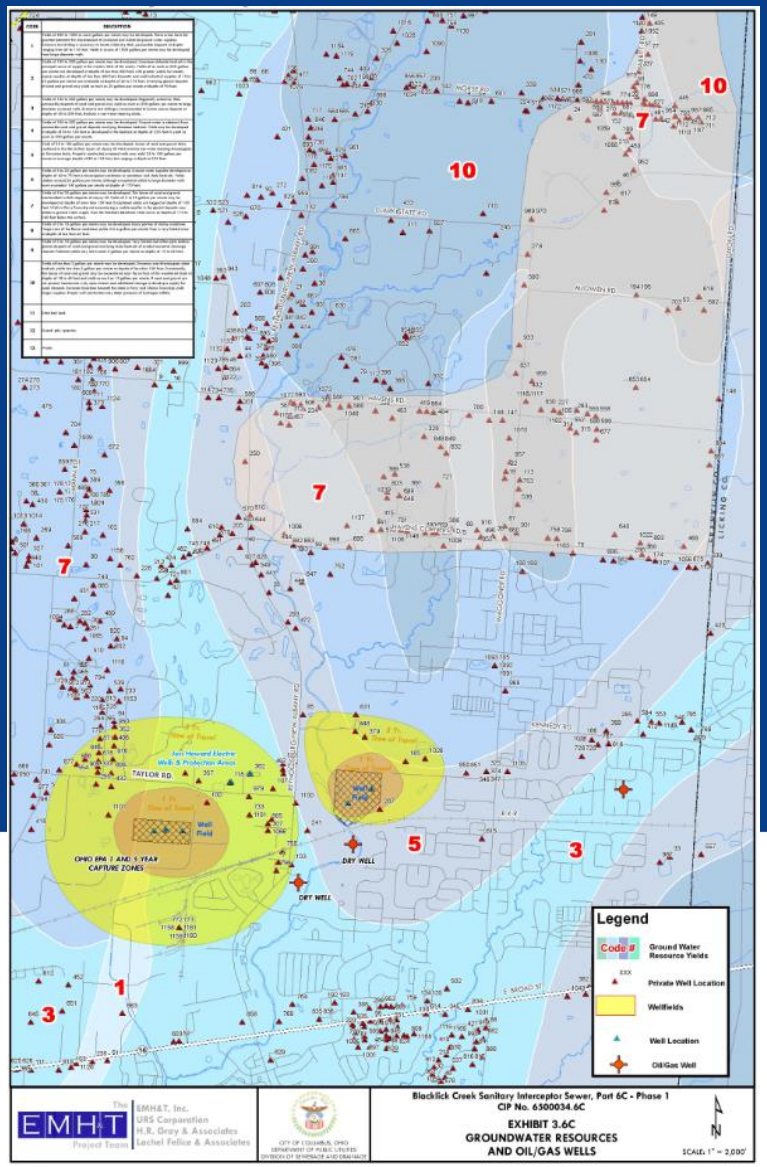
- Bedrock (3 Bedrock Units)
- Soil (7 Soil Units)
- Transitional Material (1 Unit)

All defined in the GBR

Hydrogeology of Project Corridor

- Protection of Groundwater was a major driver in the design of the project…
  - Approx. 240 Wells within ¼ Mile
  - Approx. 610 Wells within ½ Mile
- At Public Meeting residents expressed concern on impacts on wells
- Specifications limit impact to groundwater for shaft and tunnel construction
  - Maximum Groundwater drawdown limit
  - Heading Inflow/Shaft Inflow Limits (in GBR)
- Defined in the Specifications and GBR
  - Hydrogeologic Report in Appendix of GDR





Hydrogeology of Project Corridor

WELL SURVEY – DEFINE CURRENT CONDITIONS

- Wells within ¼ Mile of Shafts & 600 feet of Tunnel
- Measured Static Water Levels
- Measured Drawdown & Pumping Rate
- Basic Water-Quality Parameters
- Temporary Water Supply & Action Plan

1 Documentation of Baseline Conditions

- Well Log Search - Spring 2014
- Door-To-Door Residential Well Survey - Summer 2014
- Residential Well Performance & Water-Quality Testing - Summer 2014
- Compile Residential Well Database - Fall 2014

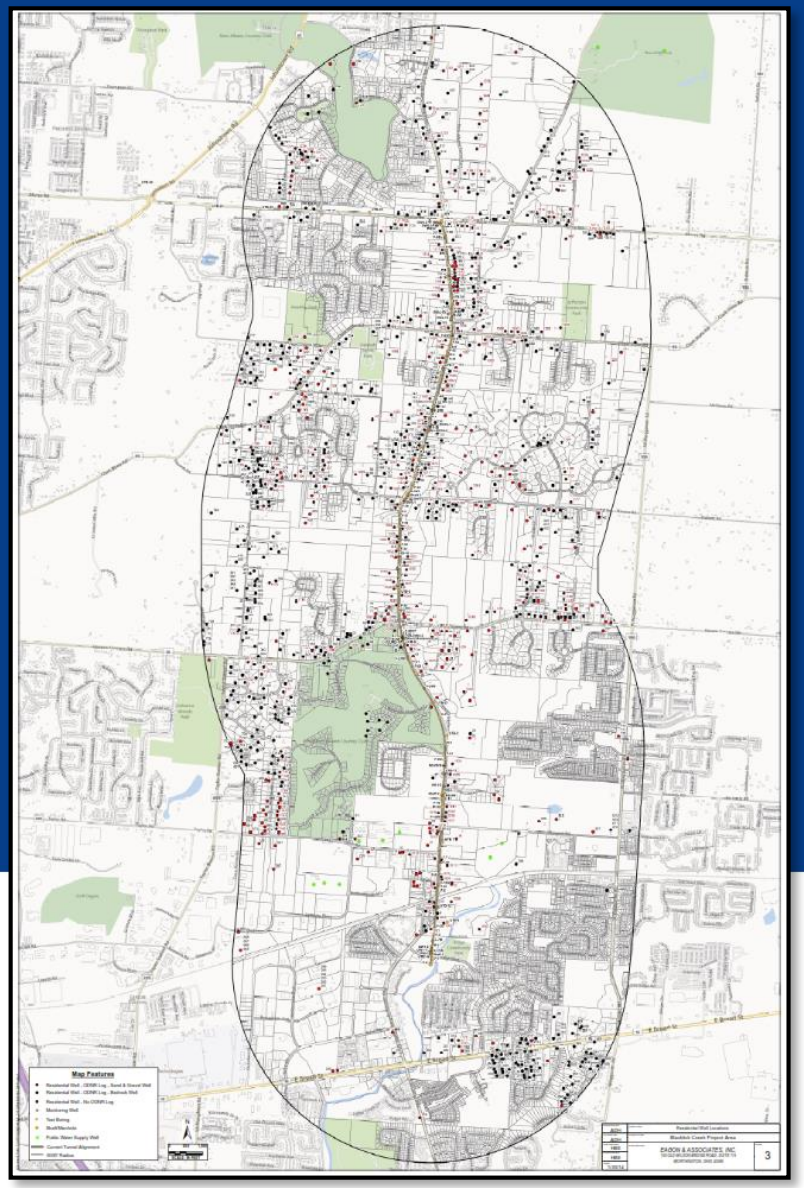
2 Pre-Construction Water-Level Monitoring

- Establish Monitoring Network - March 2016
- Begin Routine Monitoring - April 2016
- Routine Water-Level Monitoring of Observation Wells - 2012-2016

3 Water-Level Monitoring During Construction

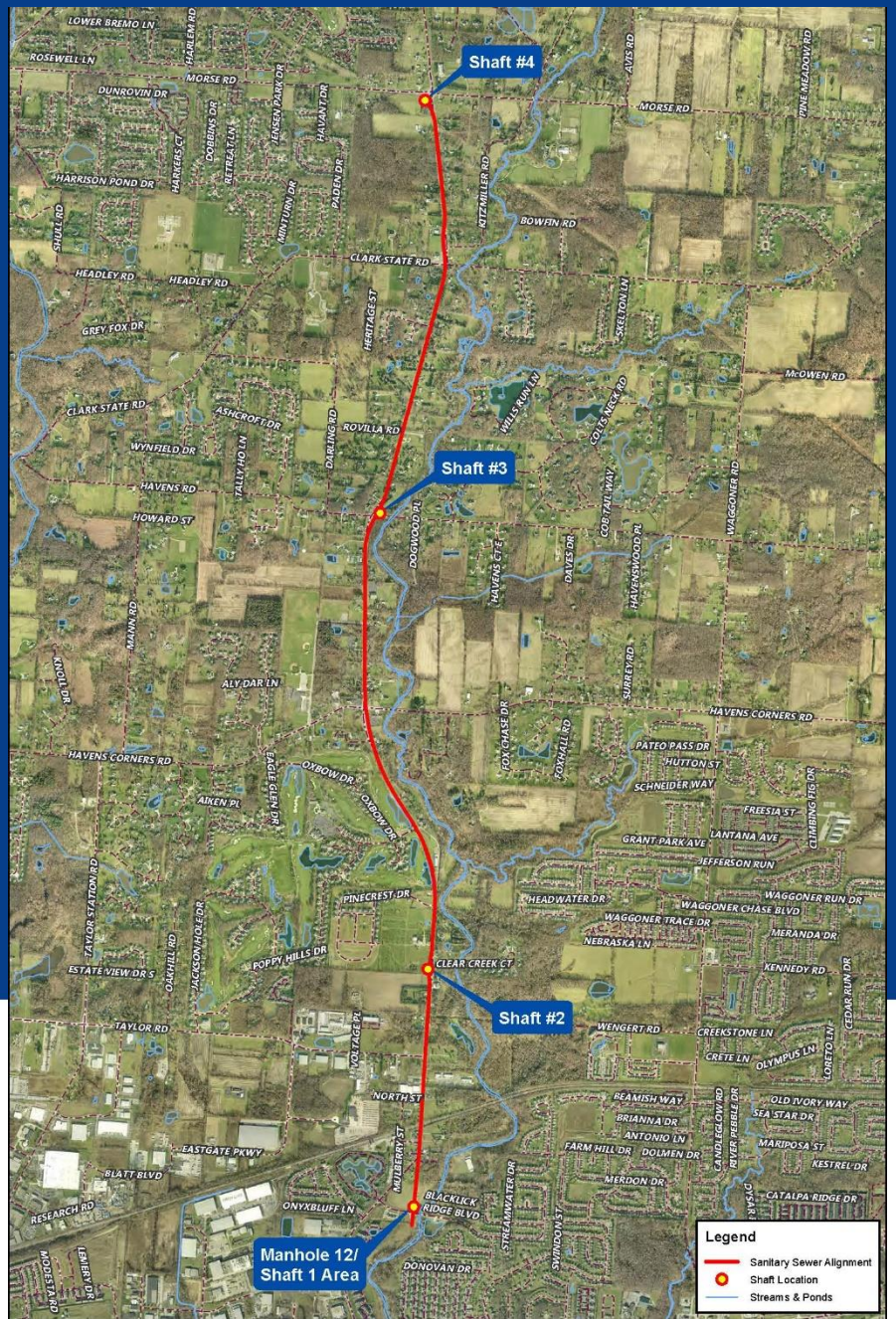
- Continue Routine Water-Level Monitoring
- Evaluate Trends in Water-Level Data
- Investigate Significant Changes in Water Levels

4 Expand Network as Needed



Final Alignment

- Generally follows Reynoldsburg - New Albany Road
- Launch Site (Shaft 1) at Blacklick Ridge Boulevard
- Intermediate Shafts 2 & 3
- Terminus (Shaft 4) Morse Road
- Gravity at 0.052% Slope



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Shaft Construction Methods

- Performance Specifications for Support of Excavation
- 8’ Finished Riser Diameter (Shafts 1-3)
- Shaft 4 is a Baffle Drop Structure for Multiple Connections
- Drill and Blast for Rock Excavation
- DEWATERING PROHIBITED (WATERTIGHT CONSTRUCTION REQUIRED) AT…
  - SHAFTS 3 AND 4
  - TRANSITIONAL MATERIAL AND ROCK ON SHAFT 2

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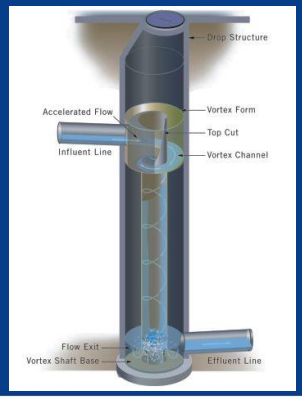
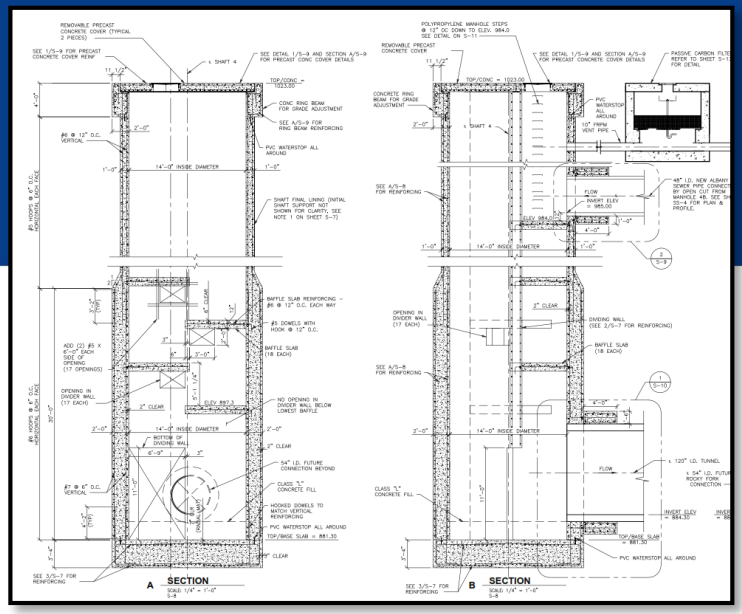
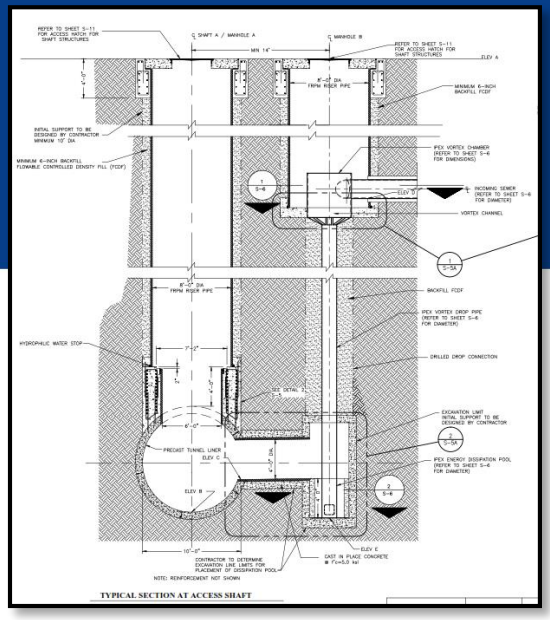
Drop Connections for Future Sewer Extensions







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Sewer Sizing

- How we evaluated size of Excavation/Tunneling?
  - Hydraulics
    - Ventilation
  - Efficiencies
    - Project Duration/Progress Rate Impacts
  - Cost Impacts
    - TBM
    - Segments
  - Risk Impacts
    - Boulders

- **Final Design (Bid) Allowed for 10’ – 12’ finished tunnel ID**
- Range of Size for Alternatives included 5.5’ - 14’

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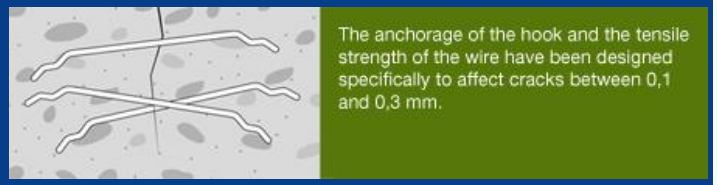
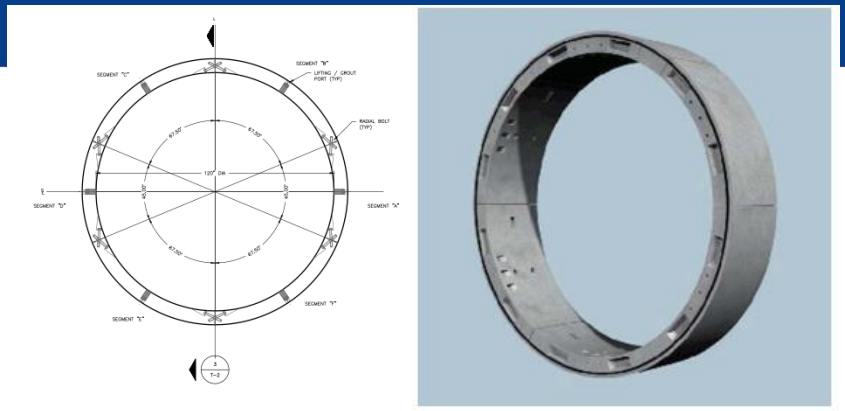
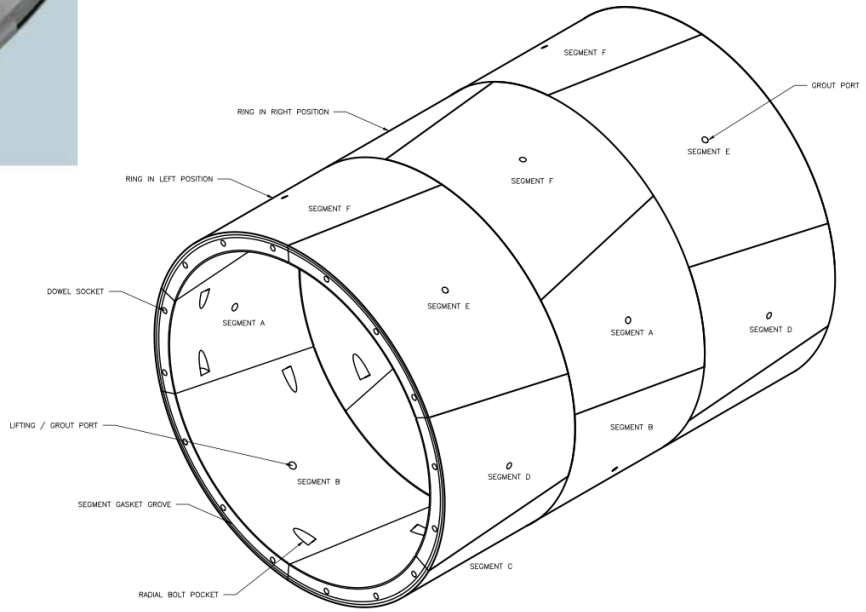
Segment Design

- Structural requirements for all load cases
- Use of steel fibers for construction handling and enhanced long-term performance, reduces rebar requirement
- Corrosion inhibiting admixtures and sacrificial cover concrete







Tunnel Design

Tunnel Boring Machine

Finished Concrete Segmented Tunnel

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Tunnel Construction Methods

- Earth Pressure Balance Machine (EPBM) prescribed for the project
  - Pressurized Face of Excavation
  - Rock and Soil Conditions
  - Groundwater Protection

- Design Team Ruled Out…
  - Multiple TBMs to deal with varying subsurface conditions
  - Slurry TBM
  - Microtunneling

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Tunnel Construction Conditions

- Potential Gassy Operation
  - Base bid has 120 hours of downtime contingency
- Cobbles and Boulders
  - Located in soft ground near transitions
  - Quantities baselined in Geotechnical Baseline Report
- Muck Removal
  - Limited onsite storage available at launch site
  - Haul routes identified in Maintenance of Traffic (MOT)
  - Ohio EPA approval is required for offsite disposal location

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Tunnel Construction Schedule

- Project Duration
  - 48 Months (1,540 days per CMS Item 108.03, Milestones)
  - Tunneling activities observed as critical path
  - Sizing of tunnel allows for California Switch/Improved Support Activity
  - 24-hour activity allowed with some limitation
- Preparation
  - Milestone No. 2 –Downstream Sewer Tail Tunnel (470 days)
  - Milestone No. 3 – TBM Startup and 500’ Initial Mining (560 days)

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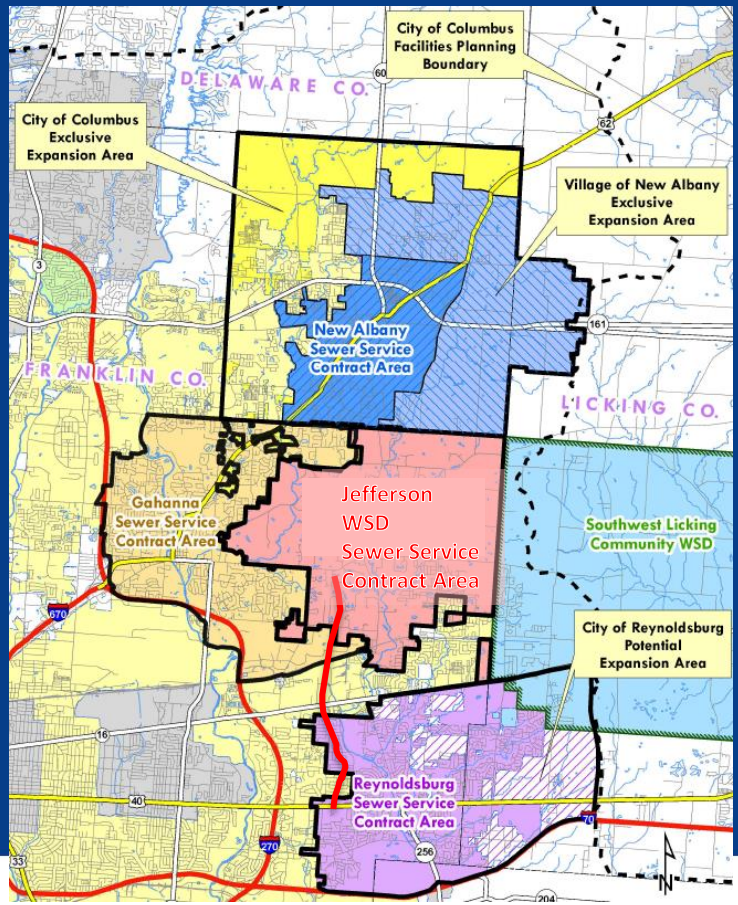
Final Design Features

- Sewer Service Contract Area
- Geology (Mixed Shale & Glacial Soil Deposits) & Hydrogeology
- Length: 23,020 Feet
- Depth: 40-140 Feet
- Finished Diameter: 10-12 Feet
- Earth Pressure Balance (EPB) Tunnel Boring Machine (TBM) w/Precast Segmental Lining
- Shafts and Drop Structures
- Construction Cost: $108,974,000



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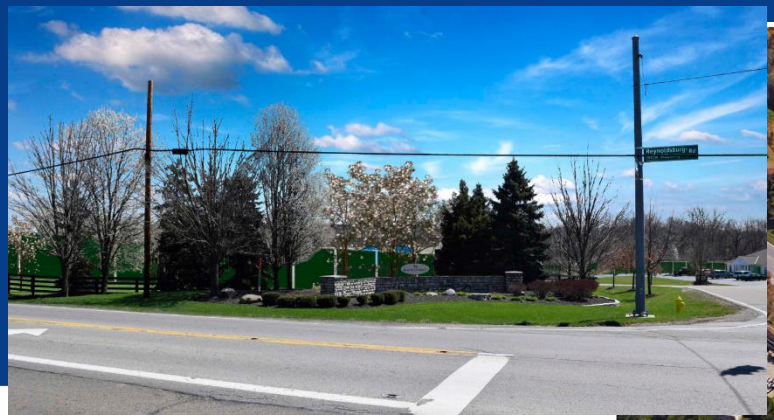
Other Facilities- Tunnel Launch Site

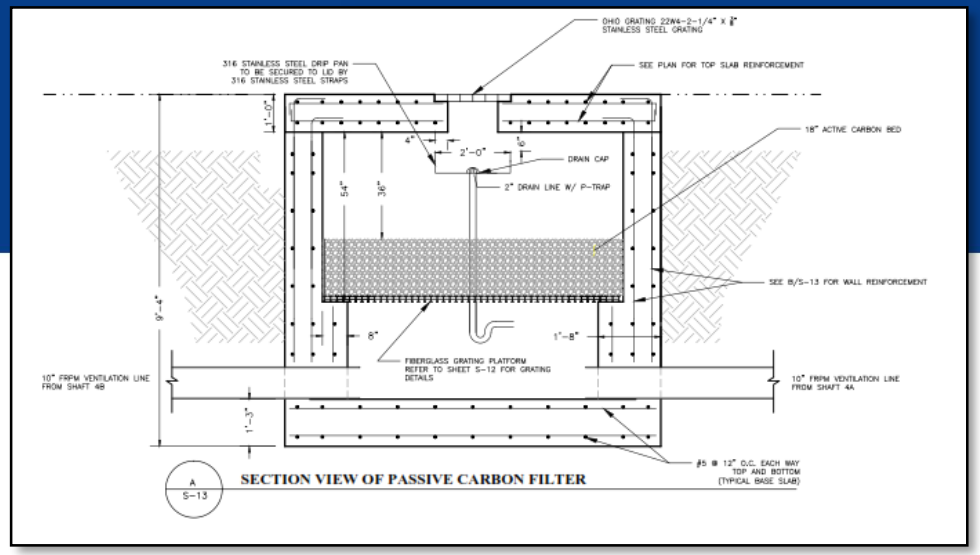
Shaft 1 / Main Project Site - North of Blacklick Ridge Blvd

- Main Project Site Location
- Daily Operations
- Columbus/Design Team coordinated with Jefferson Township on screening and other site considerations



Other Facilities - Odor Control

- Air Quality Control Facility
  - Shaft 1
- Passive Carbon Filter
  - Shaft 4



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Construction Phase

- Construction Management Team
  - CM: Black & Veatch, iTunnel, Dynotech, Hatch, HR Gray
  - DP: EMH&T, Aldea, AECOM, Eagon & Associates
  - City Project Manager
- Contractor : Blacklick Constructors, LLC
- Current Progress Statistics

BLACKLICK CONSTRUCTORS LLC

MICHELS CORPORATION

Jay Dee

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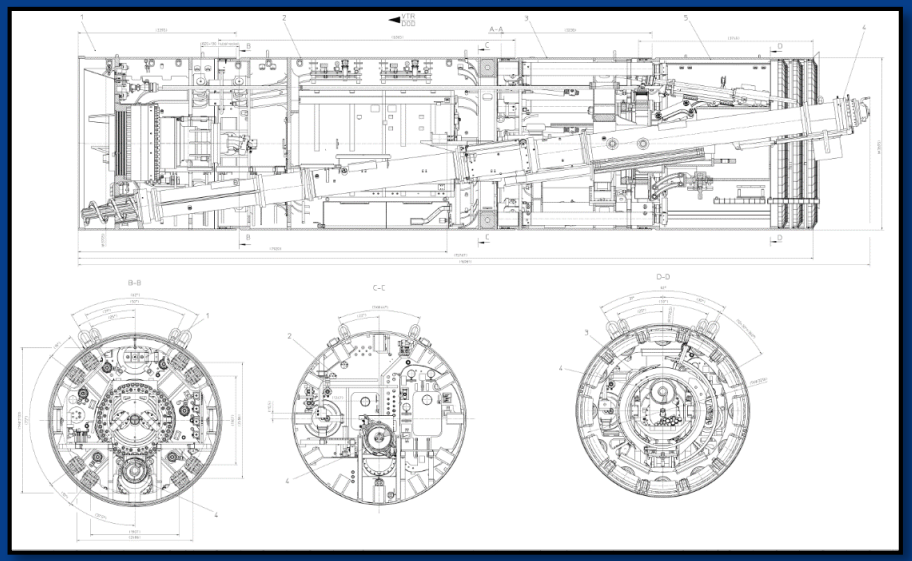
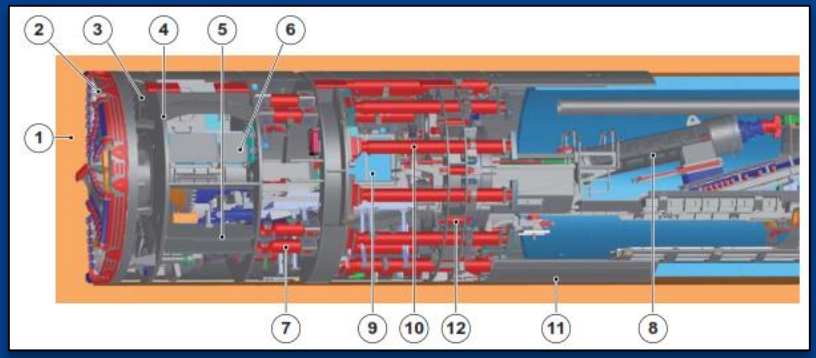
Construction – From Submittals to Field Construction





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TBM

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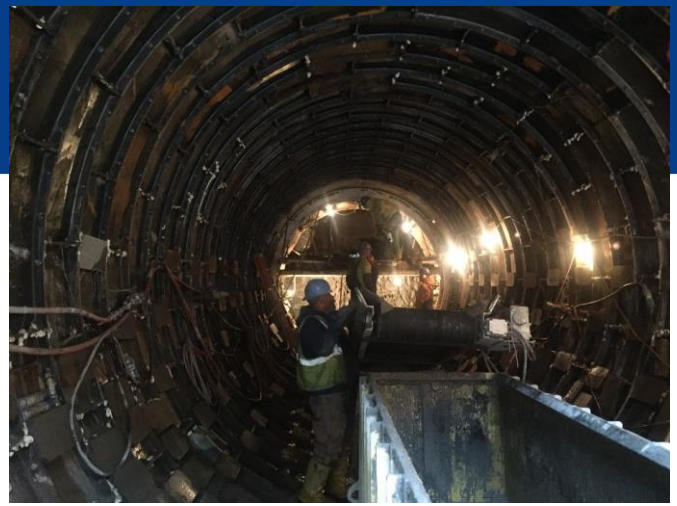
Tail Tunnel Construction



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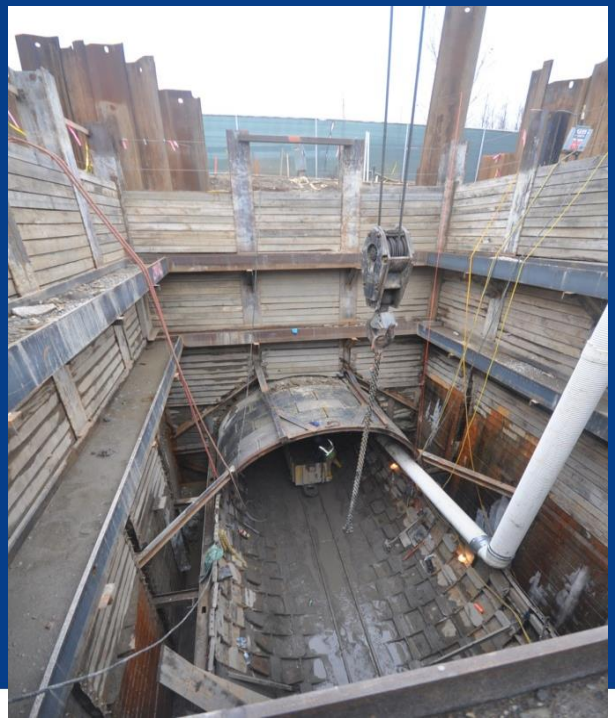
Hand Mining



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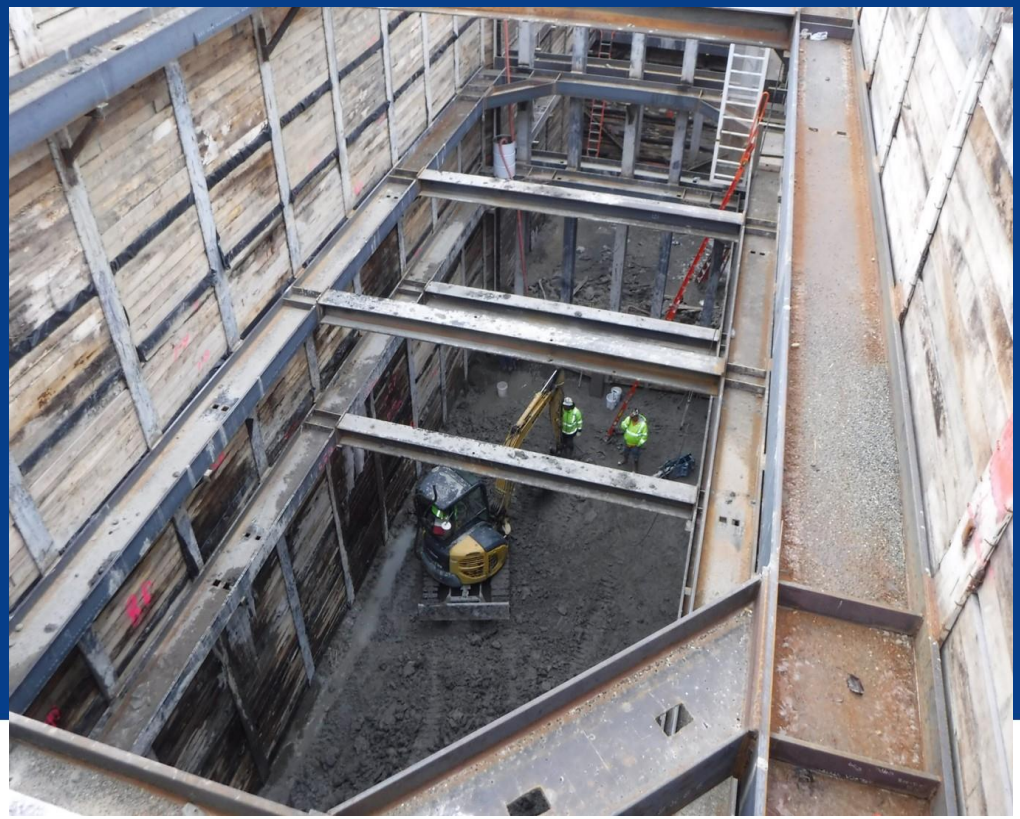
Launch Shaft 1



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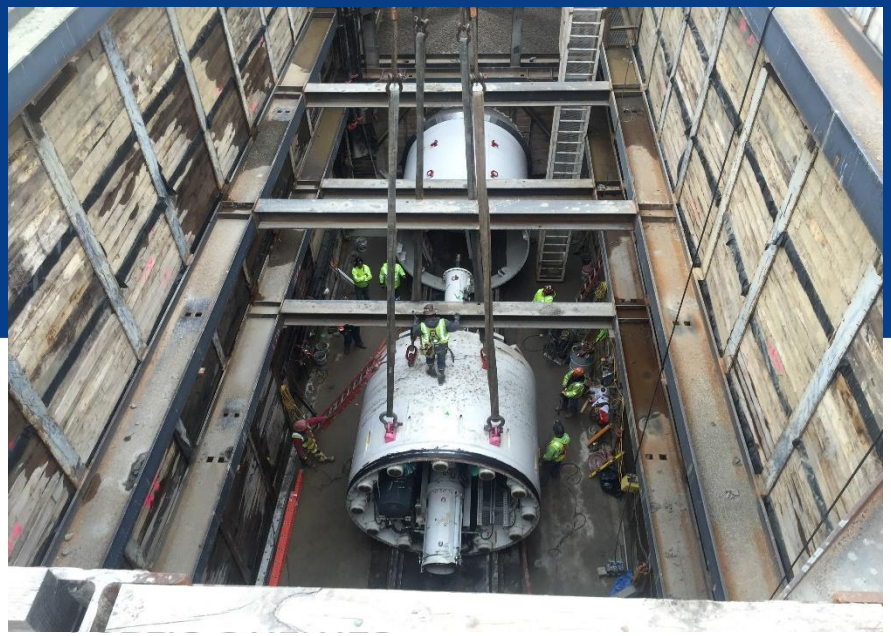
TBM Installation



TBM Installation

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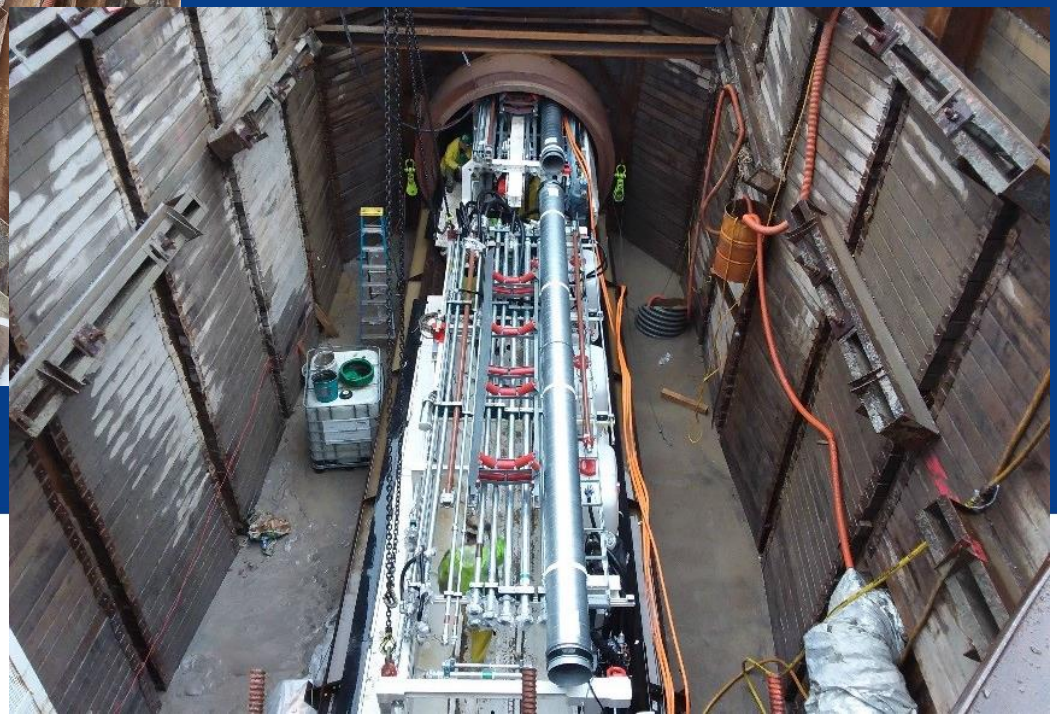

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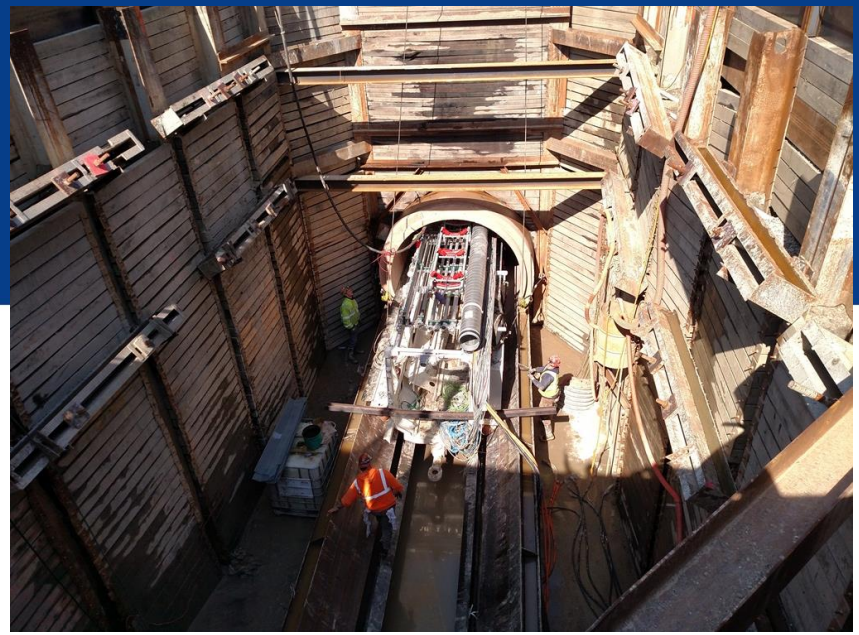
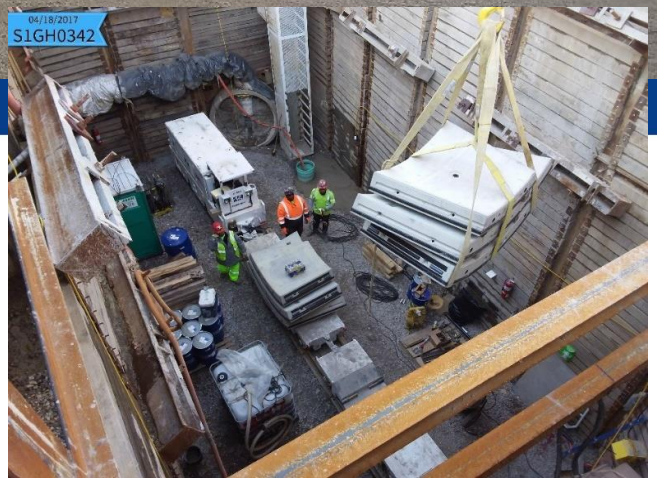


Segment Delivery and Storage



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Tunneling Activity Progress

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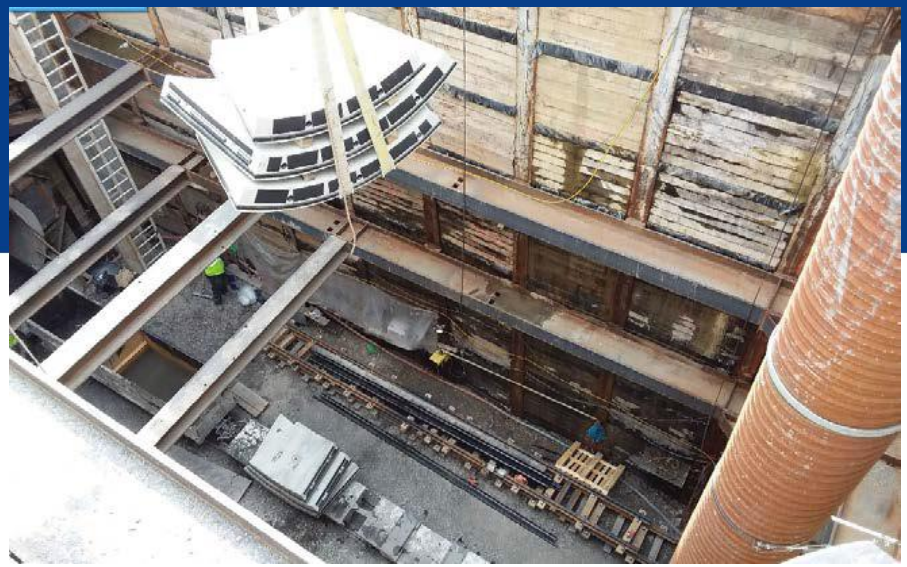

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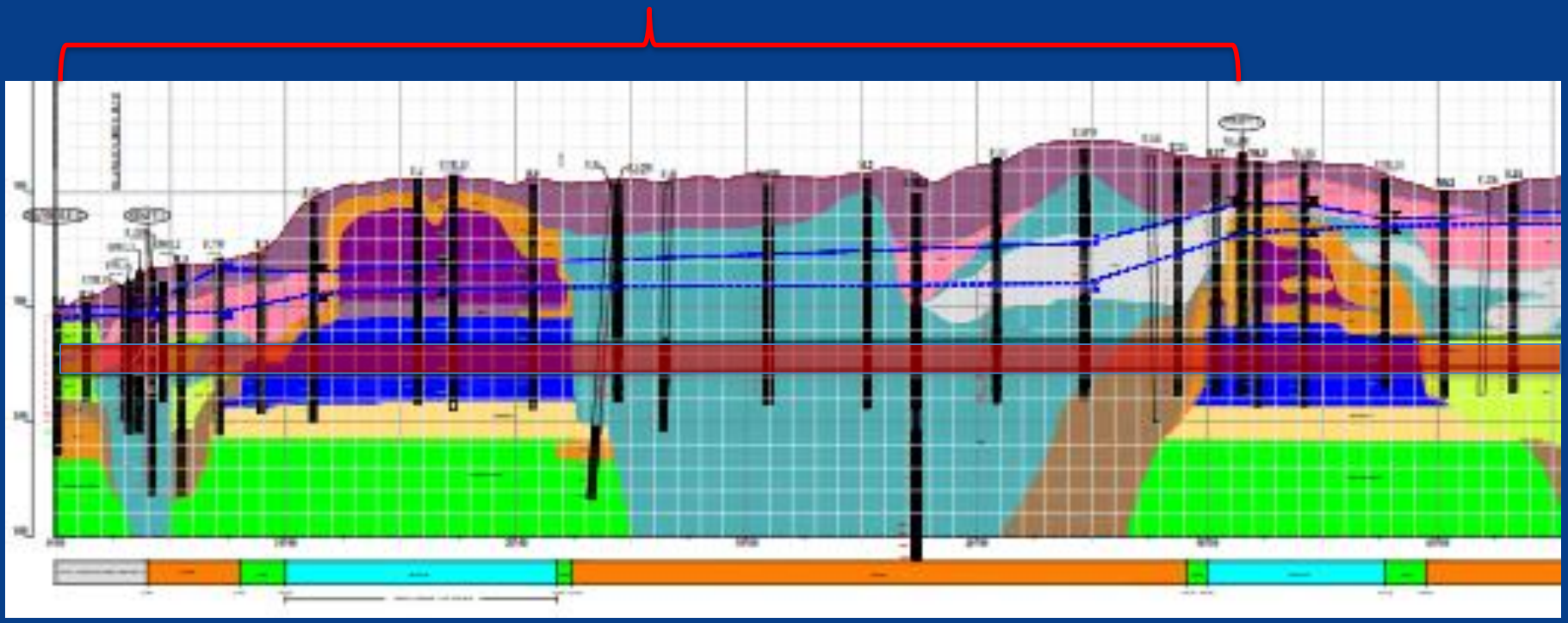
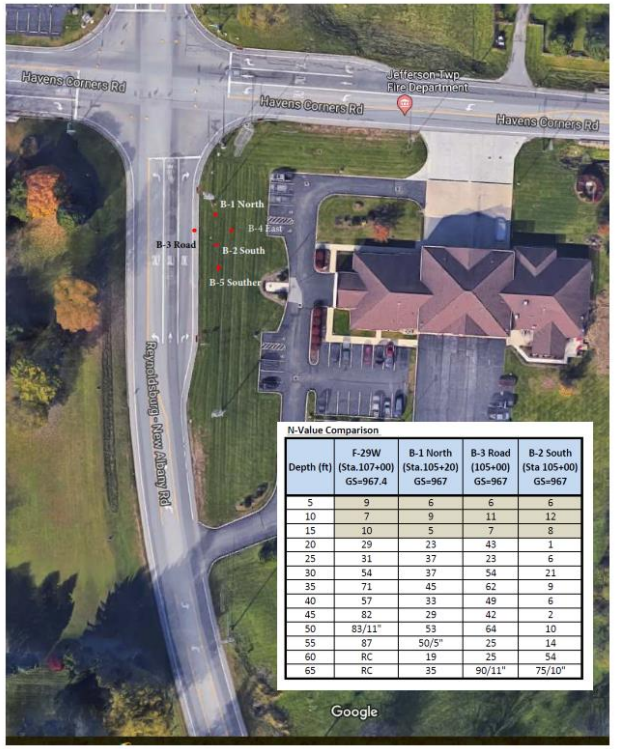


View in the tunnel with utilities and air piping shown.

Utility Extension Work in Tunnel

Sink Hole



N-Value Comparison

Depth (ft)	F-29W (Sta.107+00) GS=967.4	B-1 North (Sta.105+20) GS=967	B-3 Road (105+00) GS=967	B-2 South (Sta 105+00) GS=967
5	9	6	6	6
10	7	9	11	12
15	10	5	7	8
20	29	23	43	1
25	31	37	23	6
30	54	37	54	21
35	71	45	62	9
40	57	33	49	6
45	82	29	42	2
50	83/11"	53	64	10
55	87	50/5"	25	14
60	RC	19	25	54
65	RC	35	90/11"	75/10"

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Shaft 2

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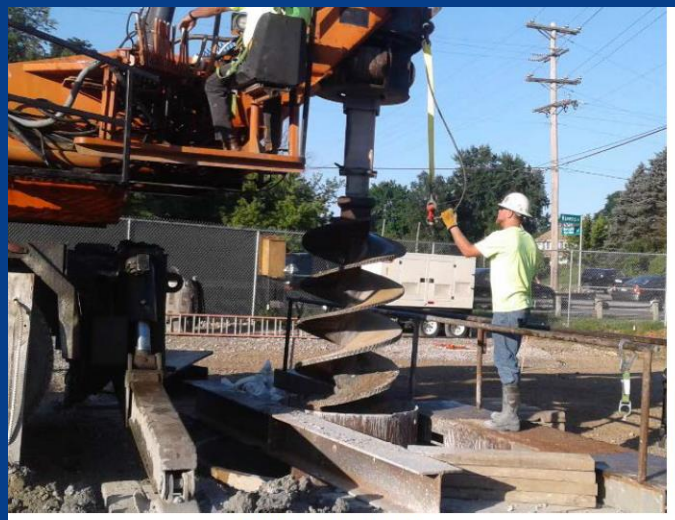
Shaft 3



Drilling Shaft 3B.

Inside of MH 3B where the connection from MH3C enters.

Start of drilling of MH 2B

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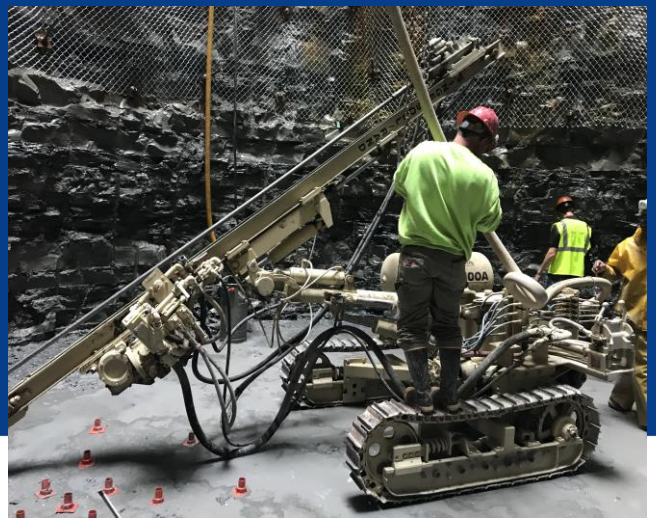
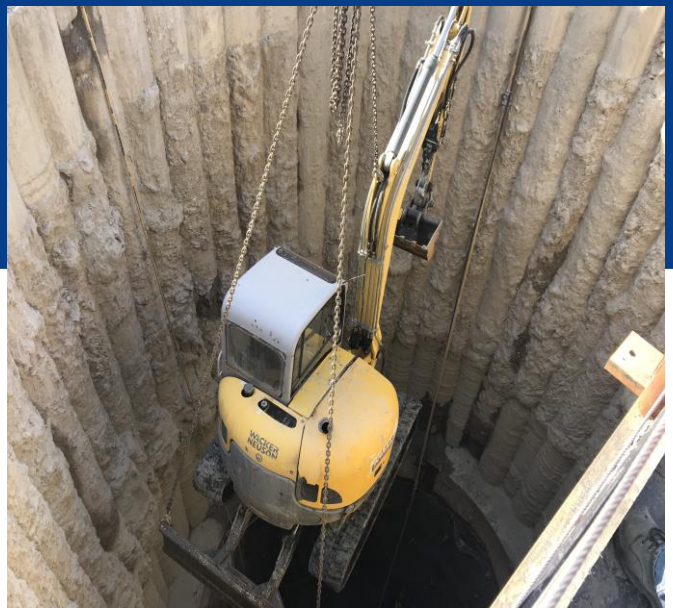
Shaft 4





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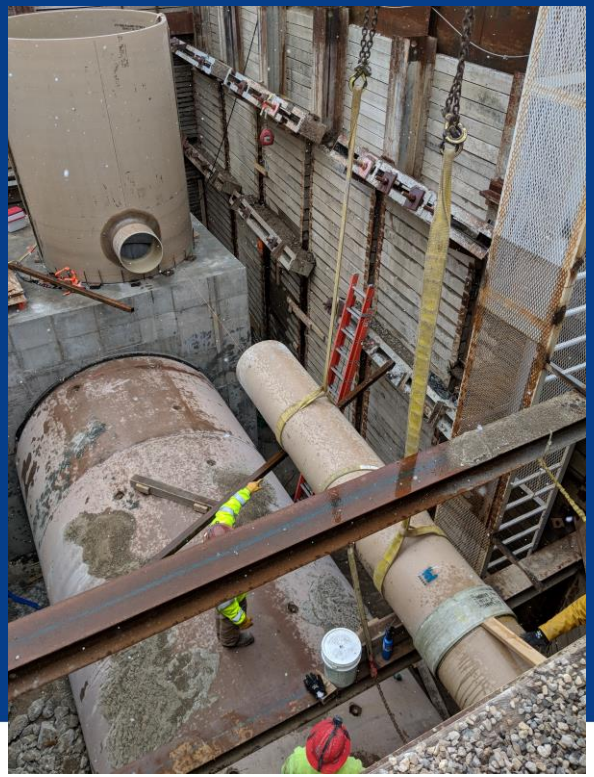
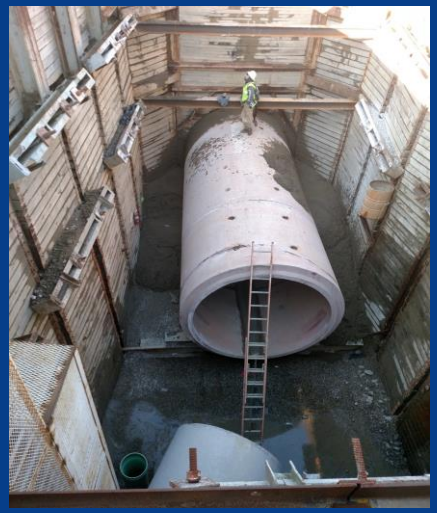
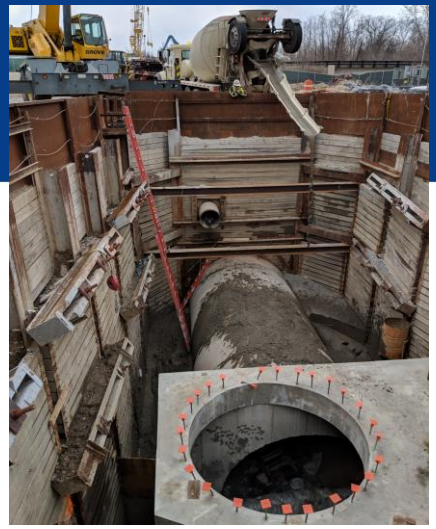
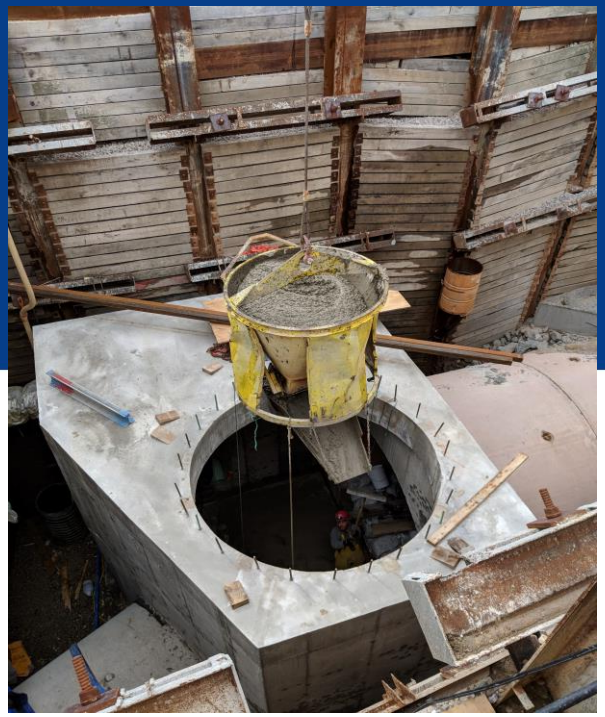
Junction Chamber









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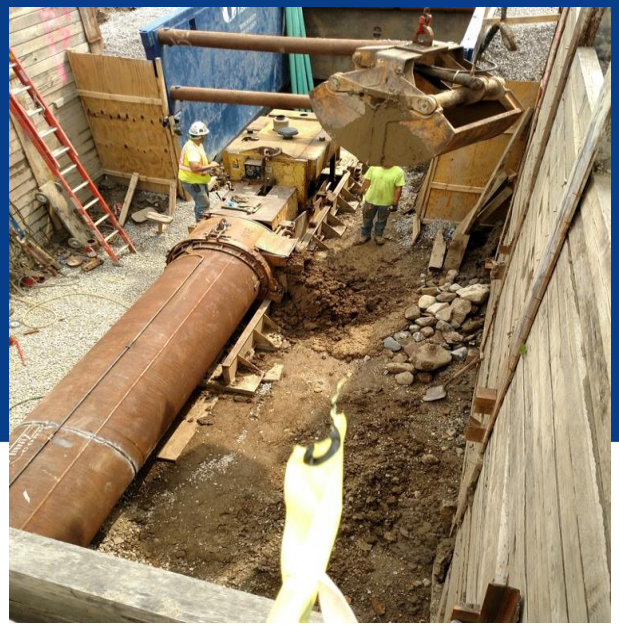
Air Pipe



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Questions

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