Tunneling to Meet the Speed of Economic Development

The Blacklick Creek Sanitary Interceptor Sewer (BCSIS) from Design into Construction

5 Cities Conference

August 16, 2017

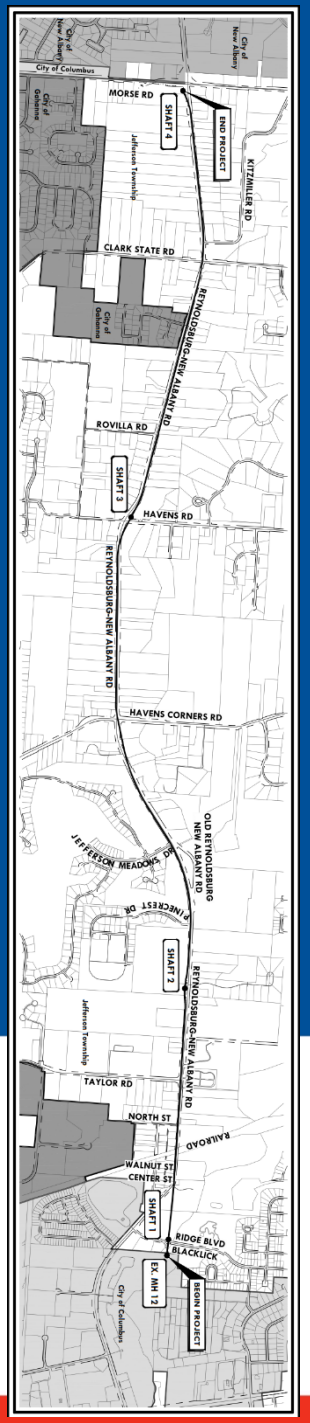
THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF PUBLIC UTILITIES

Presenters:
Nick Domenick, PE – City of Columbus
Mike Keller, PE - EMH&T

AGENDA

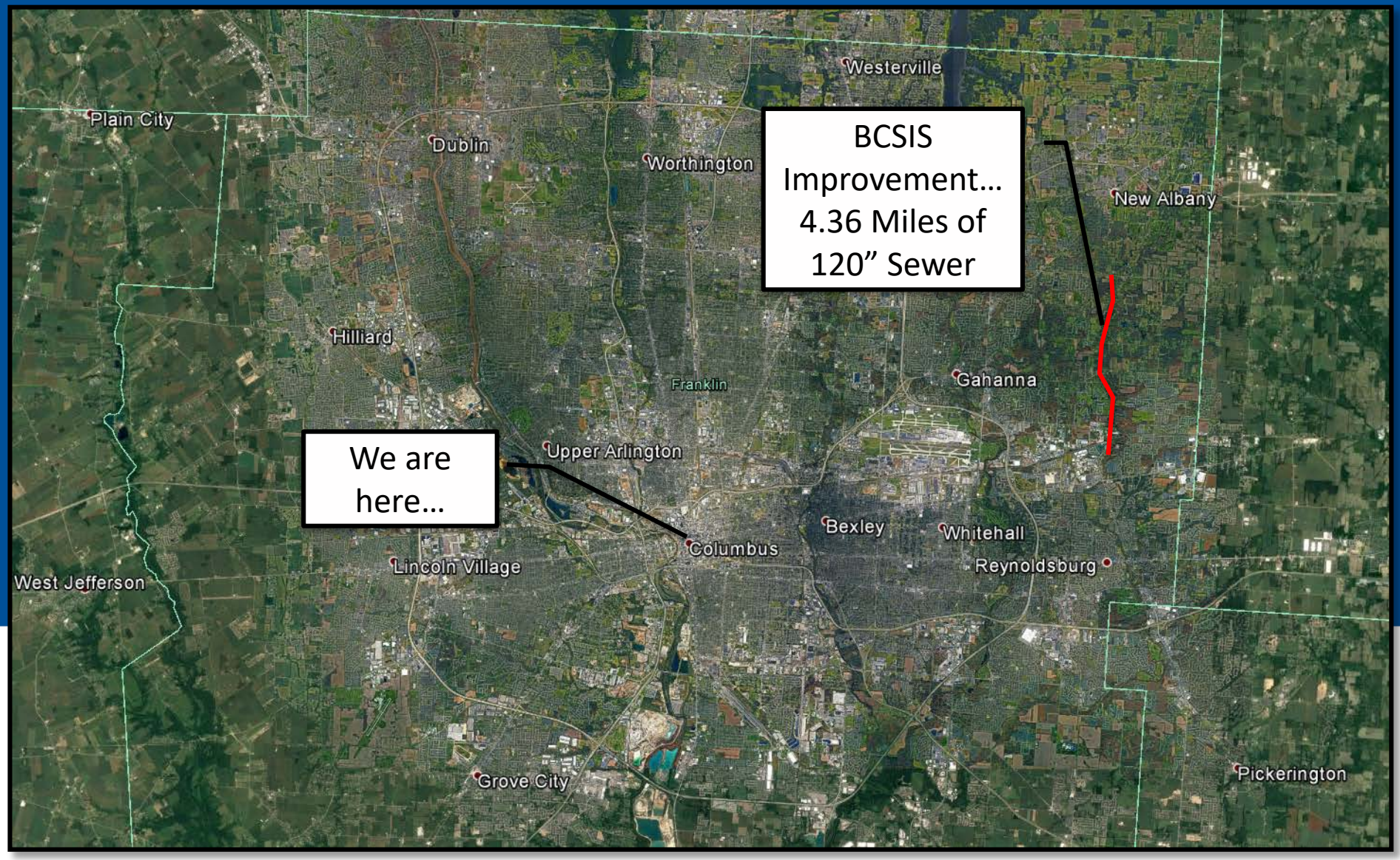
1. Project Background
2. Key Design Constraints and Final Design Components
3. Construction
4. Current Project Status



THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF PUBLIC UTILITIES

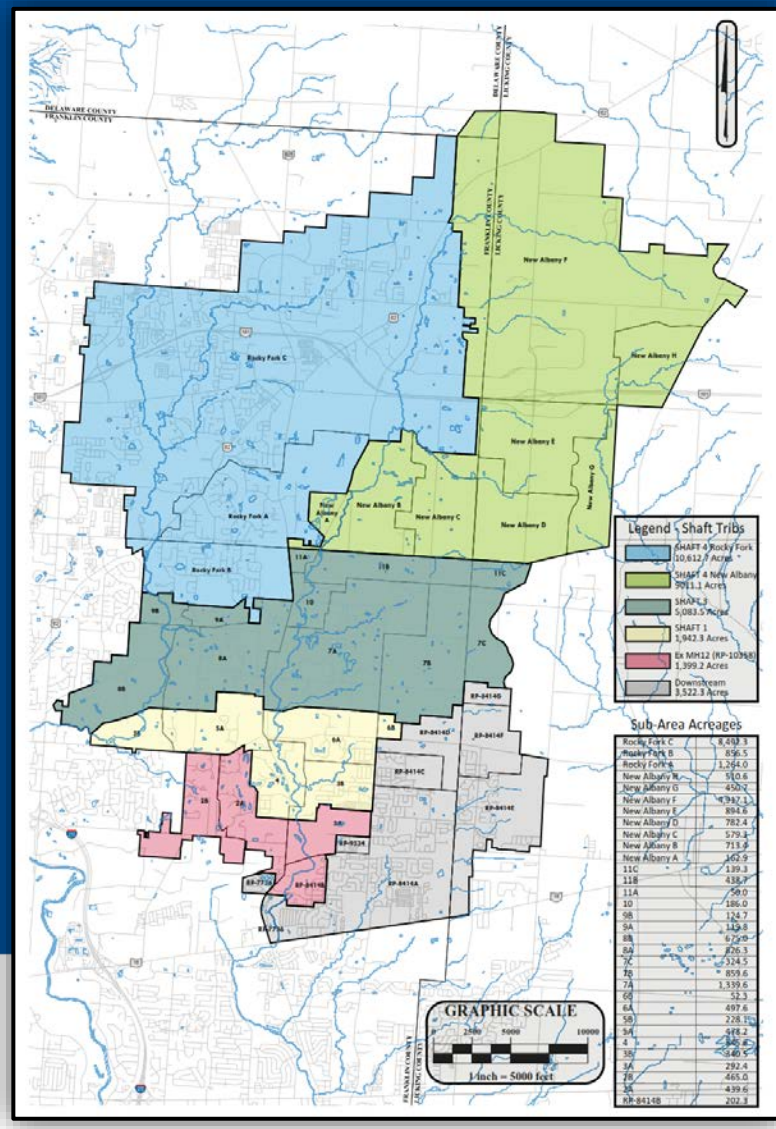
Perspective – Where we are….



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 (17,200 Ac)
    - Rocky Fork Sewershed (10,600 Ac)

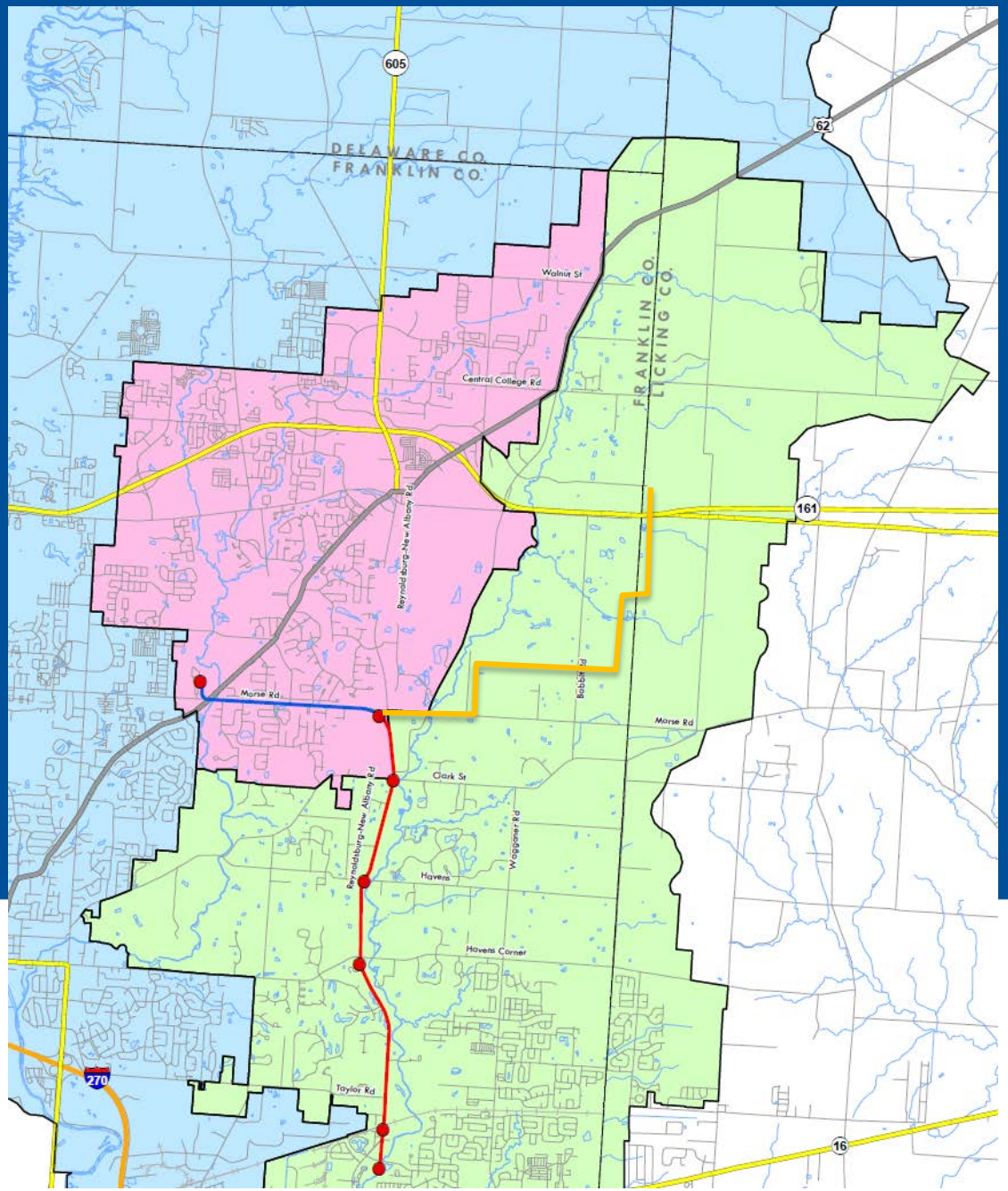


THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR

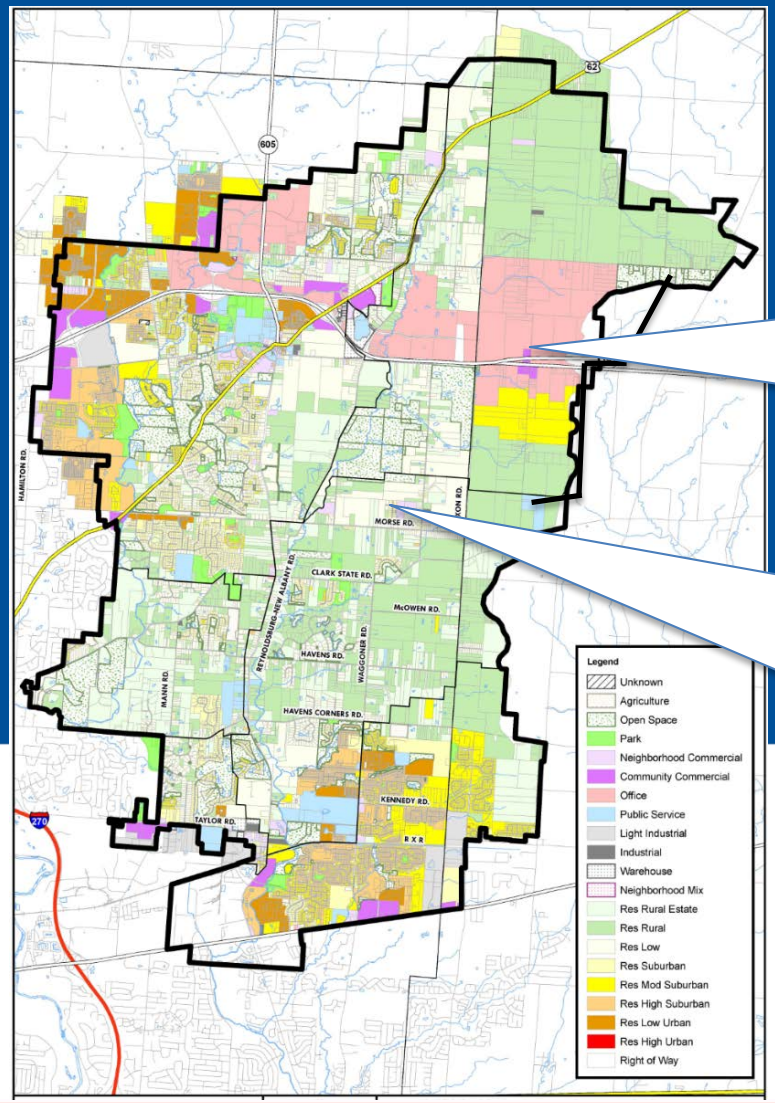
DEPARTMENT OF PUBLIC UTILITIES

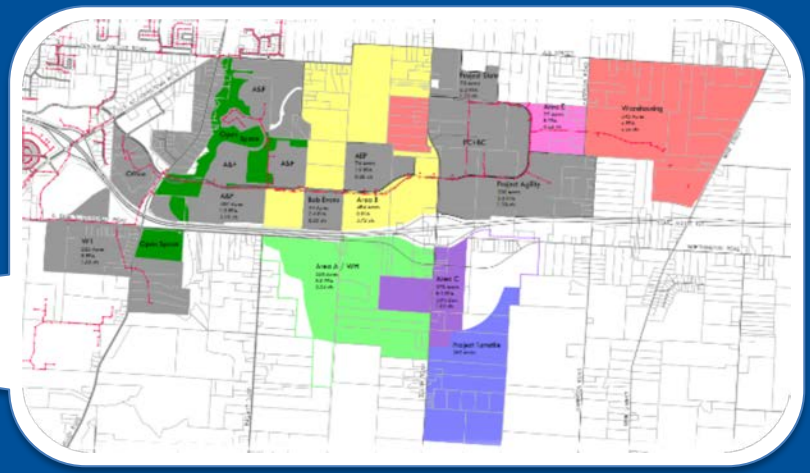
Operational Flexibility

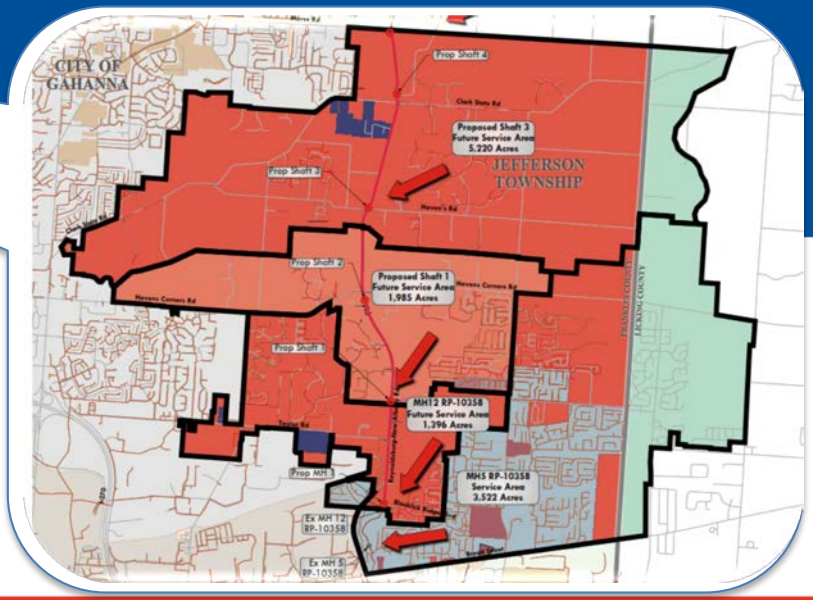
- Service
  - Blacklick Sewershed
    - BCSIS
    - BCTS
  - Rocky Fork Diversion
    - Big Walnut Sewershed
    - Divert flow to support growth



Master Planning, Contract Communities and Expansion Area



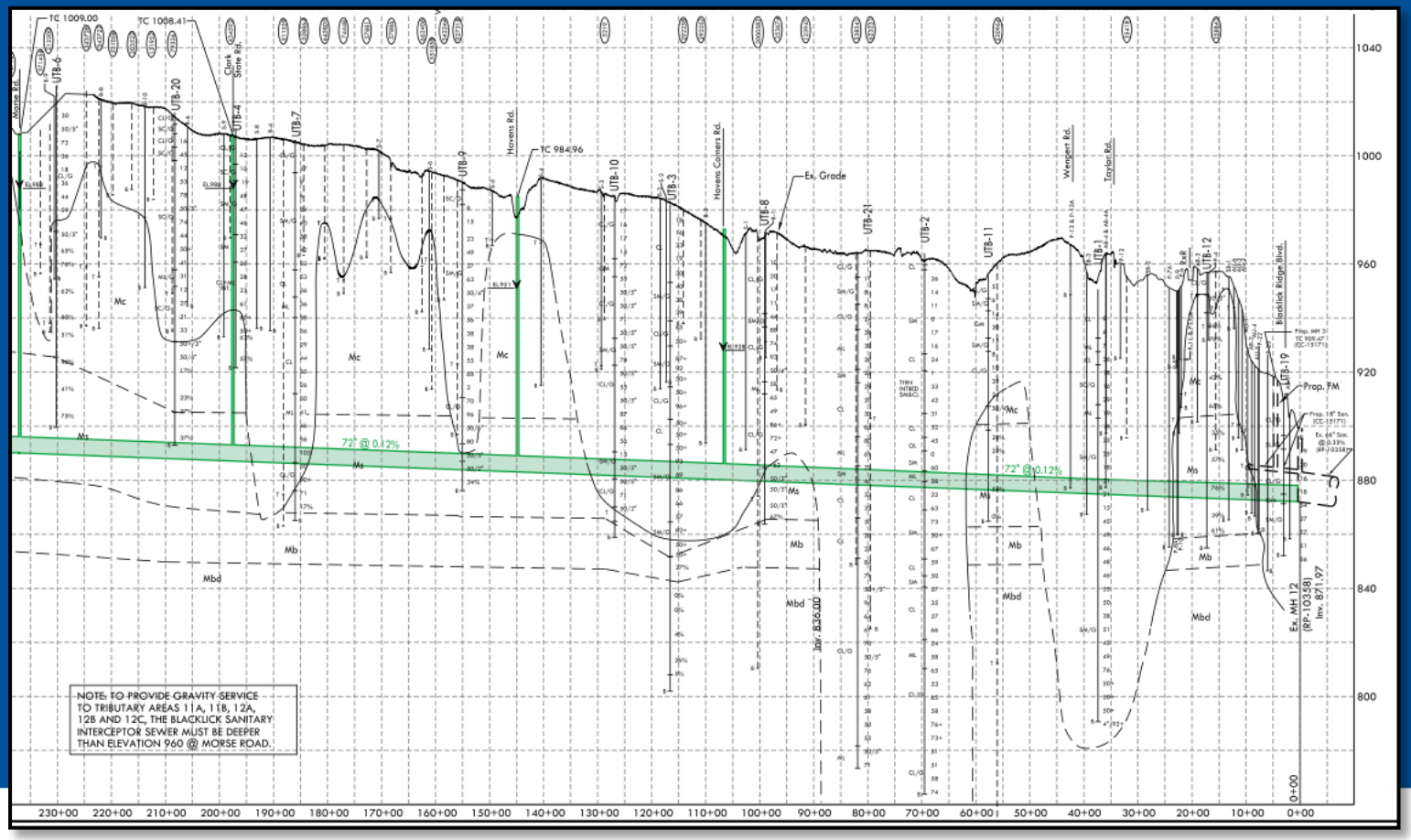




Goals at the Start of the Project (2007) vs. Final Design

	2007	Final Design/Current
Service Area	22,000 Acres (original concept was to intercept less than 50% of Rocky Fork tributary area)	Up to 28,000 Acres (opportunity to take 100% of Rocky Fork to free up capacity in Big Walnut Service Area)
Sewer Length	23,020 linear feet	23,020 linear feet
Sewer Size	66-inch	120-inch
# of Shaft Connections	6 (3 for JWSD, 1 for NA, 2 launch/connection MH)	5 (2 for JWSD, 1 for NA, 2 launch/connection MH)
Estimated Construction Cost	$64,000,000	$110,000,000
Rocky Fork Diversion (future)	Pump Station/Force Main	Gravity Option

Key Design Considerations



THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

The first key was organizing a Team…for the design investment

- Extensive Geological/Subsurface Investigation
- Hydrogeological (Groundwater) Investigation
- Coordination with Stakeholders
- Value Engineering and Technical Reviews
- Complex Design

EMH&T
Engineers, Surveyors, Planners, Scientists

AECOM

EAGON & ASSOCIATES, INC.

ALDEA SERVICES LLC

H.R.Gray
A Haskell Company

THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF PUBLIC UTILITIES

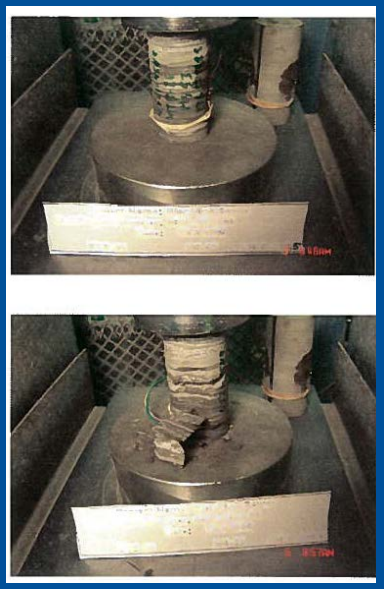
What are our Design Constraints?

- 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

THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR
DEPARTMENT OF PUBLIC UTILITIES

Geotechnical Investigation

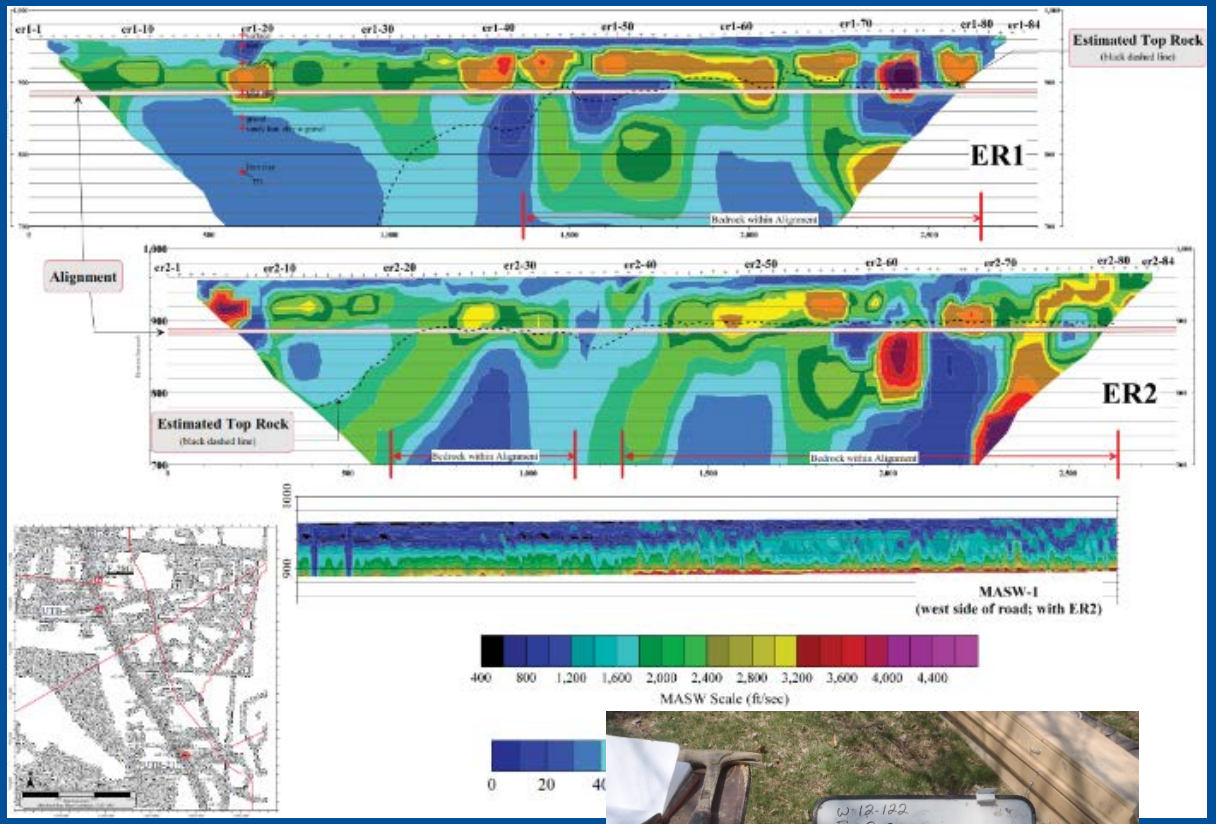
- Number of Borings
  - Phase 1- drilled 23
  - Phase 2- drilled 84
  - 107 total borings
- Vertical ft drilled = 12,025 ft/2.34 miles
- 42 Monitoring Wells total
- 12 soil to rock transitions
- 907 Total Tests - 522 Soil Tests + 385 Rock tests

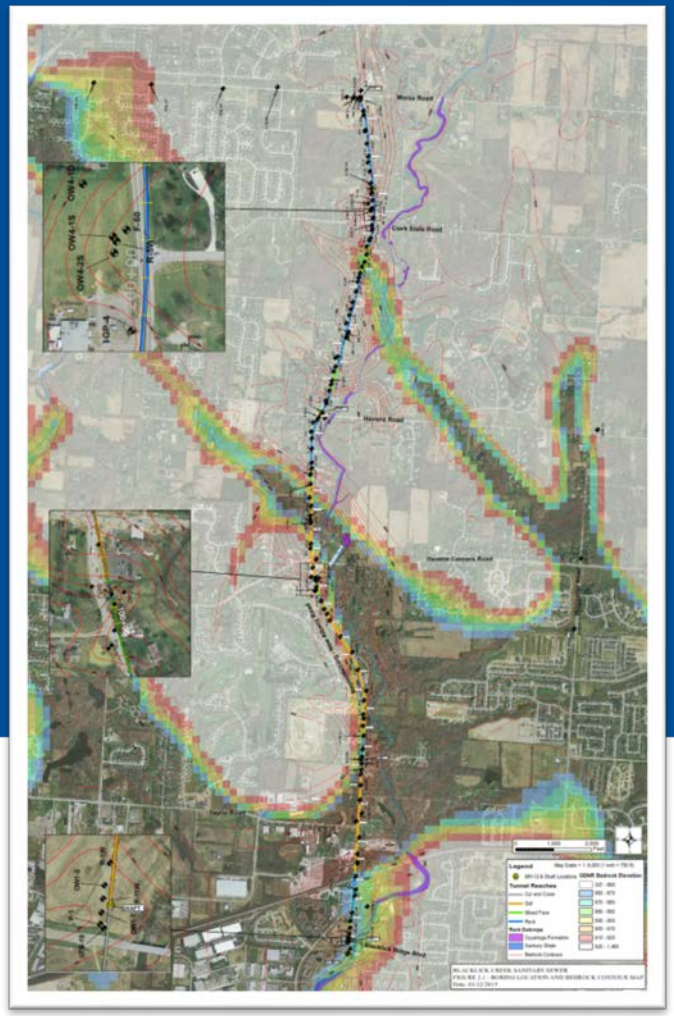


THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

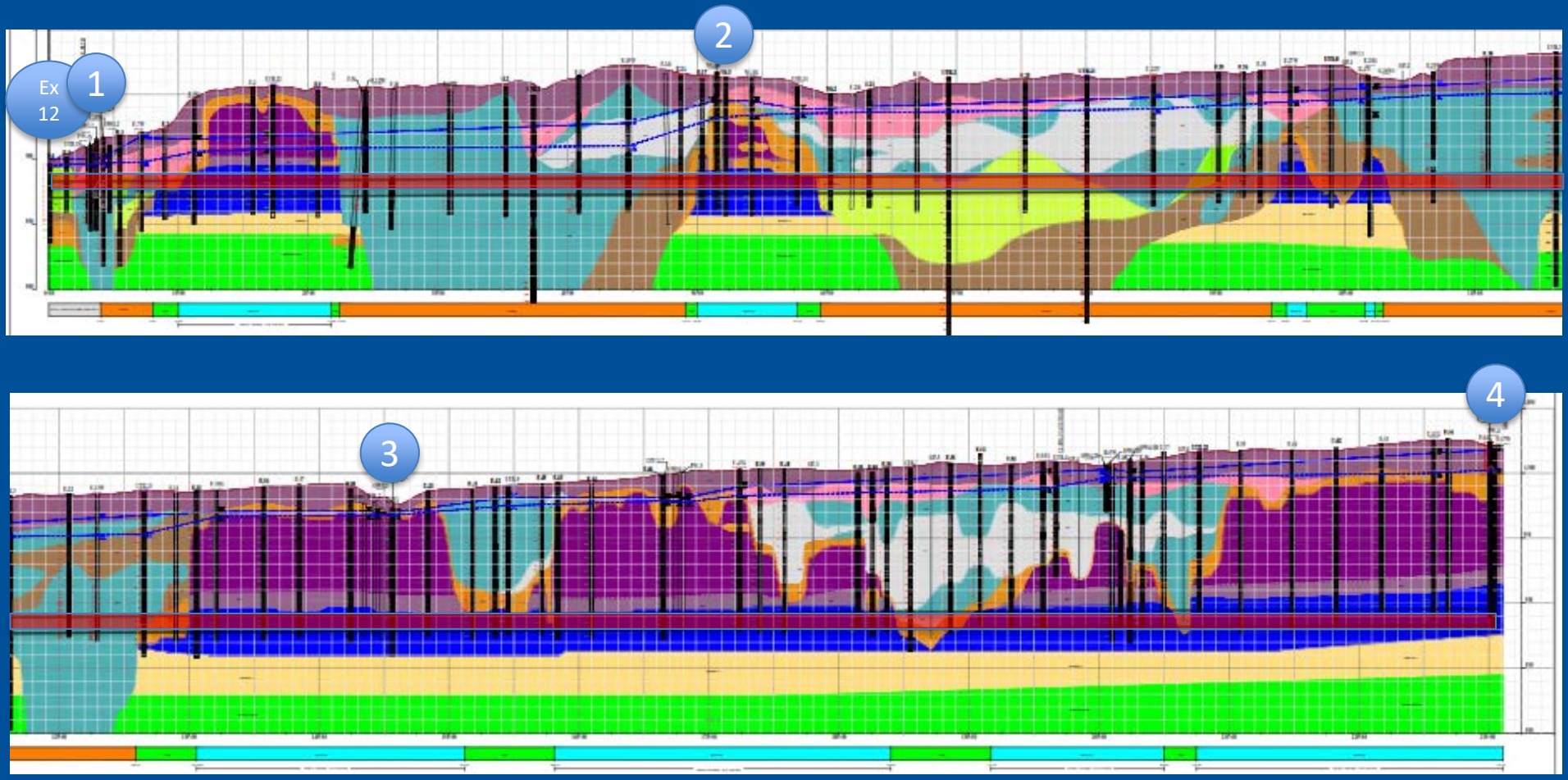
Geology of Project Corridor





THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES



THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

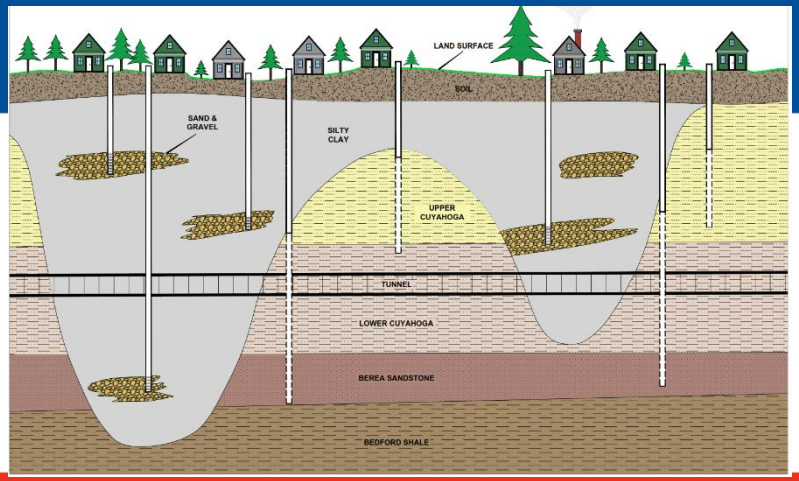
Subsurface Conditions

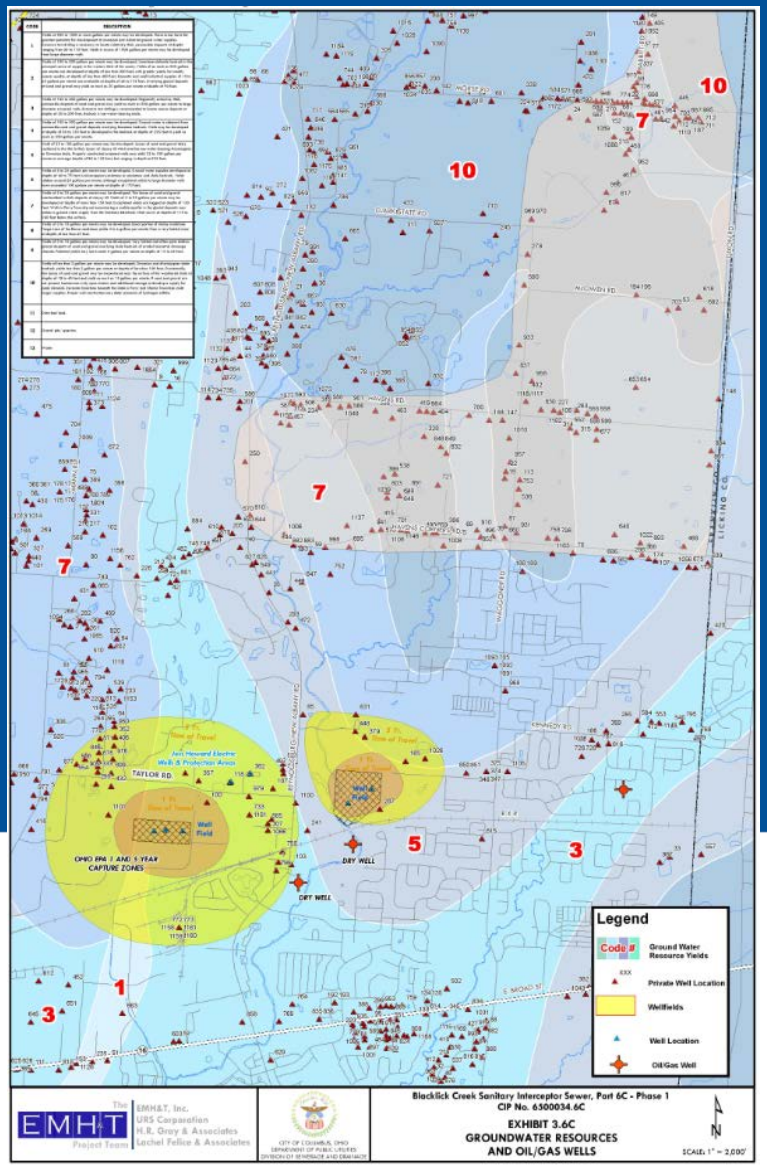
- Bedrock (3 Bedrock Units)
- Soil (7 Soil Units)
- Transitional Material (1 Unit)

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

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

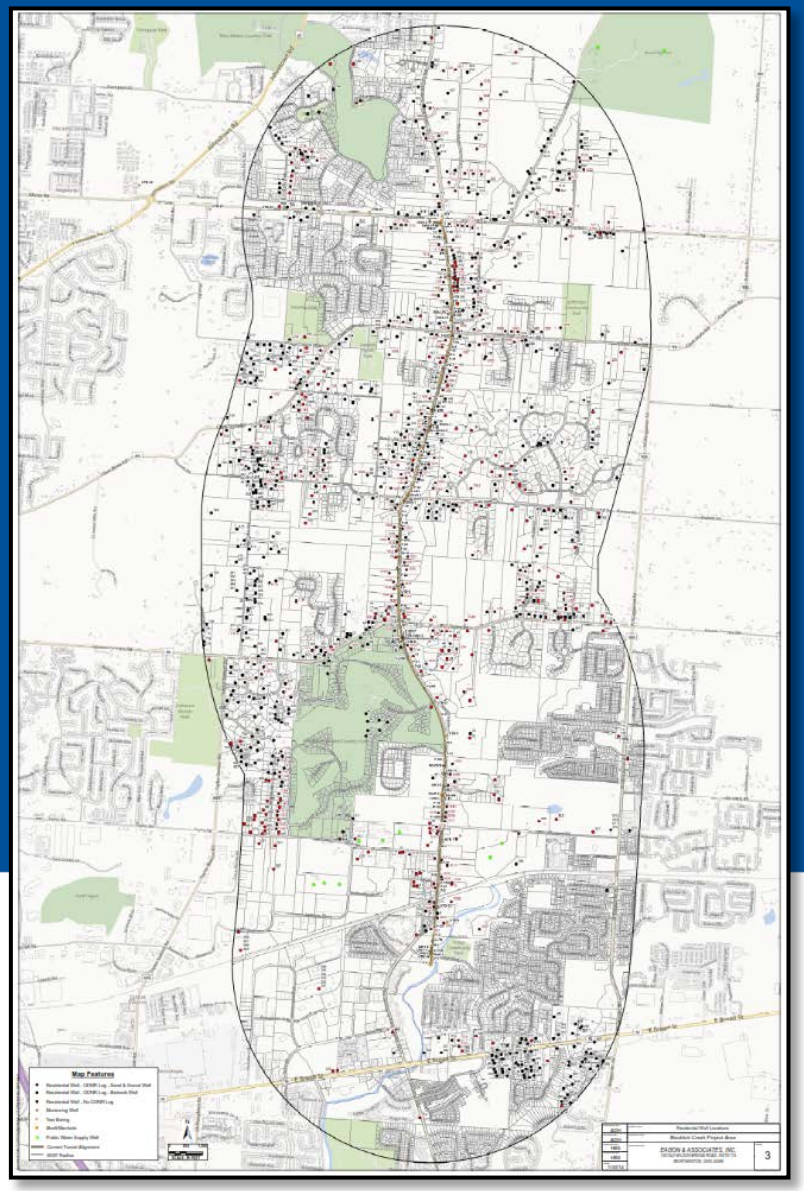
2 Pre-Construction Water-Level Monitoring

- 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



During Construction Phase
Well Monitoring and Action Plans

Construction Management Team and Contractor will monitor:

- Existing Monitoring Wells (installed during design)
- Additional Monitoring Wells Installed by Contractor
- Selected Water Wells from Survey

Contract Specification– Temporary Water Supply Allowance

- Specification Written to Provide Protection to Local Residents
- Prescribes process to follow
- $750,000 Allowance in Bid Form B4
- CMT Manages Activities (not the Contractor)

Apparent or Observed Impacts to Private Wells

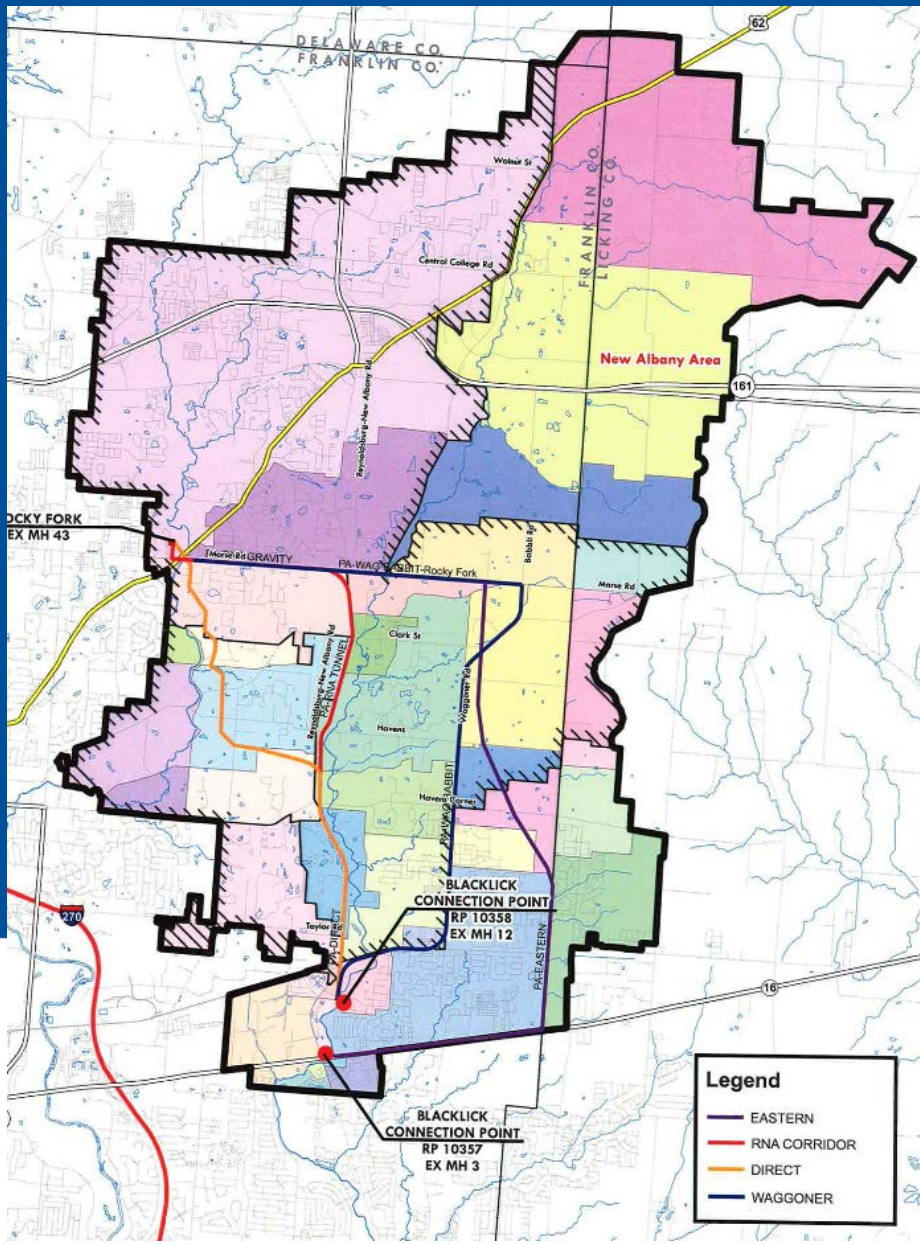
Each Situation is Unique…

Defined Well Impact Response Plan

THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR
DEPARTMENT OF PUBLIC UTILITIES

Horizontal Alignment

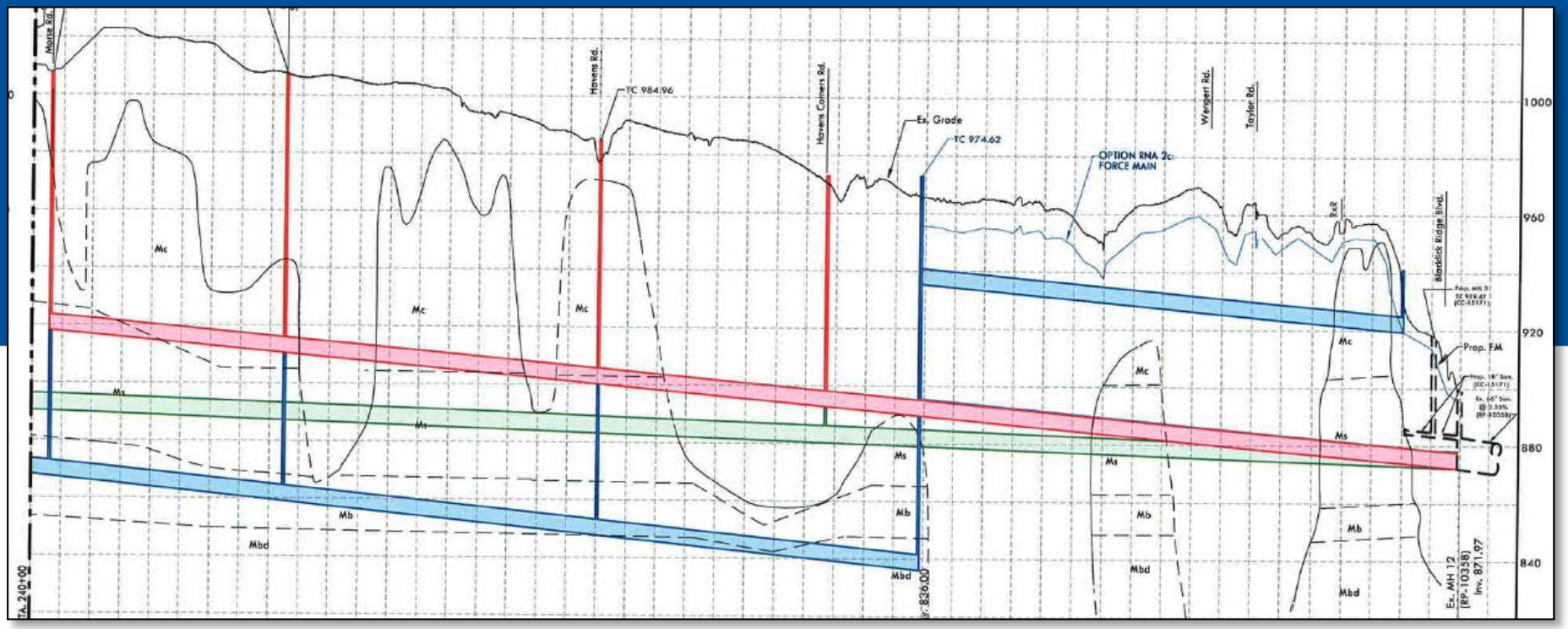
- Alignment Evaluation
  - Corridor Analysis
  - Subsurface Conditions
  - Gravity vs Pump Station
- Future Connections
  - Rocky Fork
  - City of New Albany
  - Jefferson Water and Sewer District



THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR
DEPARTMENT OF PUBLIC UTILITIES

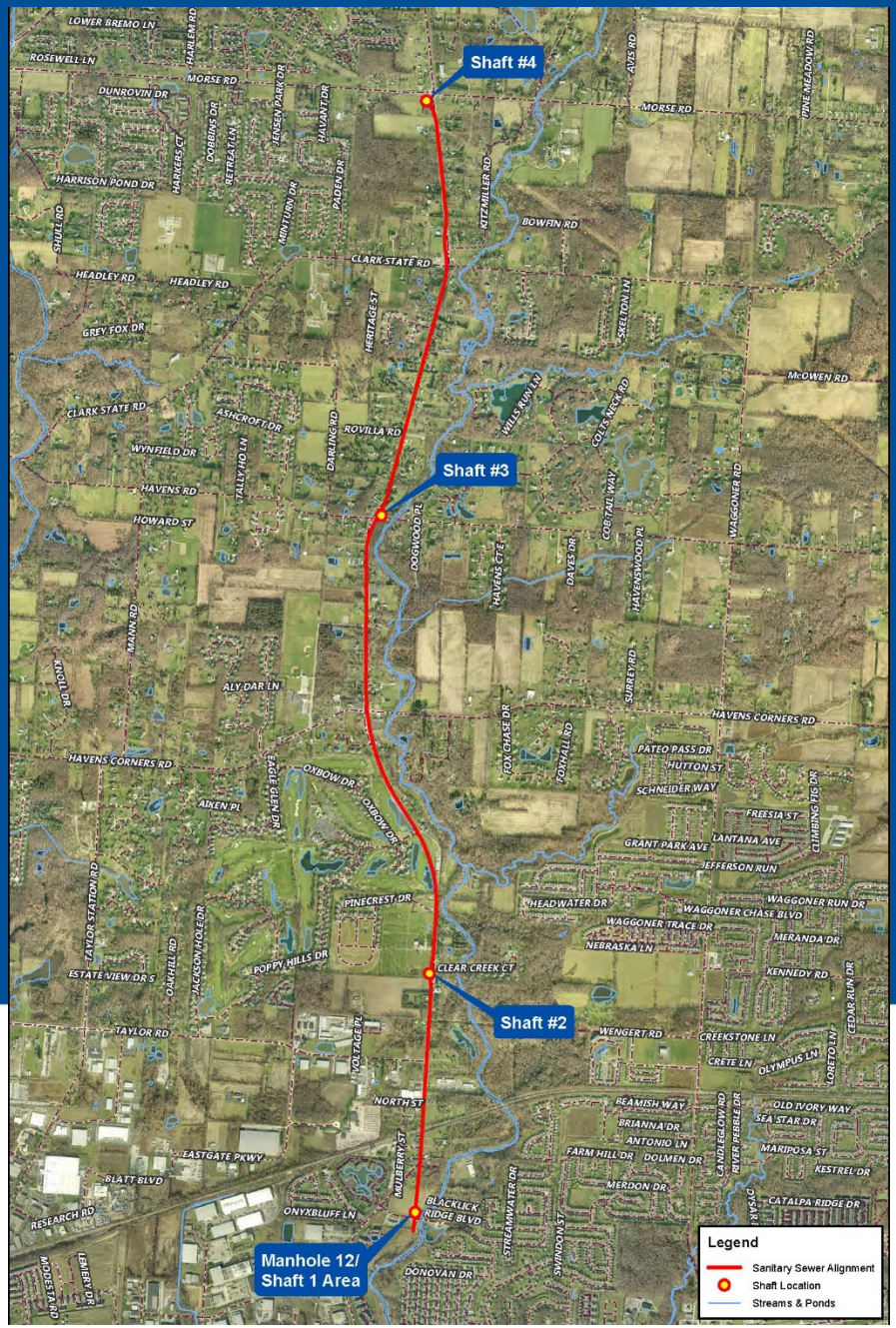
Vertical Alignment

- Gravity Sewer Control Points
  - 66” BCSIS Section 5
  - Future 54” Rocky Fork Connection
- Preferred Geology/Hydrogeology



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



THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR
DEPARTMENT OF PUBLIC UTILITIES

Value Engineering and Business Case Evaluation

- Business Case Evaluation
  1. Tunnel Construction Method
  2. Tunnel Sizing
  3. Corrosion Protection
  4. Dewatering/Shaft Construction

- Examples of Value Engineering Recommendations
  1. Minimize number of shafts
  2. Contractor to determine size of tunnel
  3. Reduce Slope
  4. Fiber reinforcement of segments
  5. Reconcile Cost with independent estimator

THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF PUBLIC UTILITIES

Shaft Location

- Four (4) Project Access Shafts, Three (3) Drop Shafts, and Two (2) Connection MHs

ACCESS SHAFTS

- Shaft 1 / Main Project Site - North of Blacklick Ridge Blvd (Launch)
  Geology - Soil; Depth – Approximately 45’

- Shaft 2 - Near Clear Creek Court (Tree Farm)
  Geology – Soil Transition Material/Bedrock; Depth – Approximately 95’

- Shaft 3 - Reynoldsburg-New Albany Rd & Havens Road
  Geology – Soil Transition Material/Bedrock; Depth – Approximately 100’

- Shaft 4 - Reynoldsburg-New Albany Rd & Morse Road (Retrieval)
  Geology - Soil Transition Material/Bedrock; Depth – Approximately 145’

THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

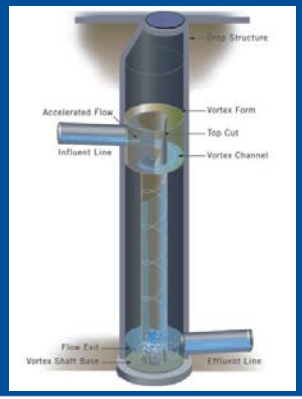
Shaft Construction Methods

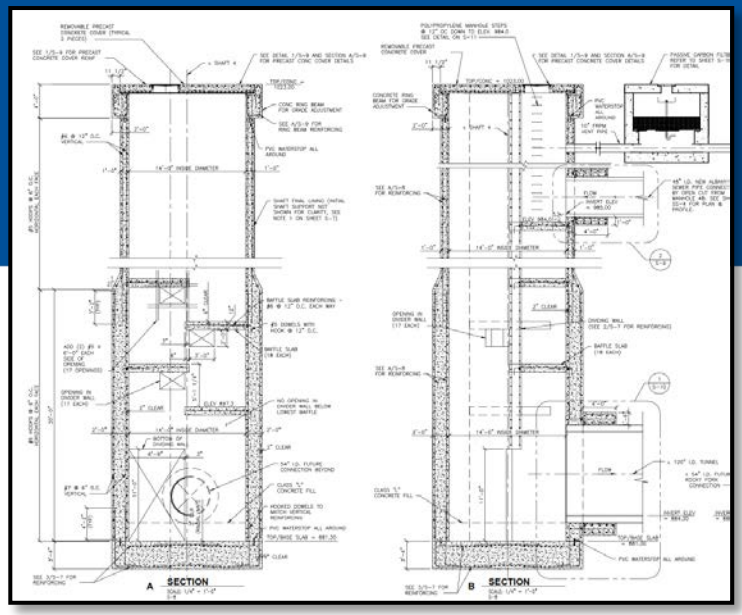
- Performance Specifications
- Minimum Excavated Diameter Provided
- Finished Riser Diameter
  - 8’ (nominal) for Shafts 1, 2, and 3
- Shaft 4 has baffled drops as per dimensions provided on plans (S-8)
- Drill and Blast allowed by not required (Specification 02305)
- DEWATERING PROHIBITED (WATERTIGHT CONSTRUCTION REQUIRED) AT…
  - SHAFTS 3 AND 4
  - TRANSITIONAL MATERIAL AND ROCK ON SHAFT 2

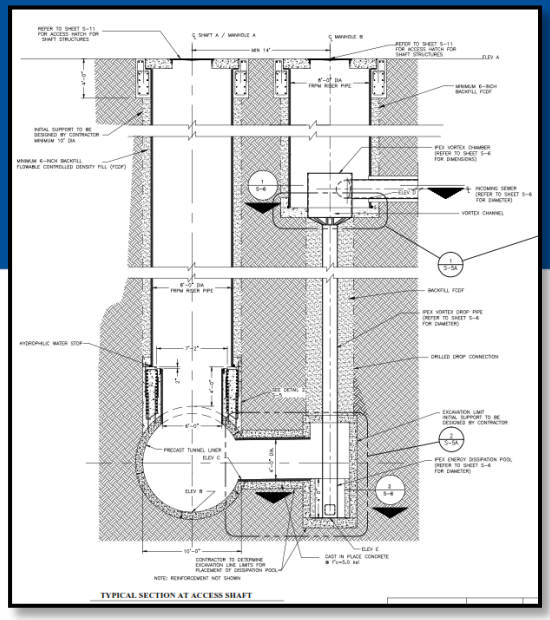
THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

Drop Connections for Future Sewer Extensions







THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR

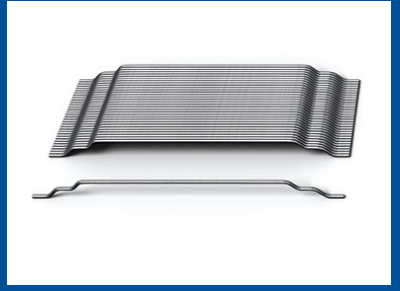
DEPARTMENT OF PUBLIC UTILITIES

Sewer Sizing

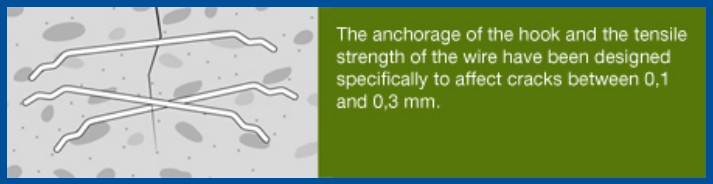
- How we evaluated size of Excavation/Tunneling?
  - Hydraulics
    - Ventilation
  - Efficiencies
    - Project Duration/Progress Rate Impacts
  - Cost Impacts
    - TBM
    - Segments
  - Risk Impacts
    - Boulders

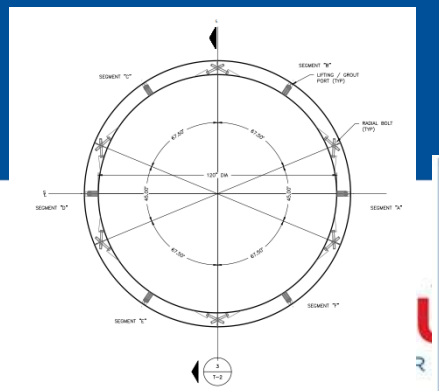
- **Final Design (Bid) Allowed for 10’ – 12’ finished tunnel ID**
- Range of Size for Alternatives included 5.5’ - 14’

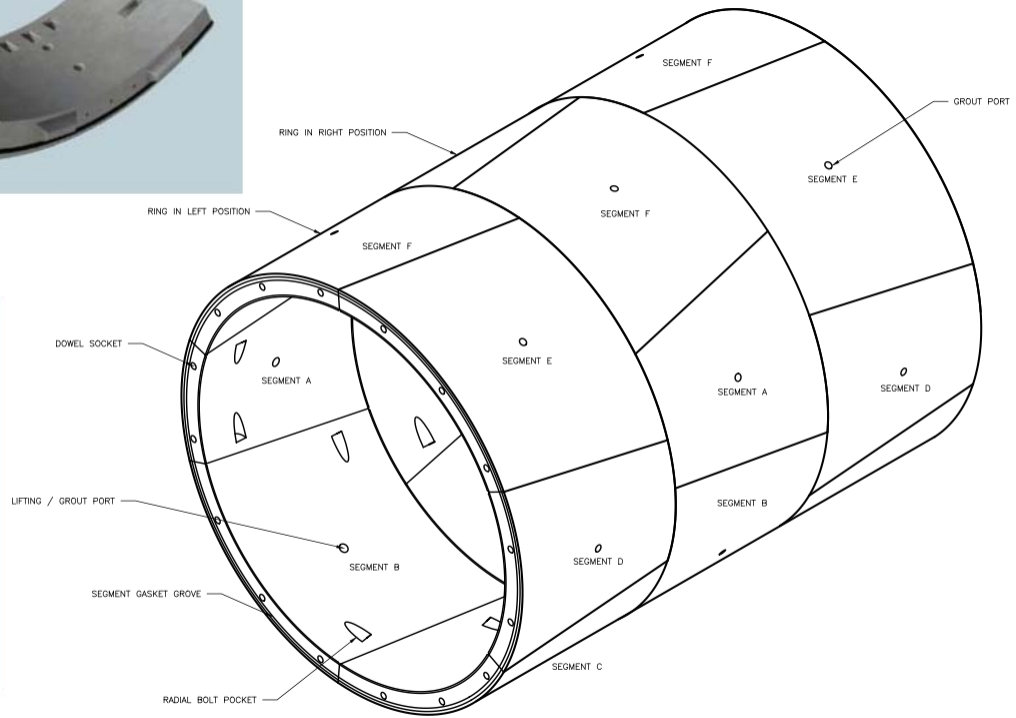
Segment Design



- 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







Segment Design

- Steel Fibers – American Iron and Steel Requirements
- Precast concrete with gaskets and guide rods
- (6) segment = 1 ring

Tunnel Design

Tunnel Boring Machine

Finished Concrete Segmented Tunnel

THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF PUBLIC UTILITIES

Tunnel Construction Methods

- Earth Pressure Balance Machine (EPBM) prescribed for the project
  - Control face in soil and mixed face zones
  - Suits the types of soils and rock at tunnel face
  - Limit groundwater inflow
    - Groundwater in open mode excavation will be closely monitored in rock and excessive inflow will require closed mode operation

- Design Team Ruled Out…
  - Multiple TBMs to deal with varying subsurface conditions
  - Slurry TBM
    - limited site access along route for slurry handling
    - Total length of tunnel

THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

Tunnel Construction Conditions

- Potential Gassy Operation
  - Base bid shall include 120 shift hours of downtime due to gas in the tunnel and/or shafts

- Cobbles and Boulders
  - Shall be expected to occur in group, lenses, and individually with all soft ground (SG) and mixed face (MF) tunnel reaches
  - 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

THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR
DEPARTMENT OF PUBLIC UTILITIES

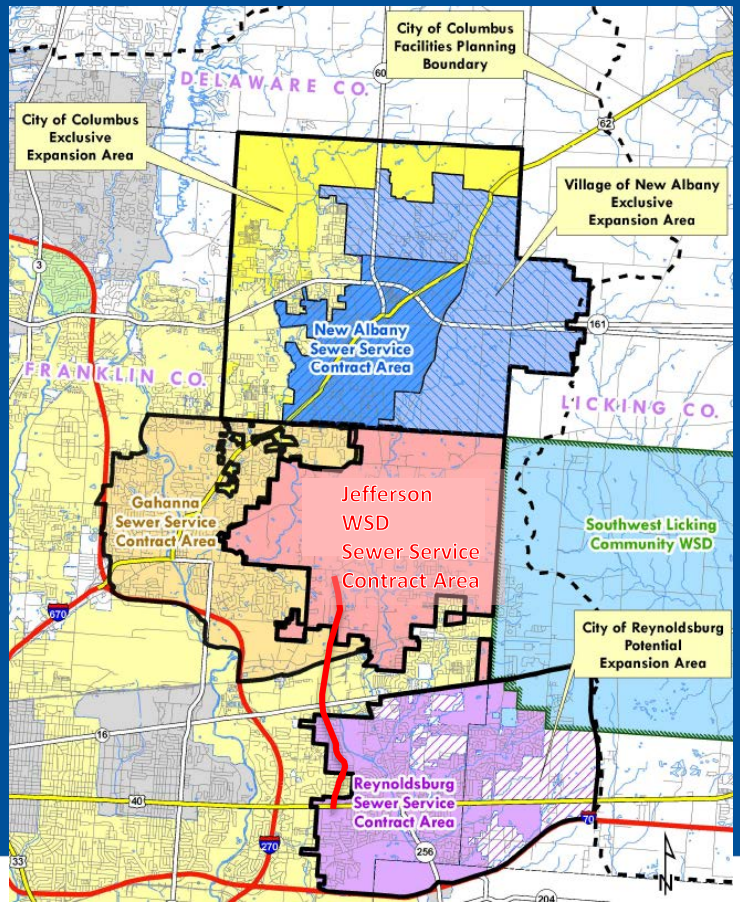
Tunnel Construction Schedule

- 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)
    - 400 Feet ± sewer for use as Tail Tunnel
  - Milestone No. 3 – TBM Startup and 500’ Initial Mining (560 days)

THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR
DEPARTMENT OF PUBLIC UTILITIES

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



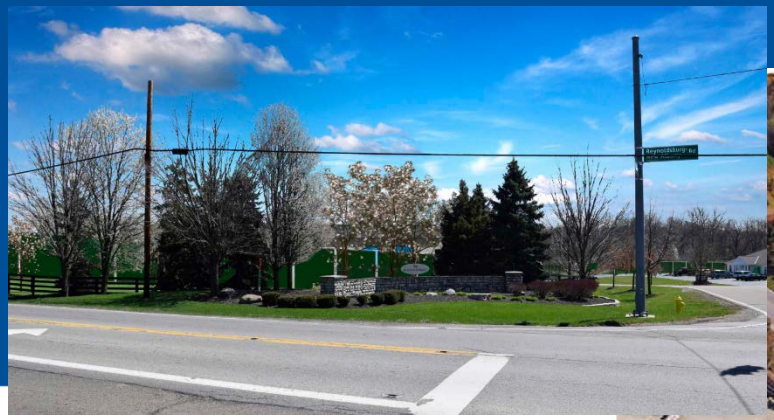
THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF PUBLIC UTILITIES

Other Facilities- Tunnel Launch Site

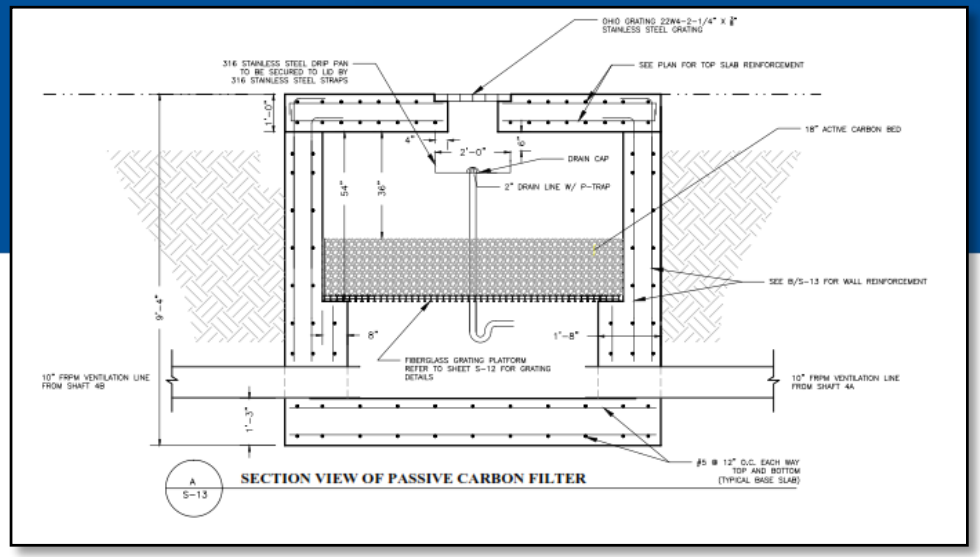
Shaft 1 / Main Project Site - North of Blacklick Ridge Blvd

- 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



THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

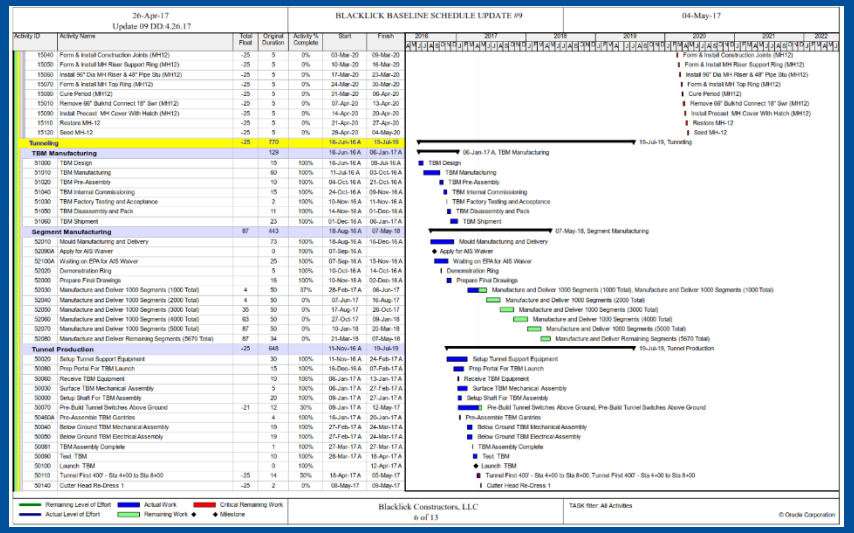
DEPARTMENT OF
PUBLIC UTILITIES

Construction Schedule

- Construction Start – May 2016

- Completion of CMT Offices – 90 days
- TBM Startup and Initial Mining – 560 days
- Substantial Completion – 1450 days

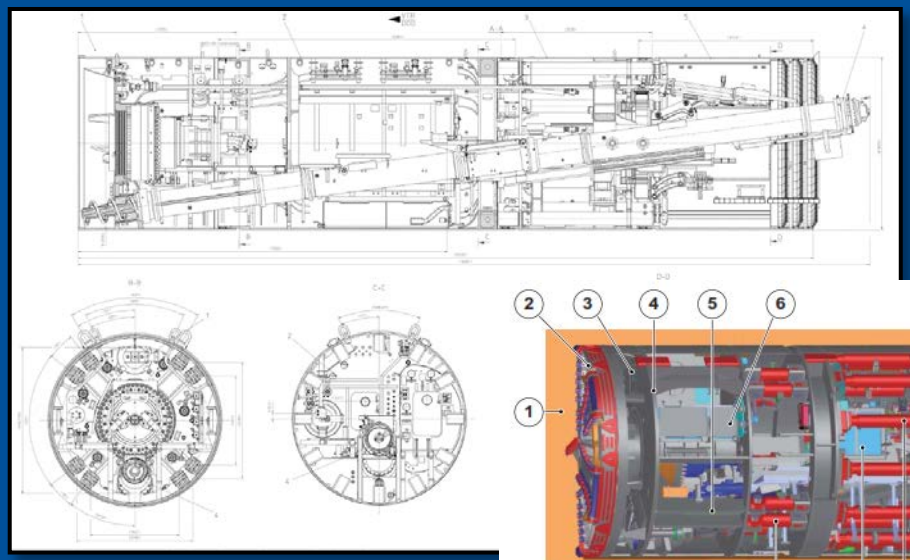
- Construction Completed – July 2020

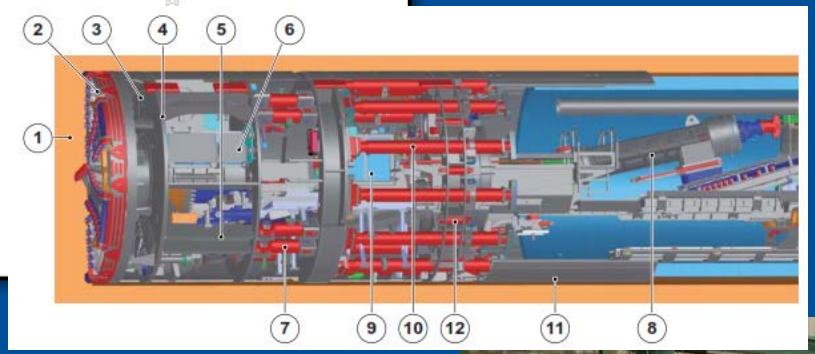


THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

Construction – From Submittals to Field Construction

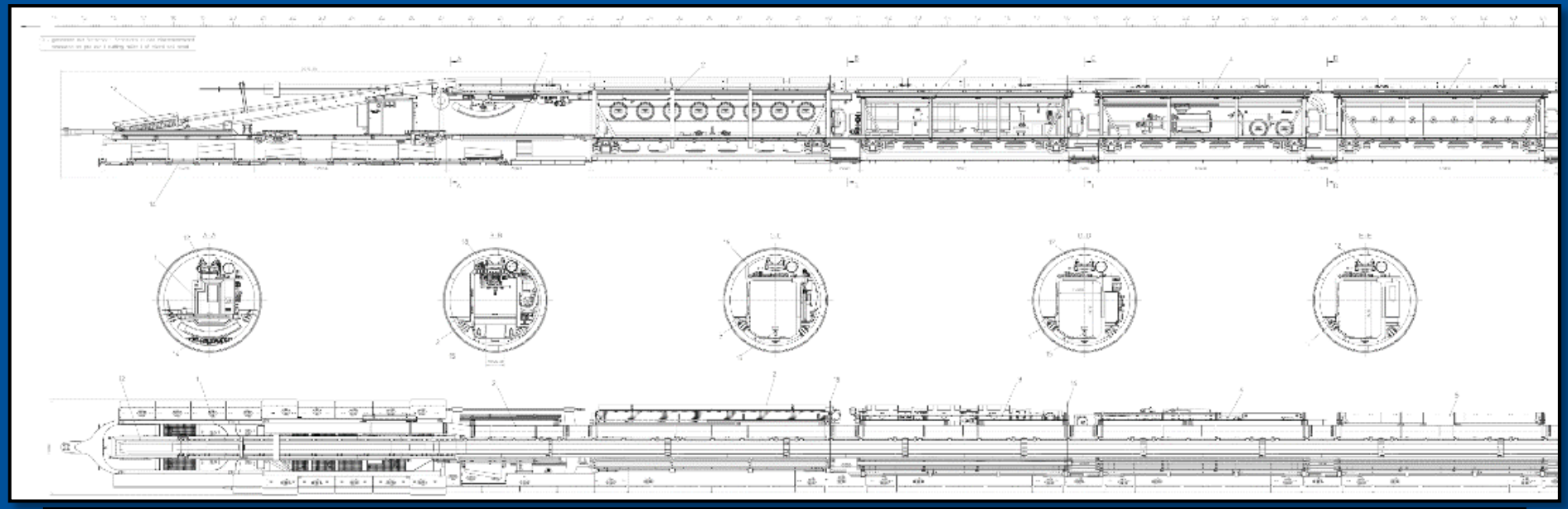


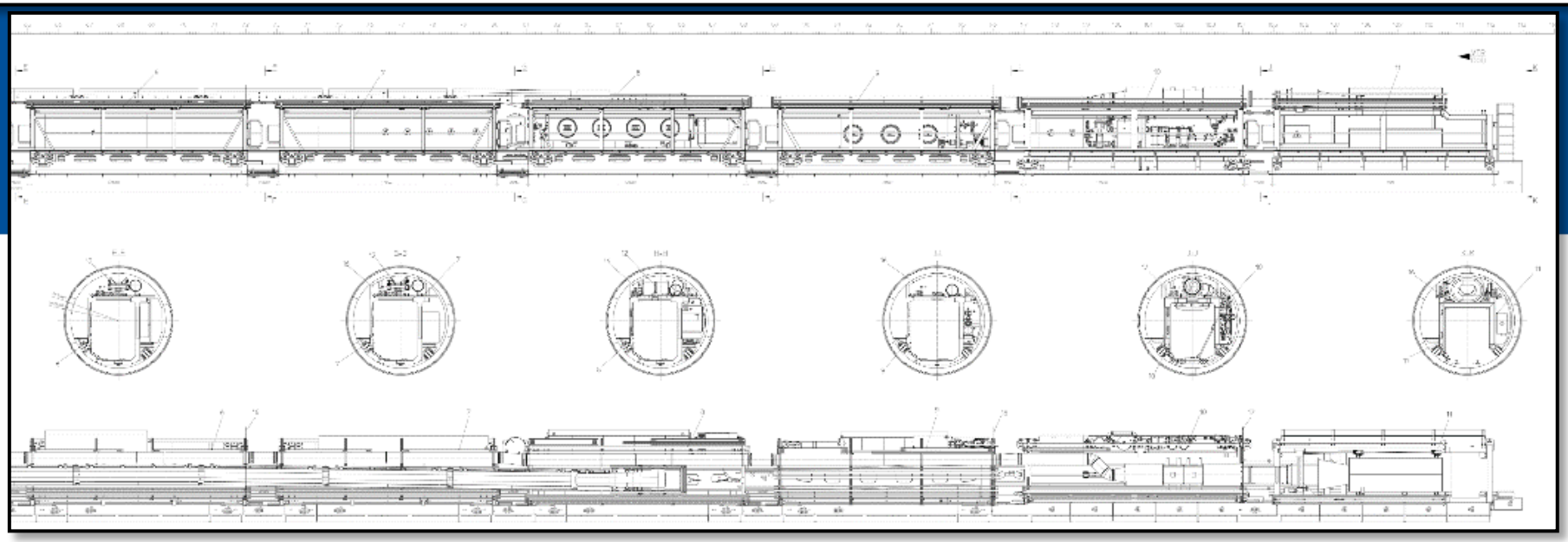


THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

TBM Submittal





Tail Tunnel Construction

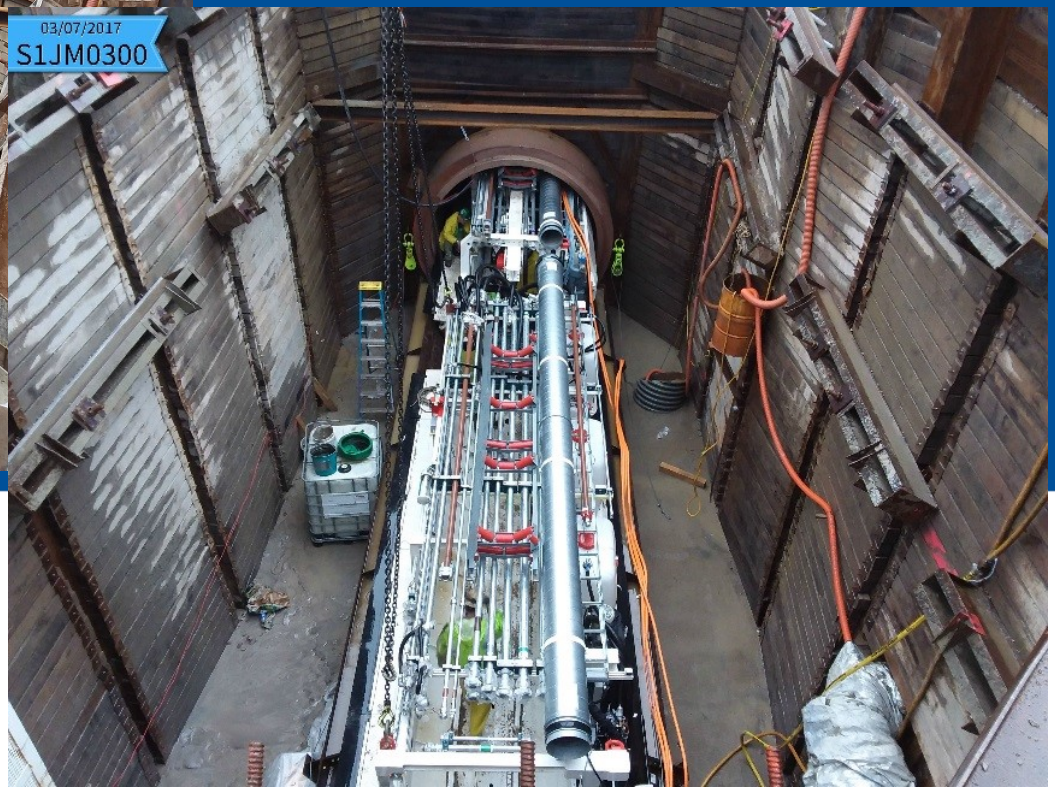
TBM Installation

TBM Installation

THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

TBM Installation



THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

TBM Installation

THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

Shaft 1 with push rings installed for TBM launch

Shaft 1 with top half of push rings removed

Segment Delivery and Storage

THE CITY OF
COLUM
ANDREW J. GINTHER,
DEPARTMENT
PUBLIC UTILI

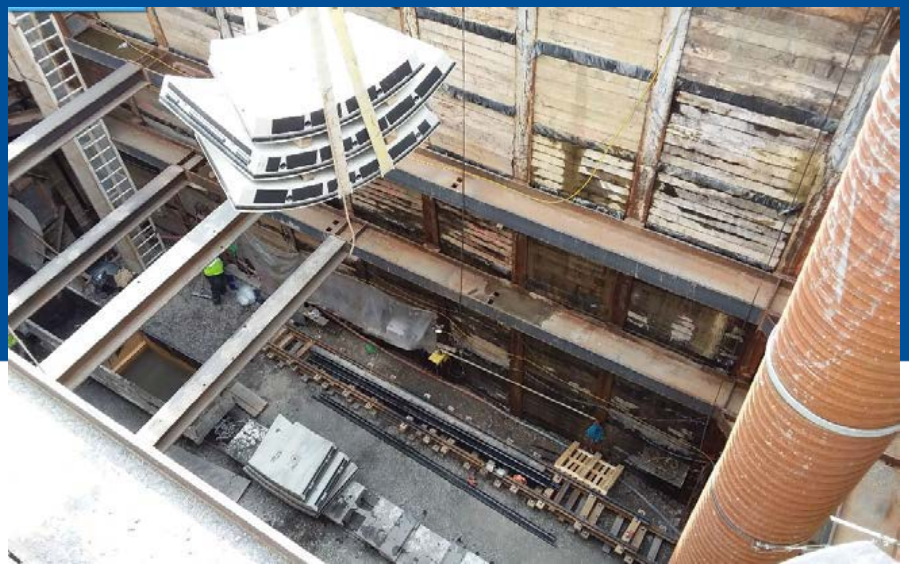
Tunneling Activity Progress

THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

Muck being dumped in the muck pond

Tunnel muck being removed from Shaft 1



Tunnel segments being lowered into Shaft 1

THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES

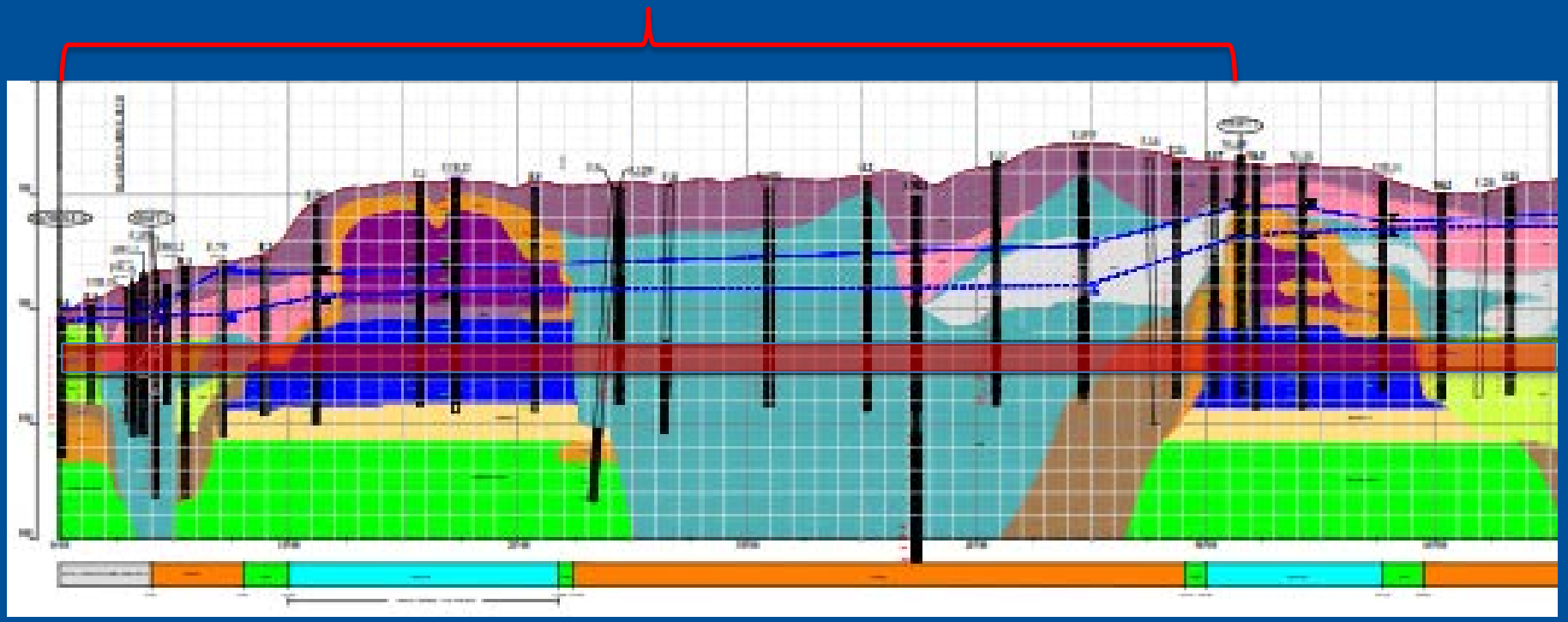
Drilling Shaft 3B.

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

Start of drilling of MH 2B

THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES



View in the tunnel with utilities and air piping shown.

Utility Extension Work in Tunnel

Questions

THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC UTILITIES