

Case History – Design and Construction of 5,100 LF of Soft Ground Microtunneling in Hartford, CT



Celebrating the 50th Anniversary of the Clean Water Act...A Job Well Done!

NEWEA 2023 Annual Conference & Exhibit
January 22 – 25, 2023



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VARVED CLAY

GRAY SHALE

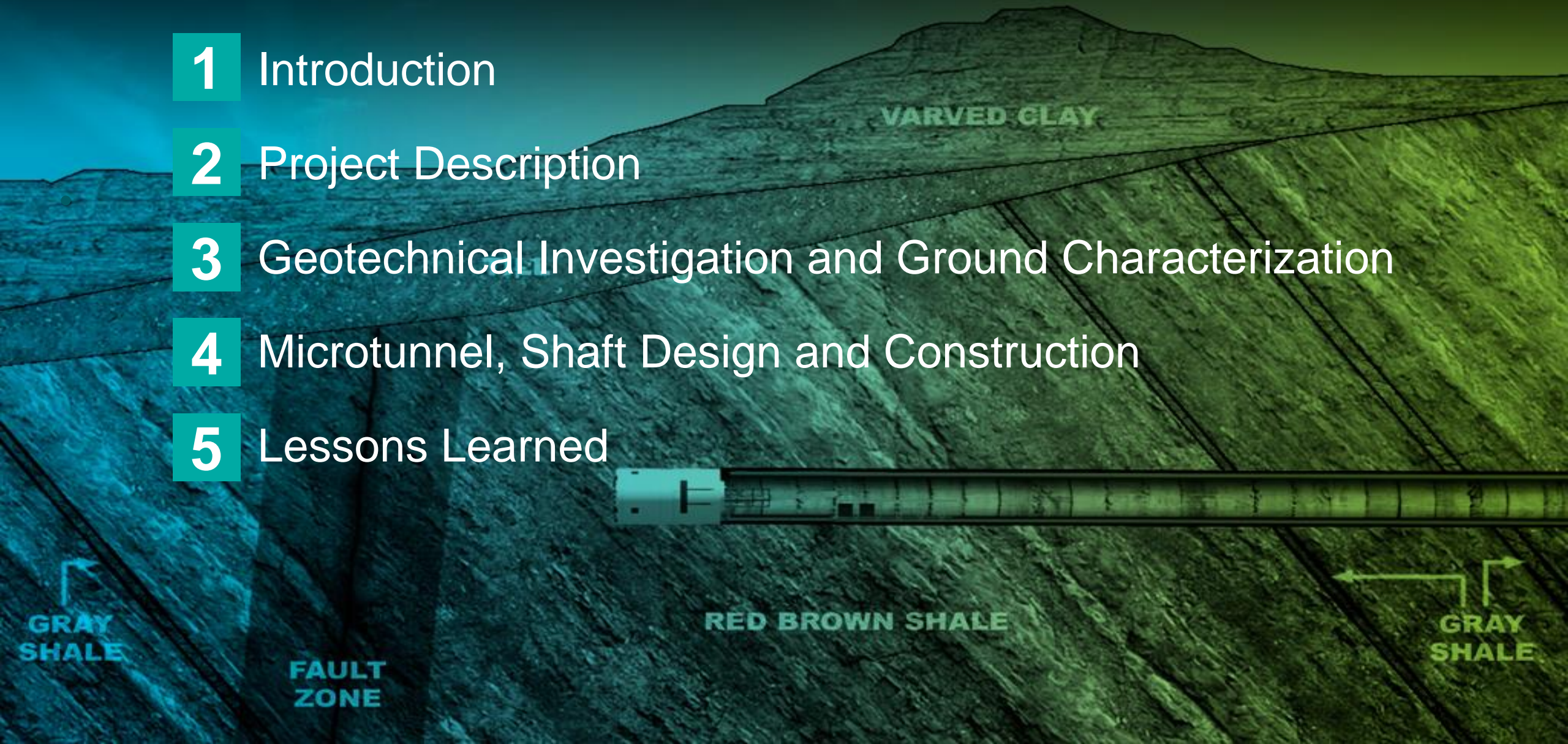
FAULT ZONE

RED BROWN SHALE

GRAY SHALE

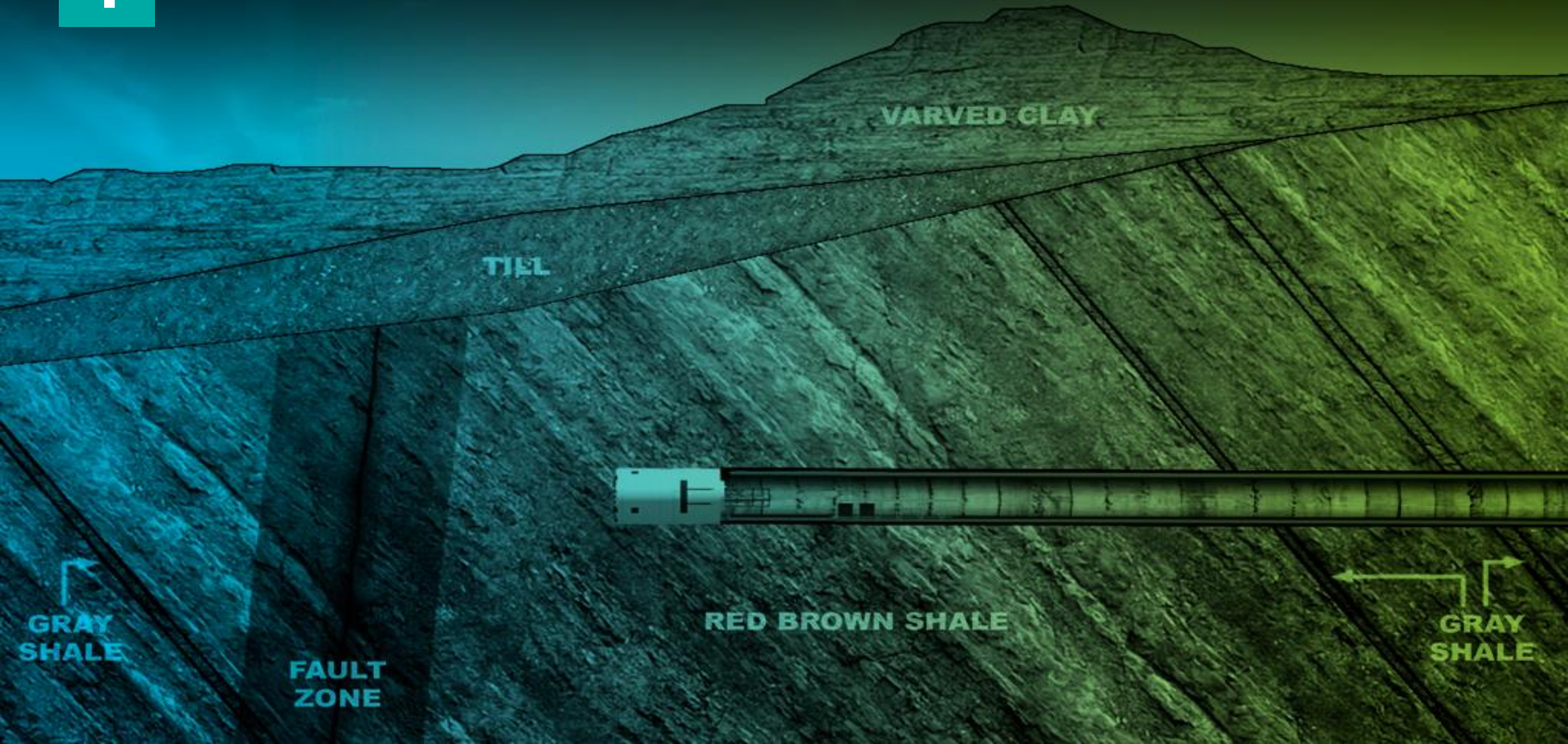
AGENDA

- 1 Introduction
- 2 Project Description
- 3 Geotechnical Investigation and Ground Characterization
- 4 Microtunnel, Shaft Design and Construction
- 5 Lessons Learned

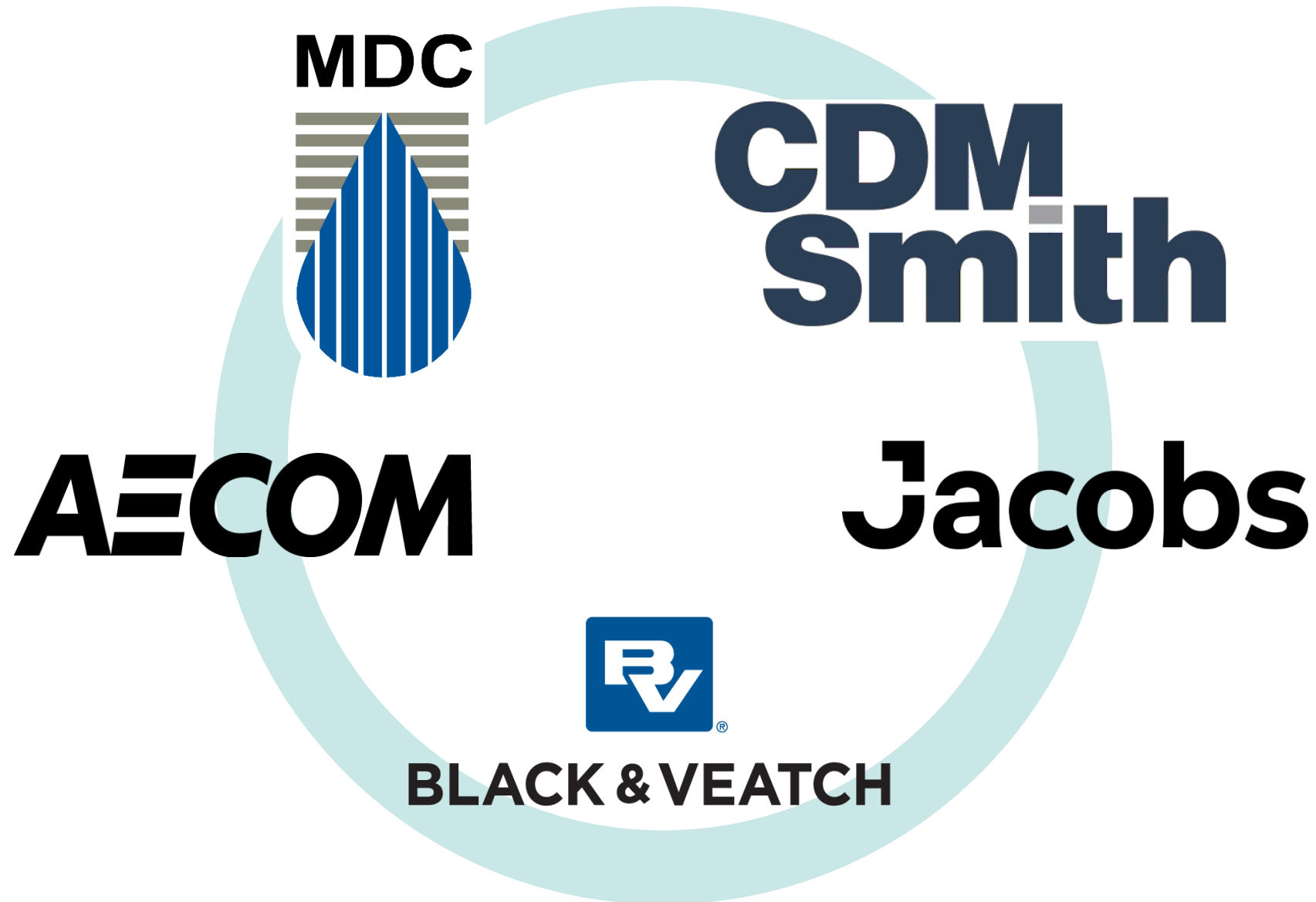


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INTRODUCTION

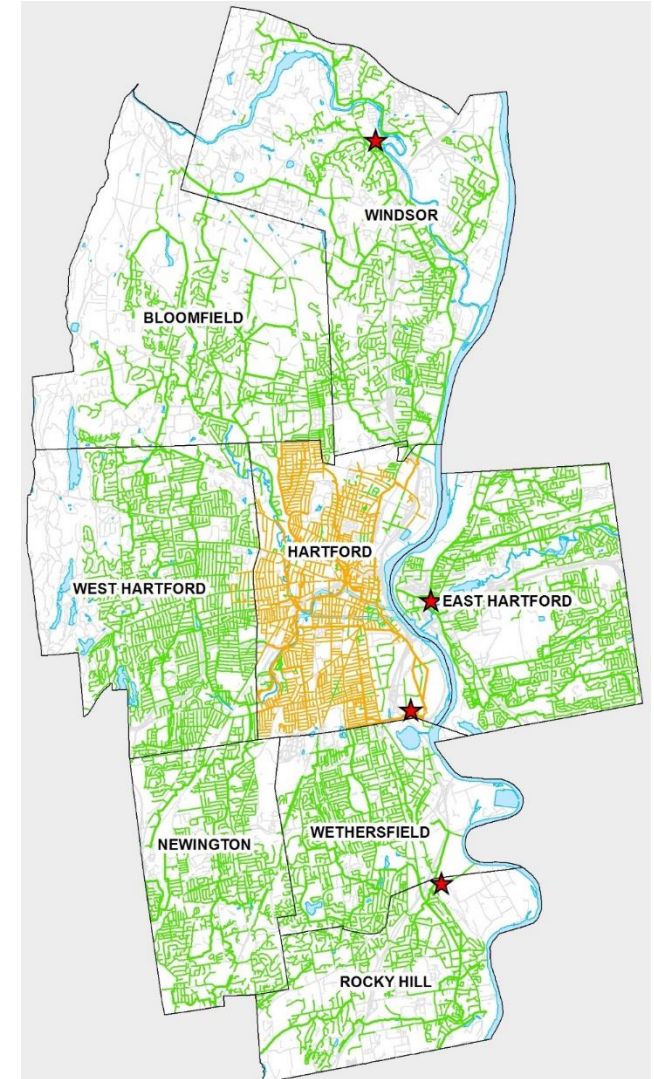


South Hartford Conveyance & Storage Tunnel Partners



Background on MDC

- Nonprofit municipal corporation chartered in 1929
- Provides water and wastewater services to 8 member Towns
- Water System
 - 39.8 billion gallon surface reservoir water supply
 - Produce approximately 45-50 MGD per year
 - 2 water treatment plants
 - 1500 miles of water mains in distribution system
- Wastewater System
 - 4 water pollution control facilities (WPCFs)
 - 1,200 miles of sewers
 - 1,013 miles of separate sewers (green)
 - 187 miles of combined sewers (orange) located in Hartford and a small portion of West Hartford



The Clean Water Project (CWP)

- The CWP is the MDC's Response to:
 1. **Consent Order** from CTDEEP to address combined sewer overflows
 2. **Consent Decree** from EPA to address sanitary sewer overflows

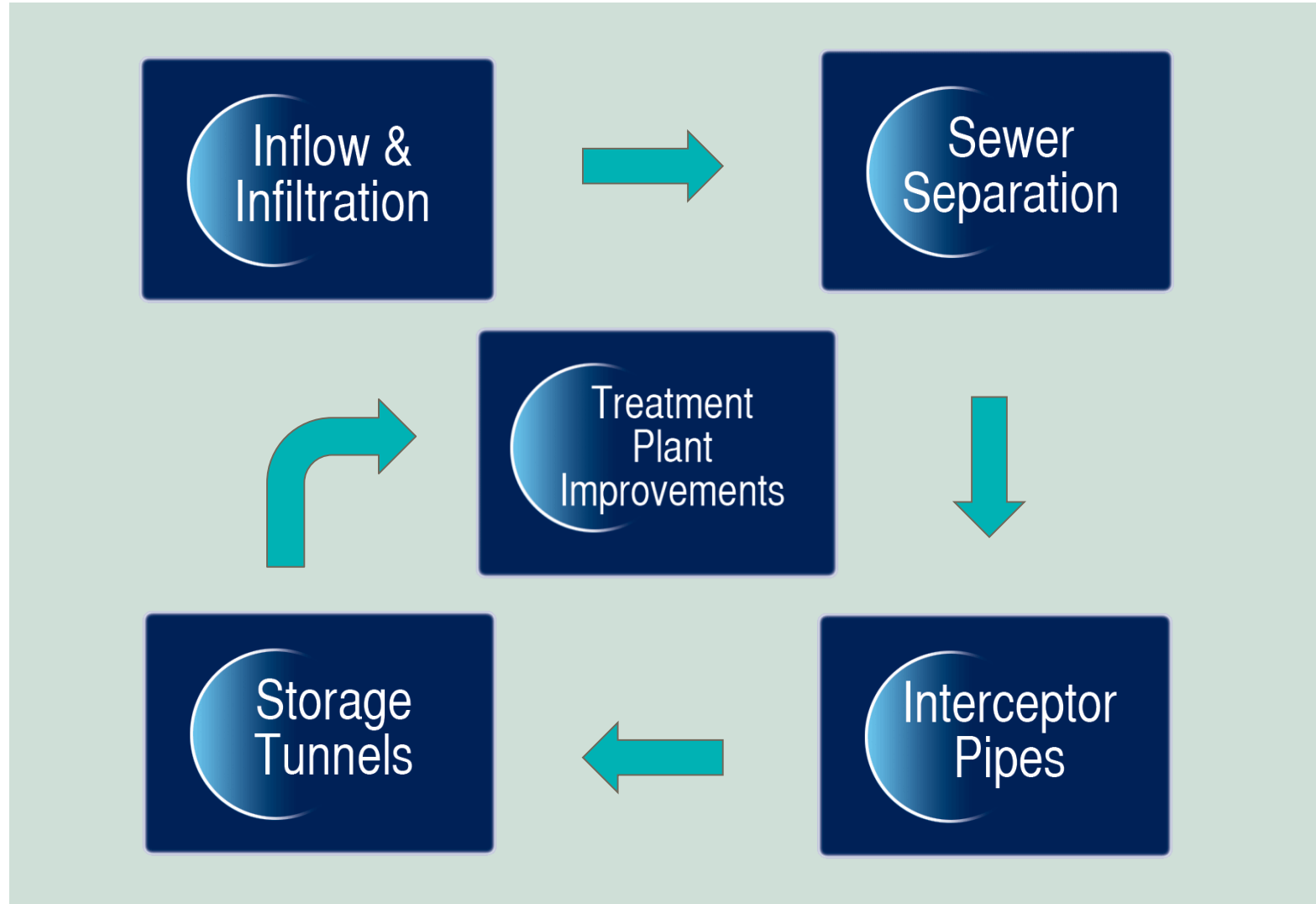
Multiphase program in excess of \$2B that will take decades to complete

Project Goals:

1. Reduce the Combined Sewer Overflows (CSOs) to Streams/Rivers
2. Eliminate CSO Outfalls to Wethersfield Cove & North Branch Park River
3. Reduce Nitrogen Discharged to CT River
4. Address Sanitary Sewer Overflows / SSOs Outside of Hartford

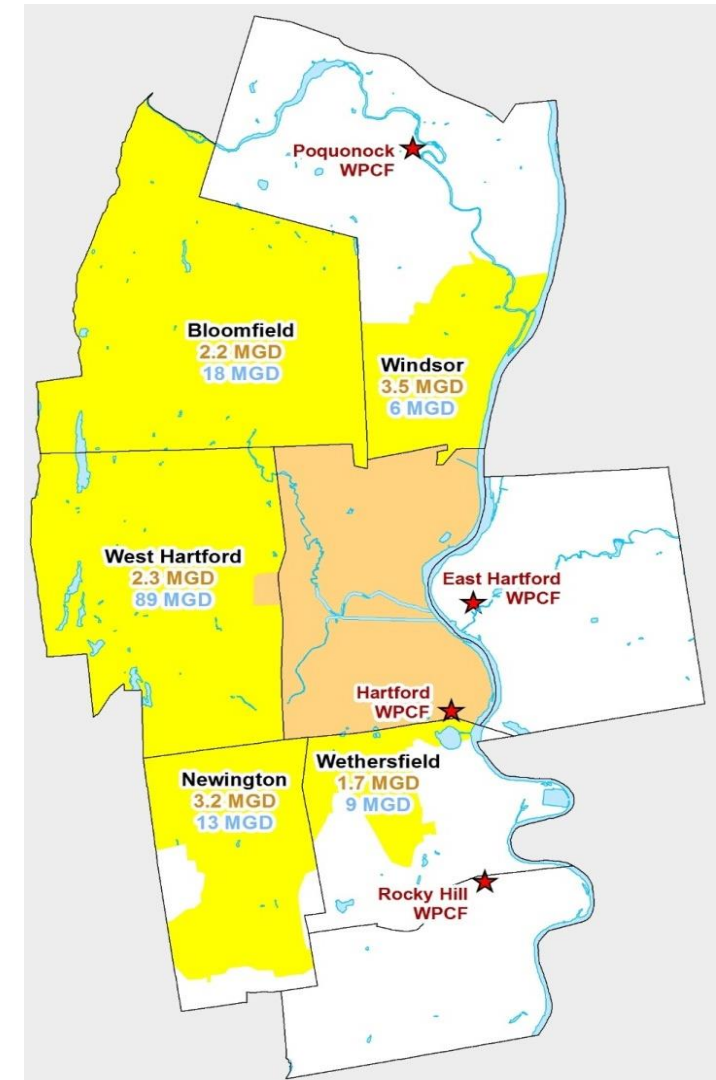


Five Components of Clean Water Project



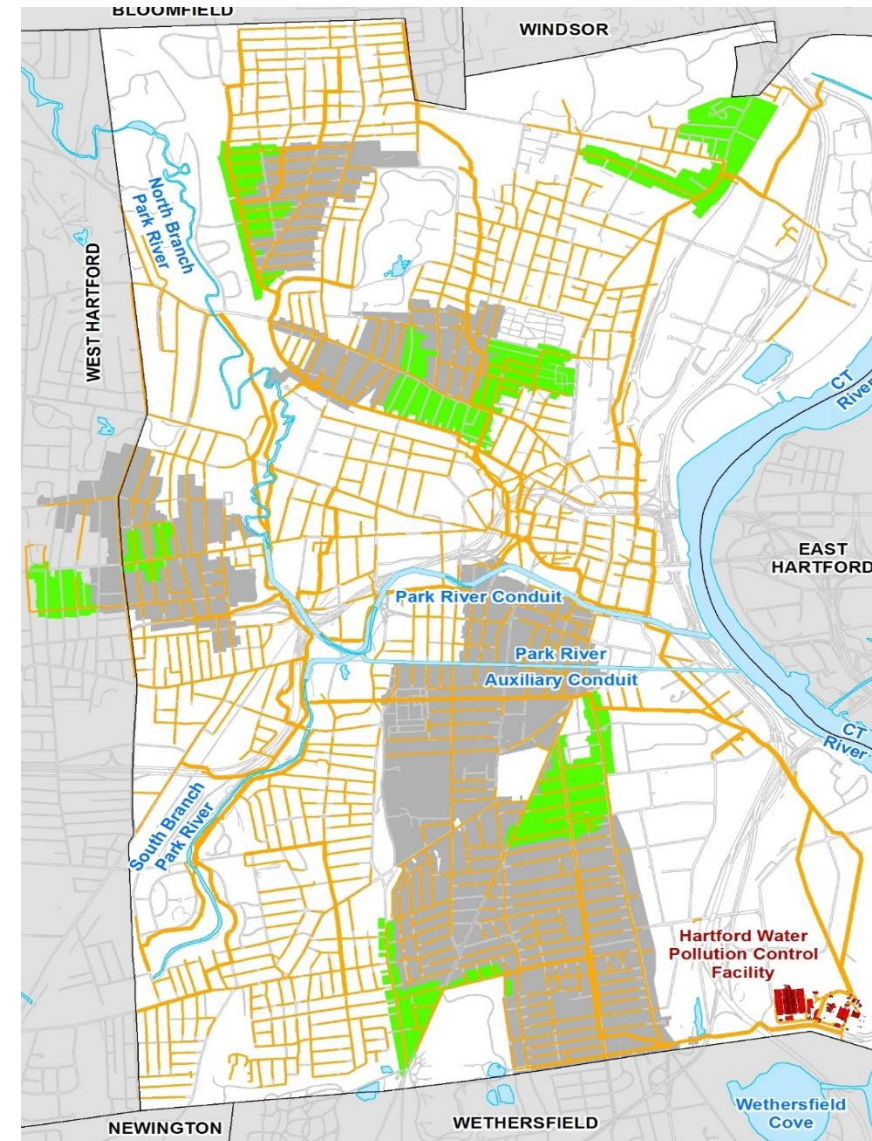
Impacts on the Hartford Sewer System from Member Towns

- Wet weather events contribute a significant amount of flow to the MDC's sewer collection system – which includes the 8 Member Towns.
- This increase in stormwater combined with the wastewater can overwhelm the MDC's Water Pollution Control Facility, previously, causing over 1 billion gallons in combined untreated sewage and stormwater to overflow into the CT River and other tributaries.



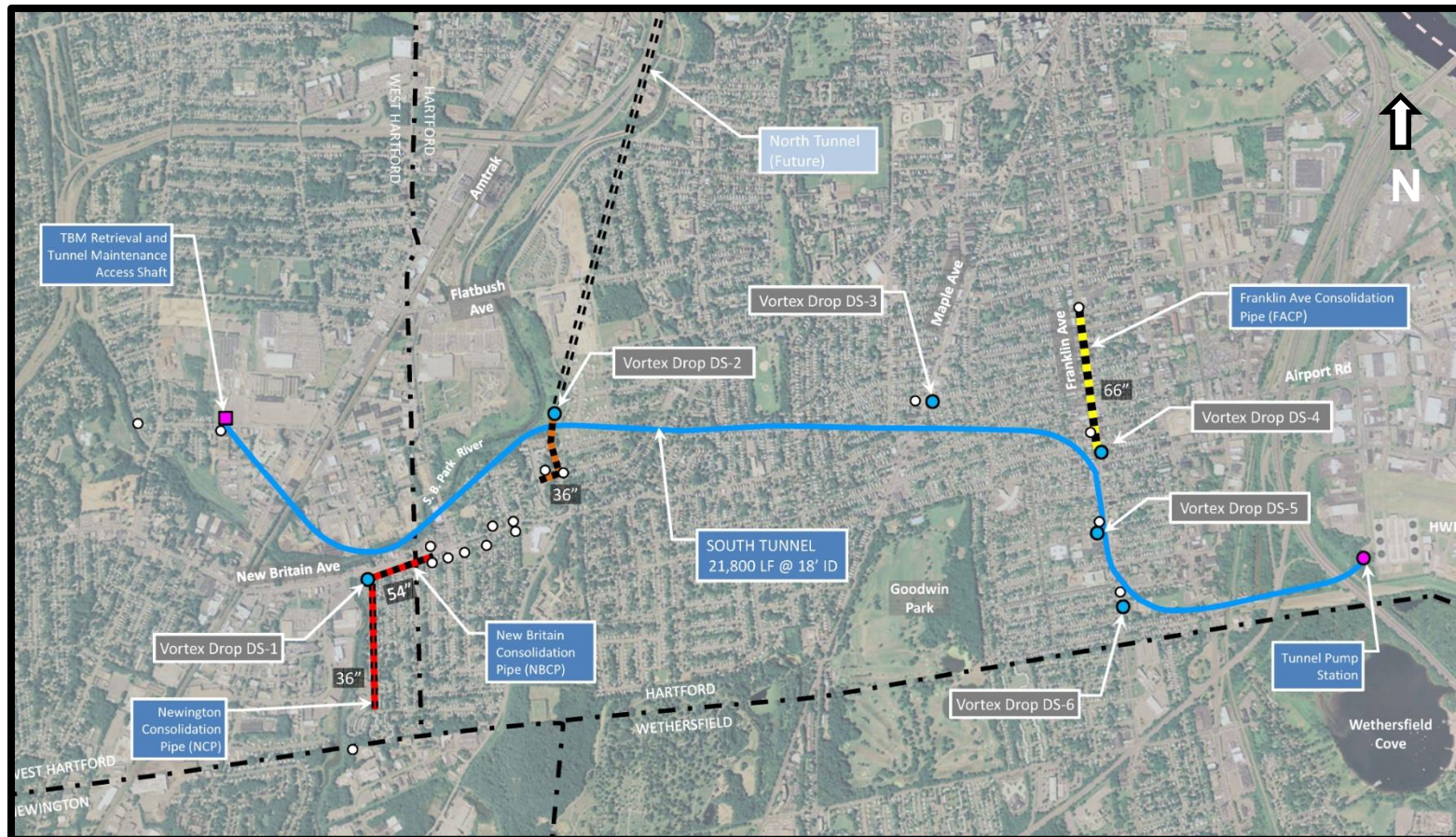
Sewer Separation

- CSO Separation Areas
 - 6 areas project wide
 - Separates combined sewers into separate sanitary and storm sewers
 - 15 completed projects
 - Total value \$180M
- Completion of South Tunnel Project will Avoid Sewer Separation Costs
 - Franklin Ave area = \$240M
 - Other areas = \$560M



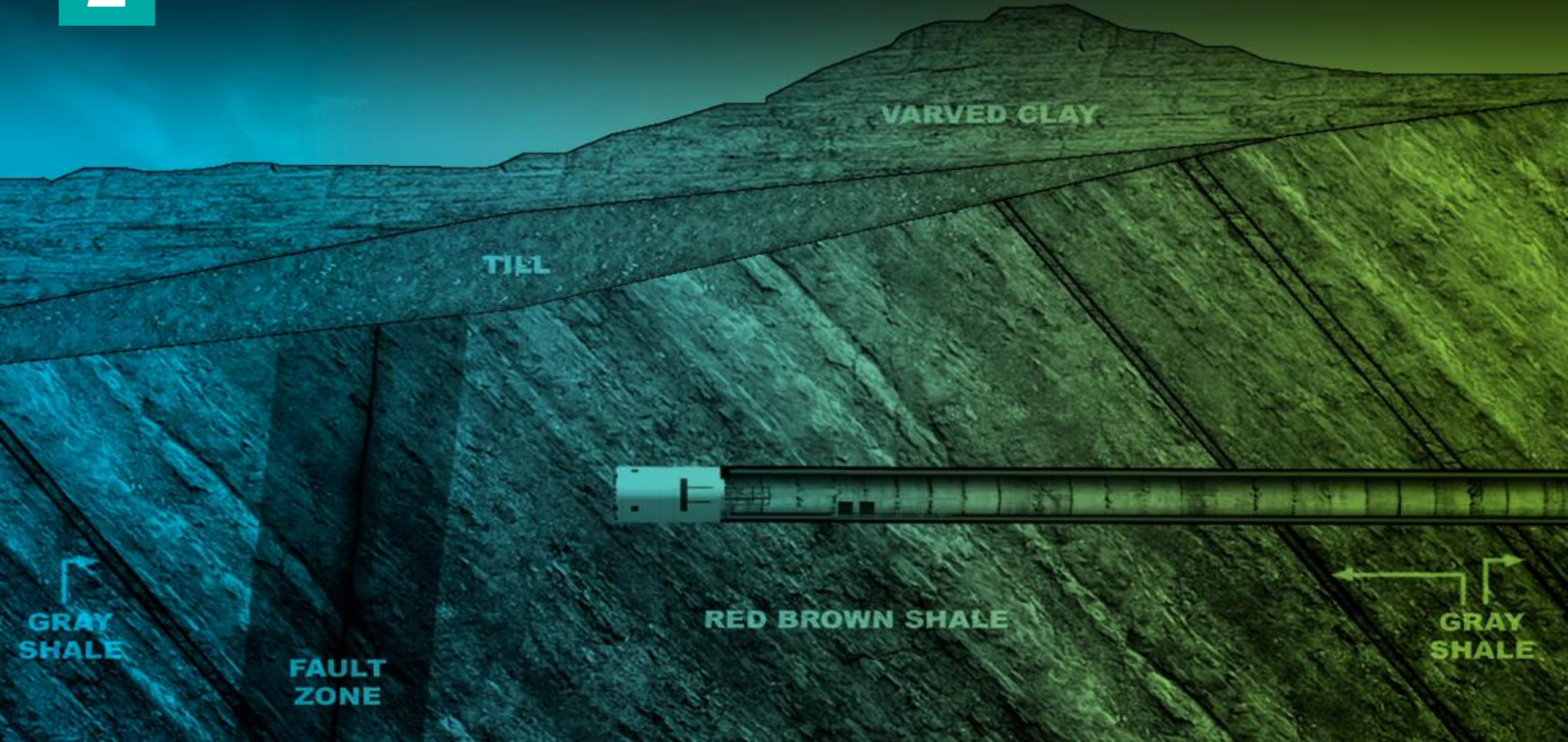
The South Tunnel Project Components:

- 4-Mile-Long Deep Tunnel
- 6 Hydraulic Drop Shafts
- 7,300 LF of Consolidation Conduits
- 50 MGD Deep Pump Station

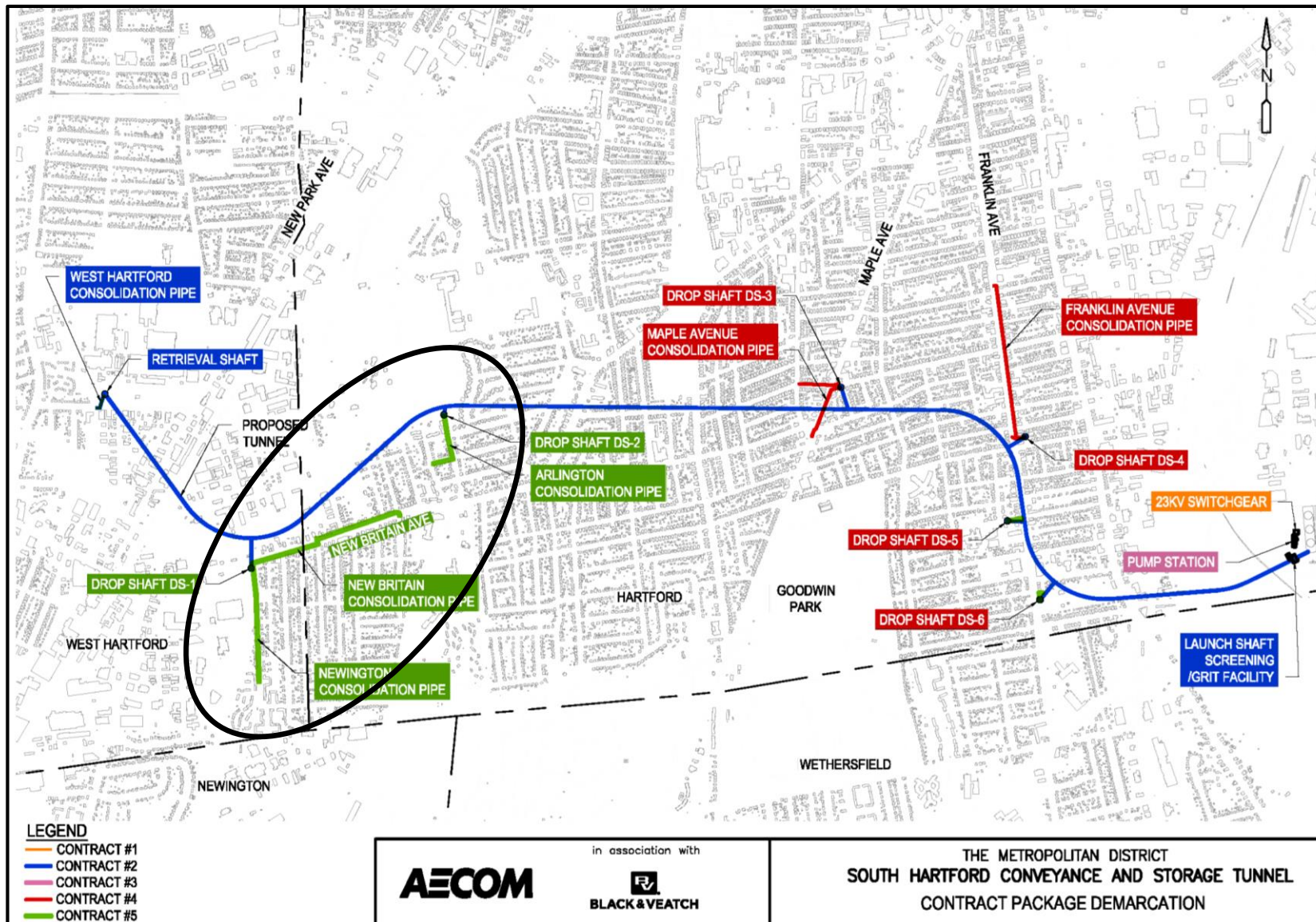


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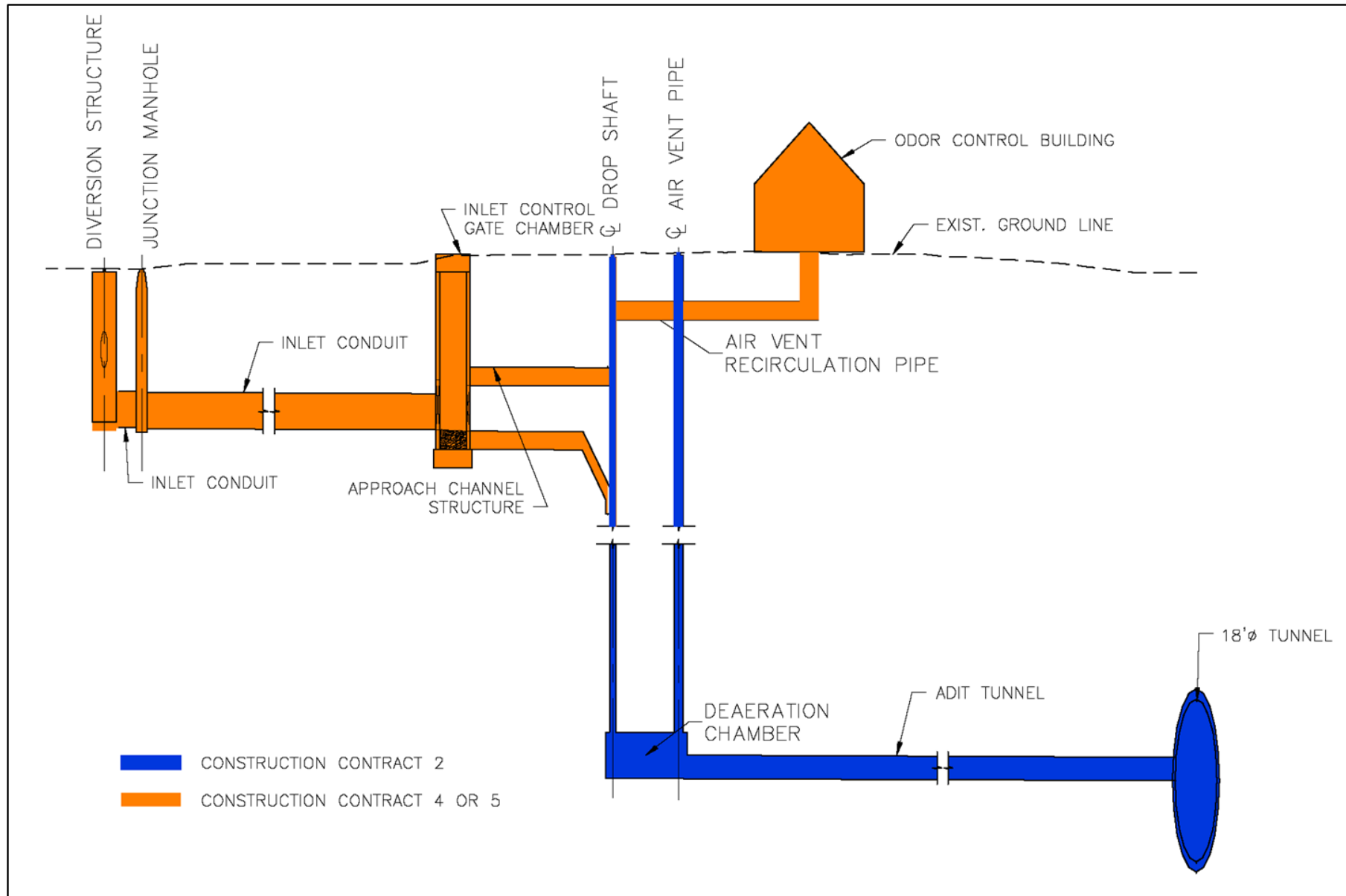
PROJECT DESCRIPTION



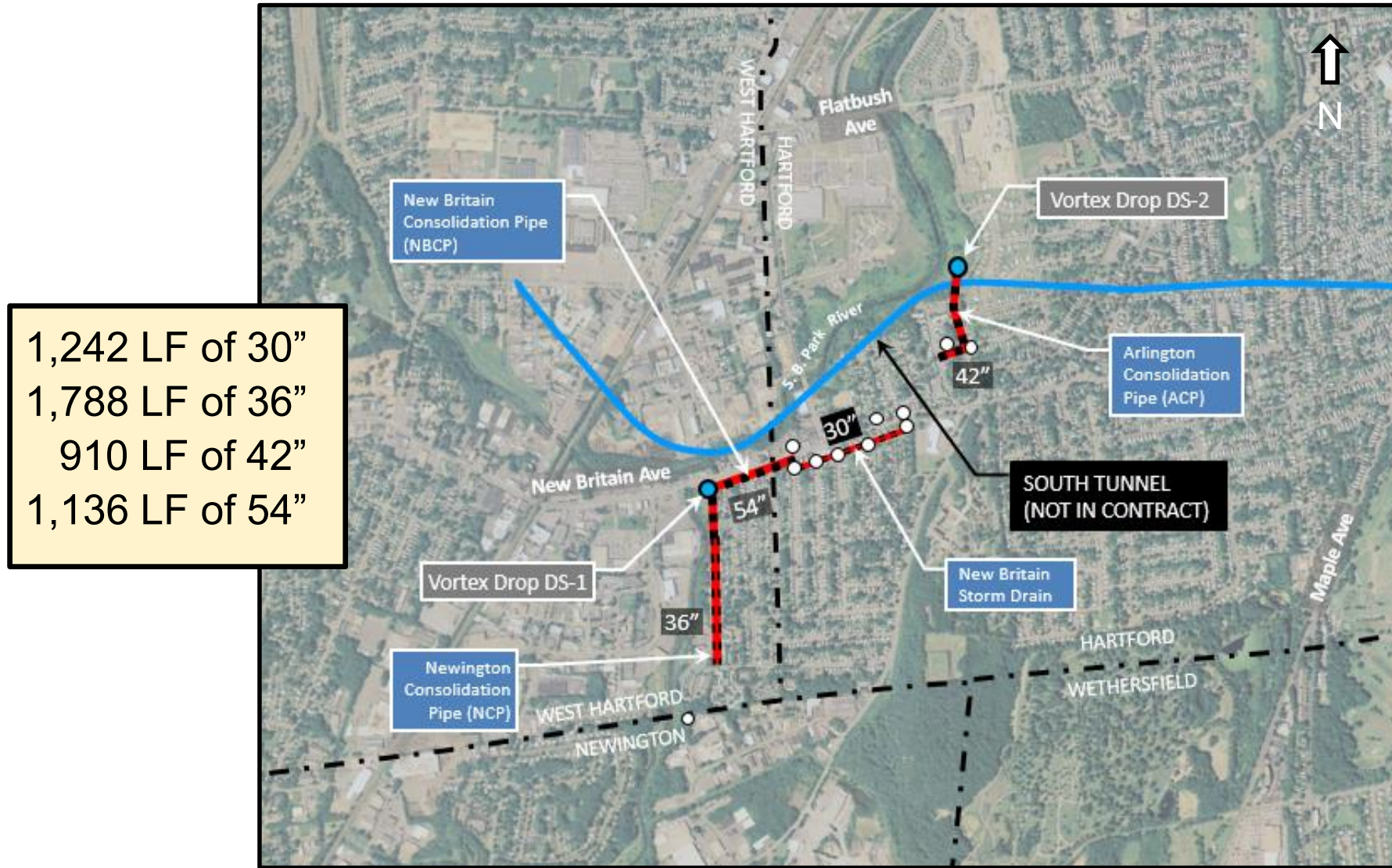
South Hartford CSO Tunnel - Contract Packaging



Contract Interface at Each Drop Shaft



Consolidation Conduits – Contract 5



Consolidation Conduits – Contract 5

- **Consolidation Conduits:**
Newington, Arlington Street, New Britain Avenue, New Britain Avenue Storm Drain
- Ancillary Structures:
 - Diversion chambers
 - Manholes
- 5,100 LF of Microtunneling
- Contractors:
 - General: **Empire Paving**
 - Microtunneling Contractor: **CRS Contractors**
 - Design Engineer/CM: **AECOM (with B&V/H&A/Aldea)**
 - Program Manager: **CDM Smith**



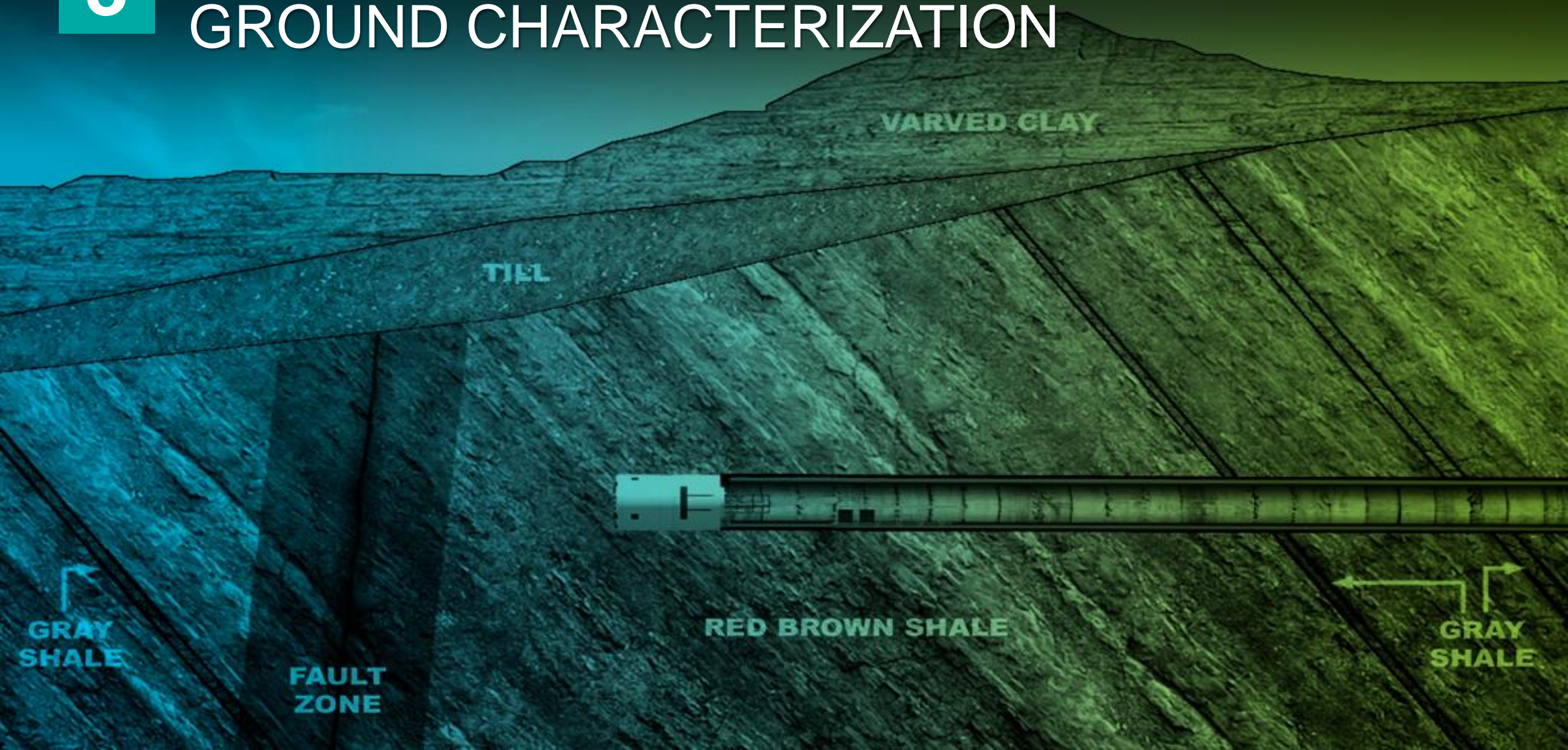
Contract 5 Scope

- Four Pipe Conduits & Associated Structures
 - Newington - NCP (carries SSOs)
 - Arlington Street – ACP (carries CSOs)
 - New Britain Avenue – NBCP (carries CSOs)
 - New Britain Avenue Storm Drain (carries separated storm water)
- Two Approach Channels/Inlet Control Gate Chambers
 - DS-2 (Arlington Street)
 - DS-1 (New Britain Avenue & Newington)



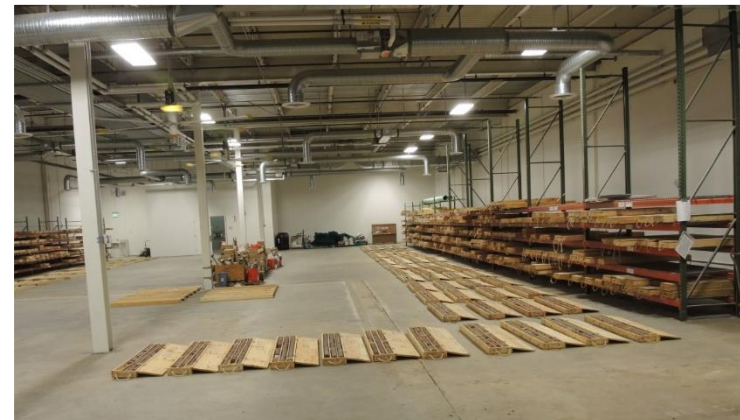
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GEOTECHNICAL INVESTIGATION AND GROUND CHARACTERIZATION



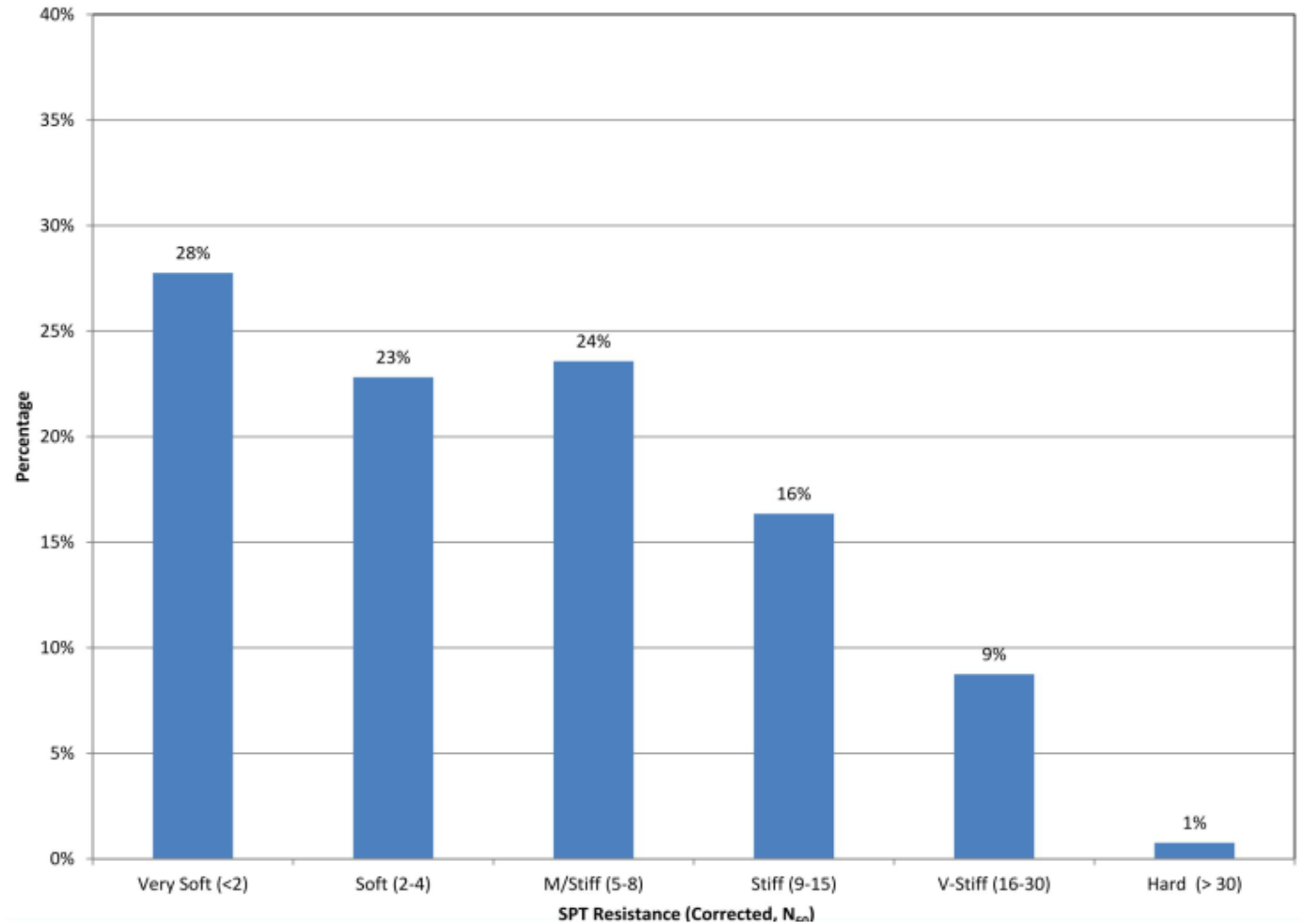
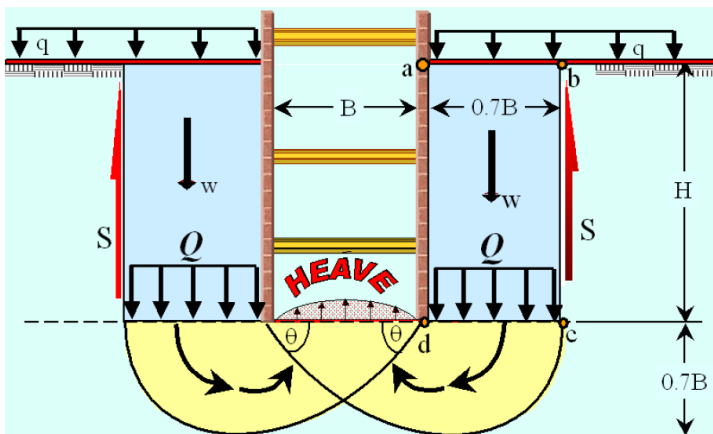
Geotechnical Interpretation – GBR Development

- Core Storage & Handling Facility
 - Located at downstream end of tunnel
 - Detailed core logging & photography
 - Geotechnical/tunnel coordination meetings
- Working Geologic Profiles
 - Maintained throughout design phase
 - Final version in GBR
- Collaboration w/ CT State Geologist Office
 - Recently published bedrock geology map
 - Collaborated on geologic interpretation
 - Shared geotechnical information



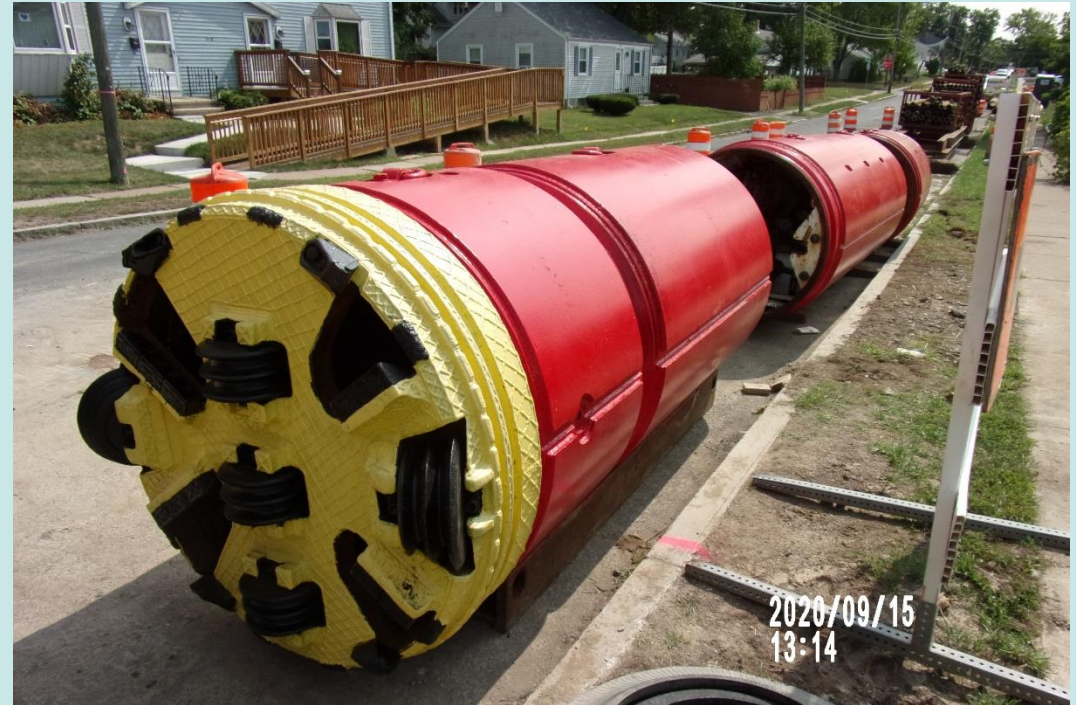
Varved Clay Properties – Contract 5

- Very Soft to Soft
 - >50% of N-values
- Highly Sensitive
 - $S_t = 10$
 - Significant strength loss when disturbed
- Bottom Heave Potential



GBR Baselines - Contract 5

- Geologic Profiles Represent Baseline Conditions
- Microtunnel Drives
 - Full face of Glaciolacustrine Deposit (varved clays)
 - No Obstructions Anticipated
- Soil Properties Baseline
 - Moisture content, unit weight, N-values, undrained shear strength, hydraulic conductivity



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MICROTUNNEL, SHAFT DESIGN AND CONSTRUCTION



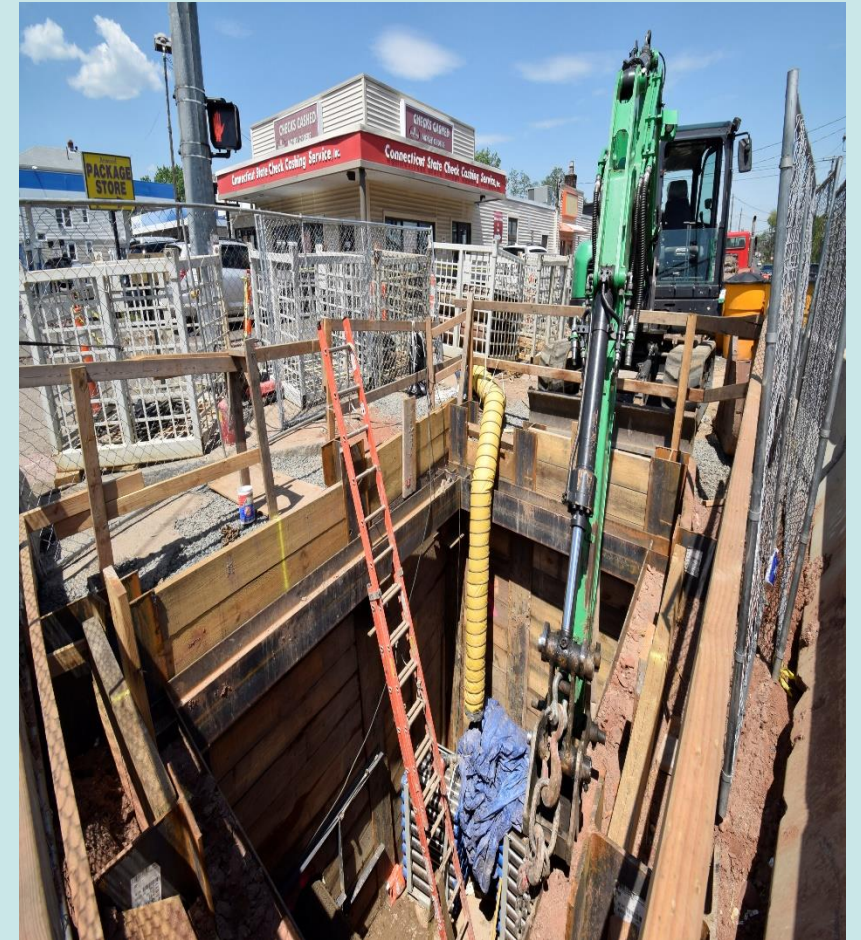
Geotechnical Construction Challenges

- Microtunneling Obstructions
- Deep Shafts in Connecticut Valley Varved Clay
- Support of Excavation Designs in Proximity to Residents and Businesses
- Deep Shaft Bottom Stability Issues and Mud Mat Heave/Displacement
- Noise and Vibration Monitoring During Pile Driving
- Geotechnical Instrumentation



Risk Mitigation – Shafts/Open Cut Excavations

- Professional Registered Engineer in CT required to design all SOE
- All SOE required to be left in place
- Limit use of trench boxes
- Minimum F.S. of 1.5 against basal heave
- Limit settlements to existing buildings to 1/2 inch and limit angular distortion to 1/360
- Filter fabric, crushed stone, mud mat invert protection
- Limit GW drawdown outside excavations < 2 feet



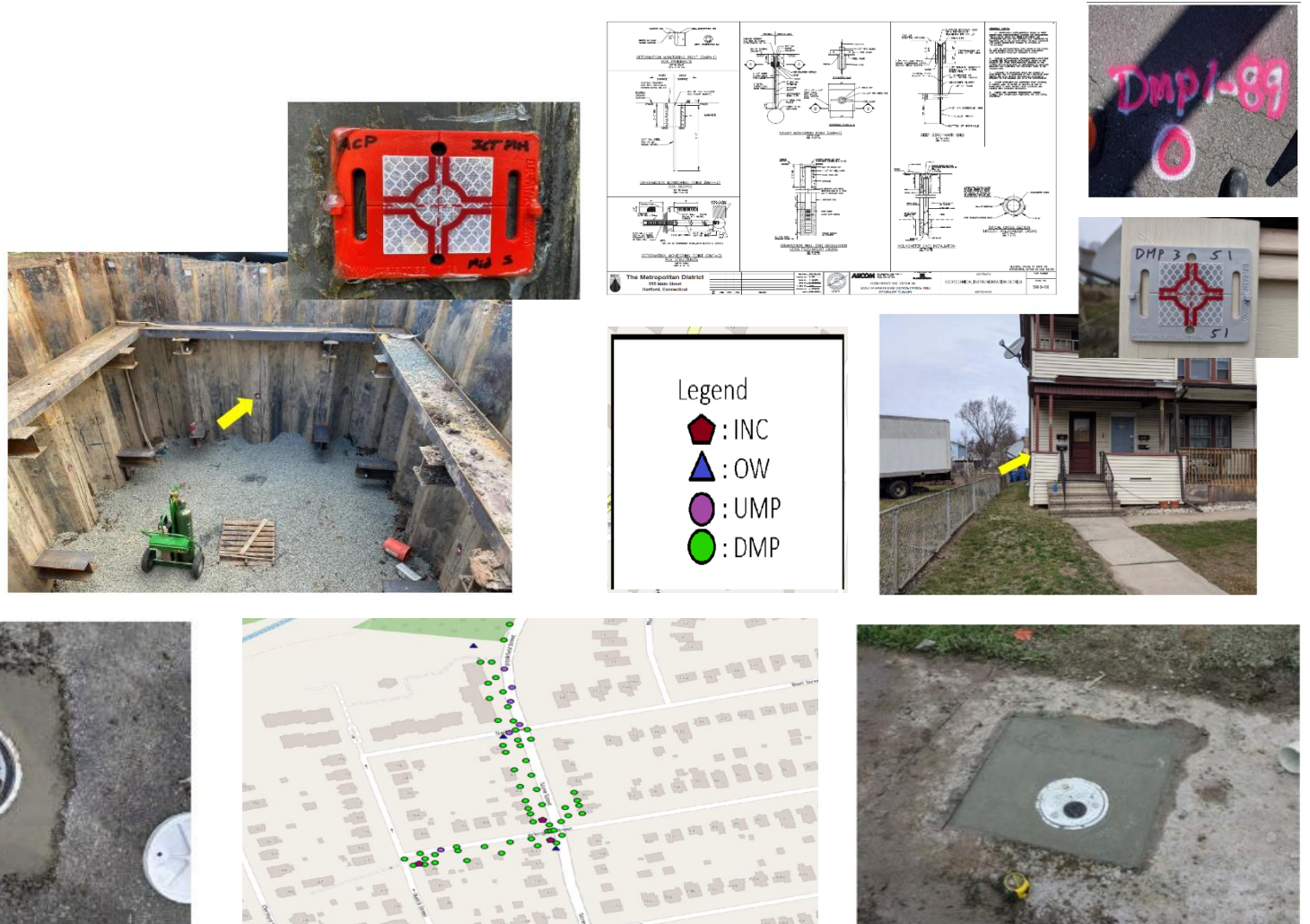
Risk Mitigation – Microtunneling

- Pressurized-face machine requirement
- MTBM break-in/break-out seal requirement
 - Ground improvement to be designed by Contractor
- Experience requirements for MT Superintendent and Operator
- MT Shafts require 6-in mudmat
- Extensive geotechnical instrumentation monitoring program



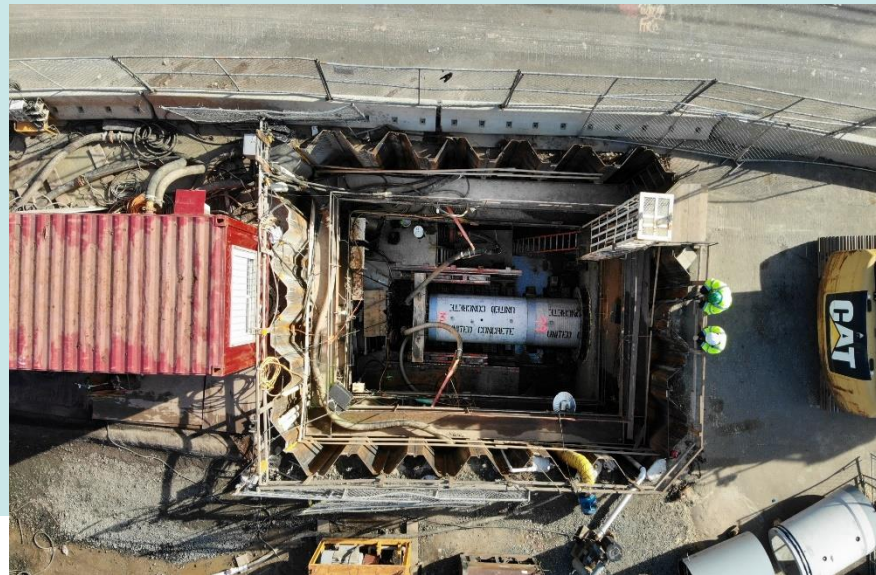
Geotechnical Instrumentation

- Monitoring Performed by a CT Registered Land Surveyor
- Monitoring Results – Interpreted and Posted on a Project Team Website

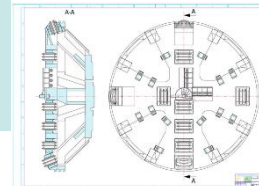
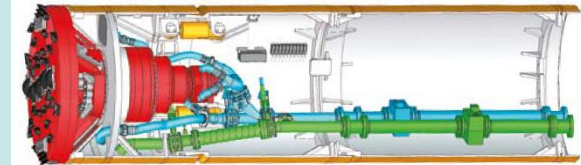


Newington Consolidation Pipe 42" RCP

- Herrenknecht Slurry MTBM
- Drive #1 Start: 9/28/20
- Drive #2 End: 12/1/20
- 31 work-days
- 58 LF/day
- Allowable Jacking Pipe Capacity: 500 Tons
- Max Jacking Pipe Force: 340 Tons

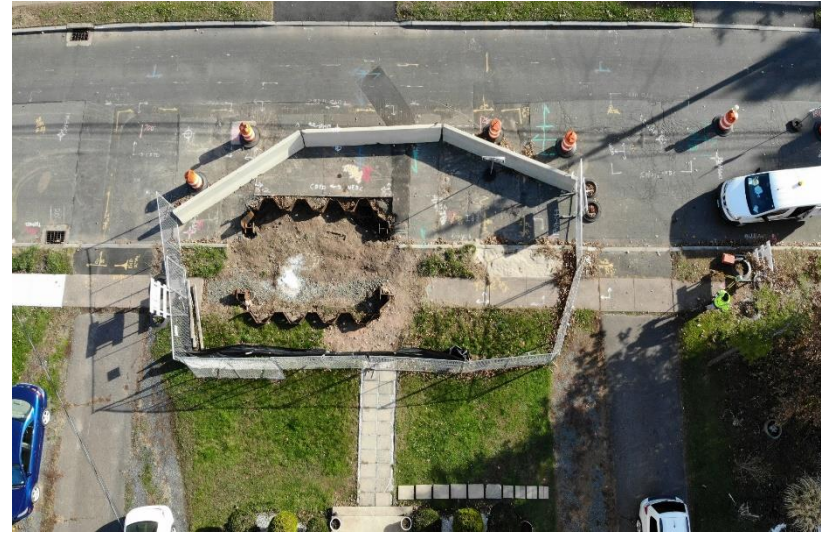


AVN800XC – AVN2000AC
PIPE JACKING



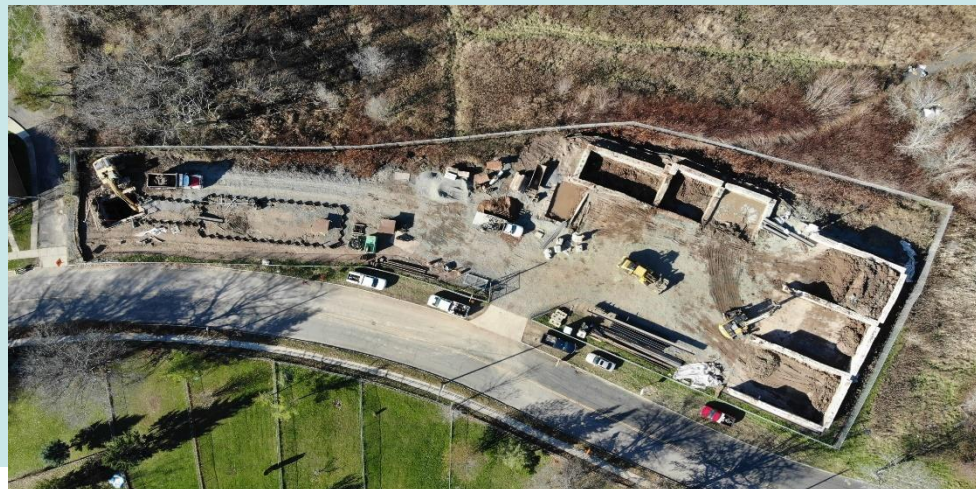
Mixed Ground
Cutterhead

Newington Consolidation Pipe 42" RCP

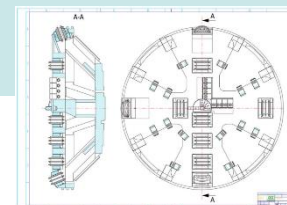
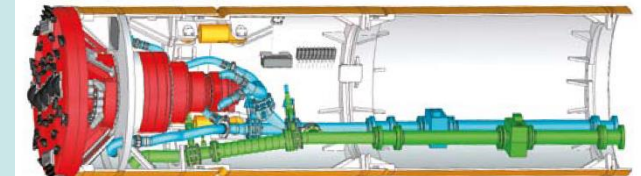


Arlington Street Consolidation Pipe 42" RCP

- Herrenknecht Slurry MTBM
- Drive #1 Start: 2/11/21
- Drive #2 End: 3/29/21
- 22 work-days
- 41 LF/day
- Allowable Jacking Pipe Capacity: 500 Tons
- Max Jacking Pipe Force: 60 Tons



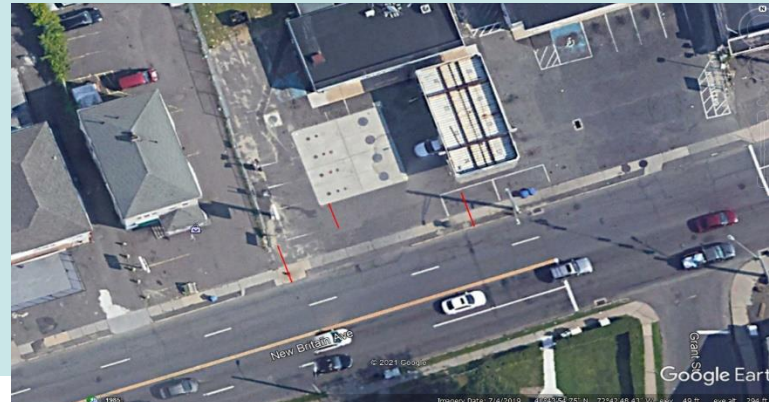
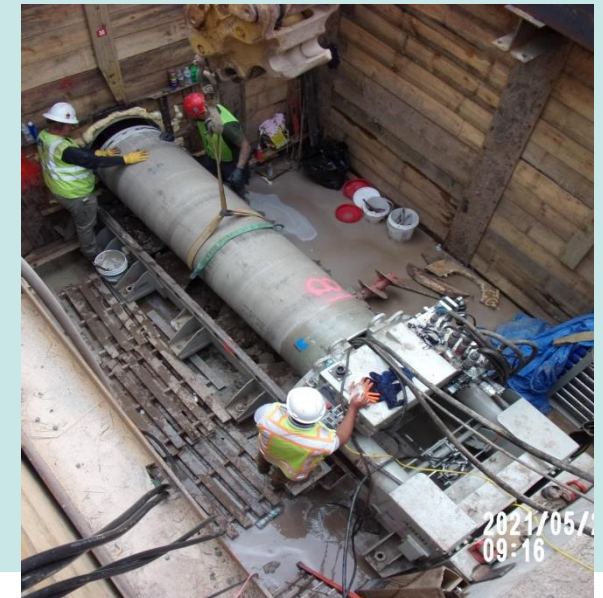
AVN800XC - AVN2000AC
PIPE JACKING



Mixed Ground
Cutterhead

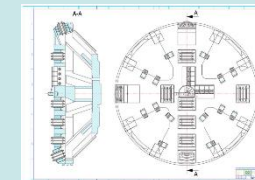
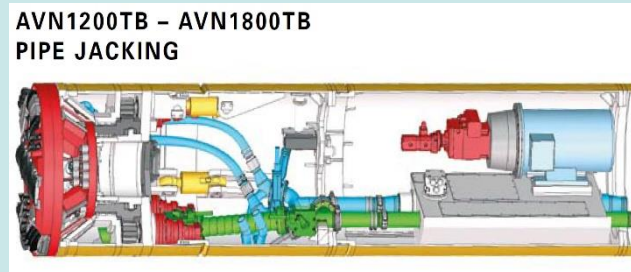
New Britain Avenue Storm Pipe 30" HOBAS

- Akkerman Guided Boring Machine System
- Drive #1 Start: 5/18/21
- Drive #3 End: 7/19/21
- 29 work-days
- 43 LF/day
- Allowable Pipe Jacking Capacity: 230 Tons
- Max Jacking Pipe Force: 140 Tons
- GBM Thrust Frame – Model 4800 Series
- 265 Tons of Jacking Force and 100 Tons of Pull Back Force



New Britain Avenue Consolidation Pipe 57" HOBAS

- Herrenknecht Slurry MTBM
- Drive #1 Start: 9/13/21
- Drive #2 End: 11/19/21
- 18 work-days
- 63 LF/day
- Allowable Pipe Jacking Capacity: 510 Tons
- Max Jacking Pipe Force: 270 Tons



Mixed Ground
Cutterhead

New Britain Avenue Consolidation Pipe 57" HOBAS

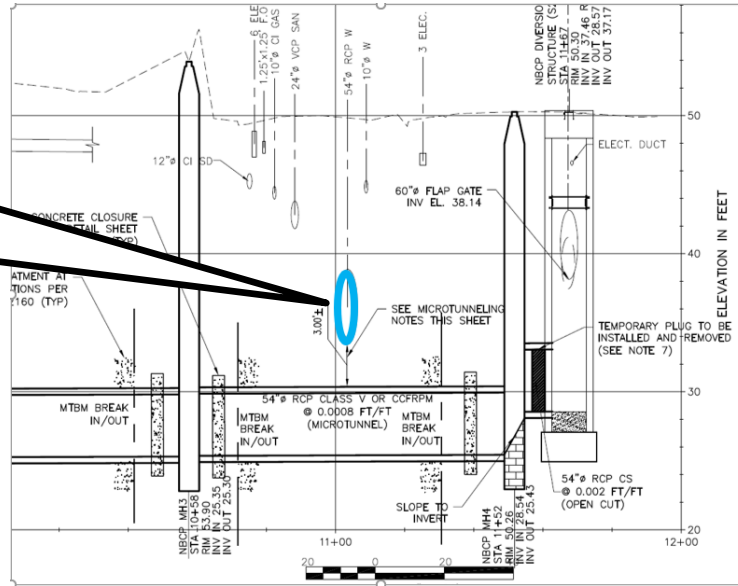


Microtunneling Obstructions



Microtunneling Obstructions

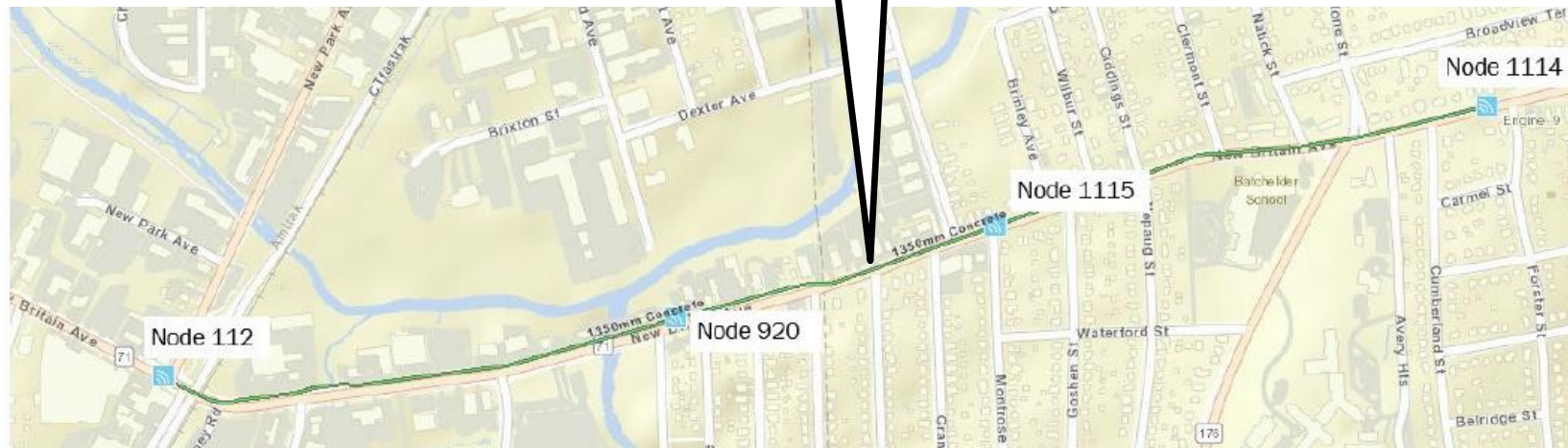
MDC 54" Water Transmission Main



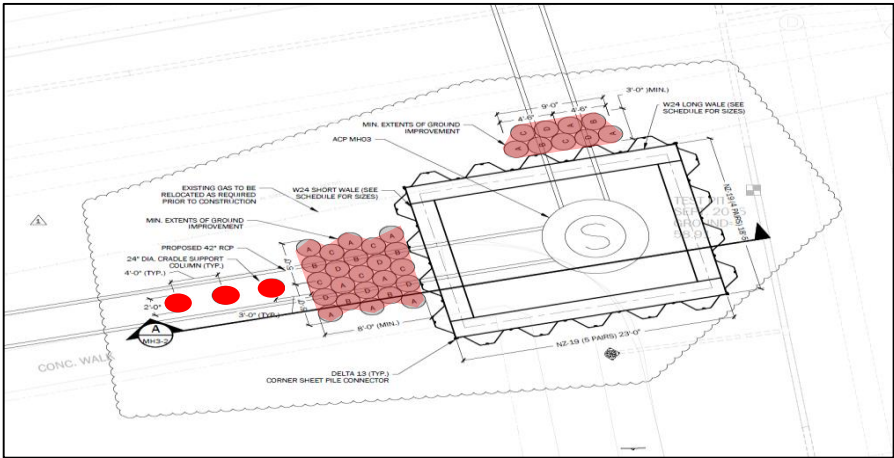
57" MT Crossing Location

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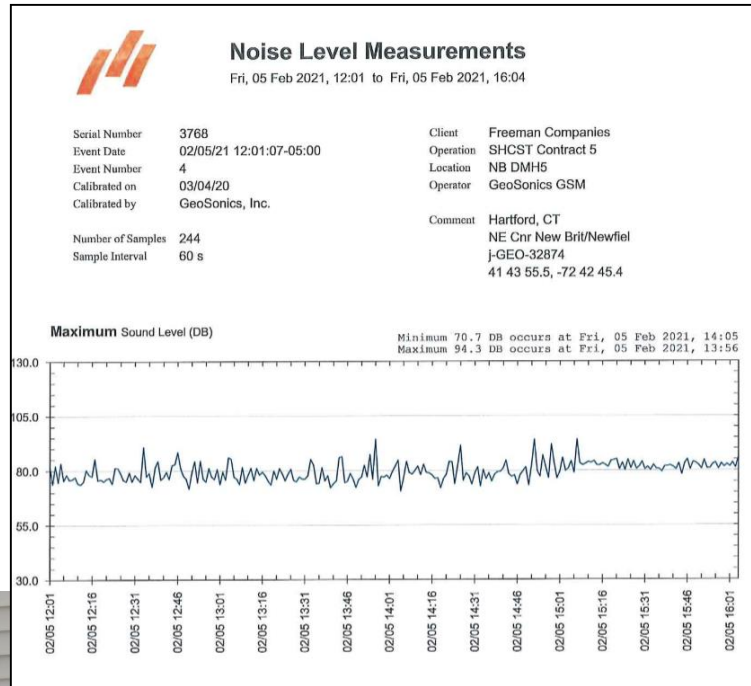
Deep Shafts in Connecticut Valley Varved Clay



Support of Excavation Design in Proximity to Residents and Businesses

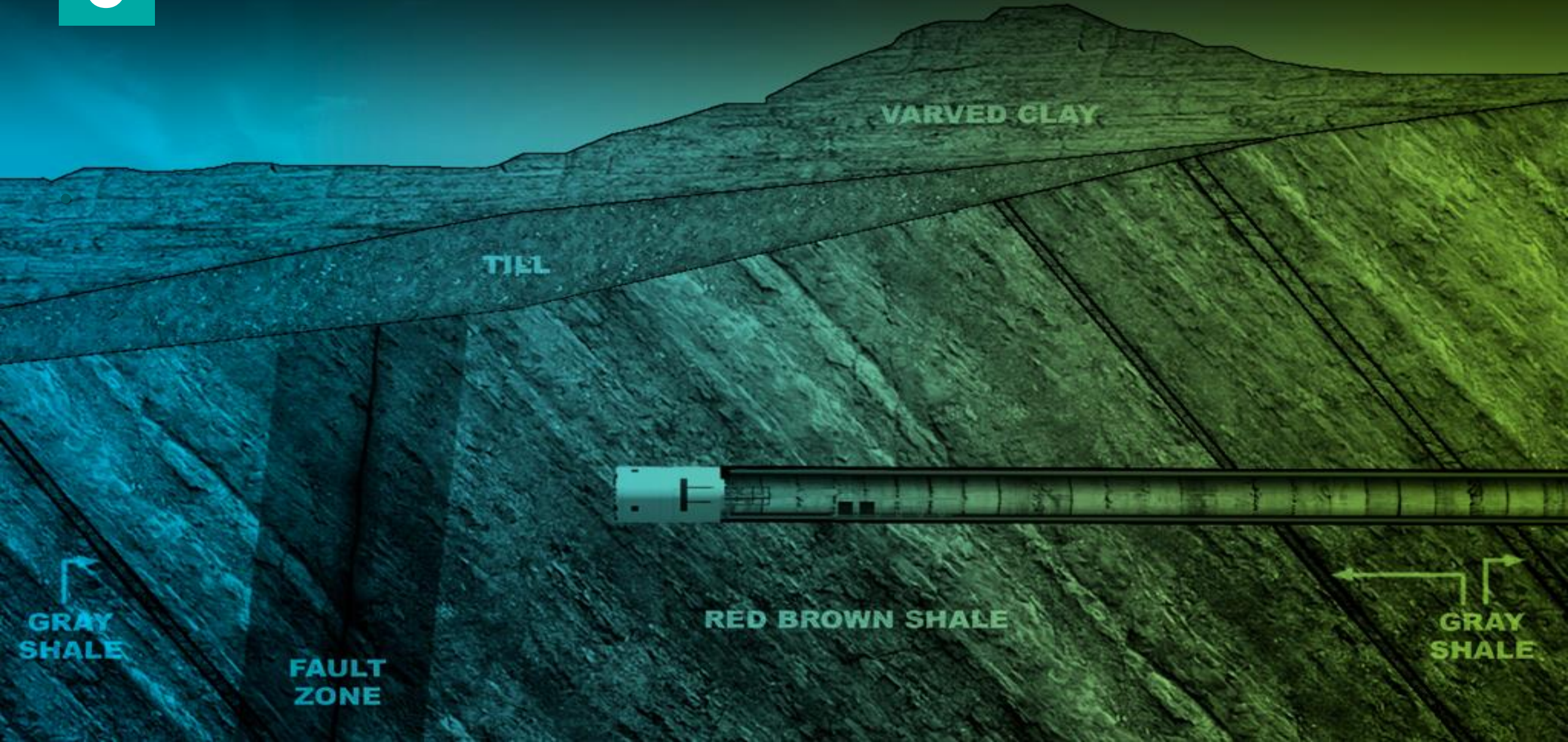


Noise and Vibration Monitoring During Pile Driving



5

LESSONS LEARNED



Consolidation Conduit – Contract 5

- Adequate Characterization of Varved Clay Properties
 - CPT and shear strength testing
 - Importance of undisturbed sampling
- Mandatory Minimum Experience Requirements
 - MTBM Operator & Superintendent
- Strict Requirements for Protection of the Excavation Subgrade
 - Groundwater/surface water control
 - Mud mat requirement
 - Sheet piling left-in-place
 - Require Contractor's SOE Designer to check bottom heave FS



Thank you!

