



**NARRAGANSETT BAY COMMISSION - PAWTUCKET CSO TUNNEL –  
Phase III CSO PROGRAM –  
NORTH AMERICA’S LARGEST CSO STORAGE TUNNEL**

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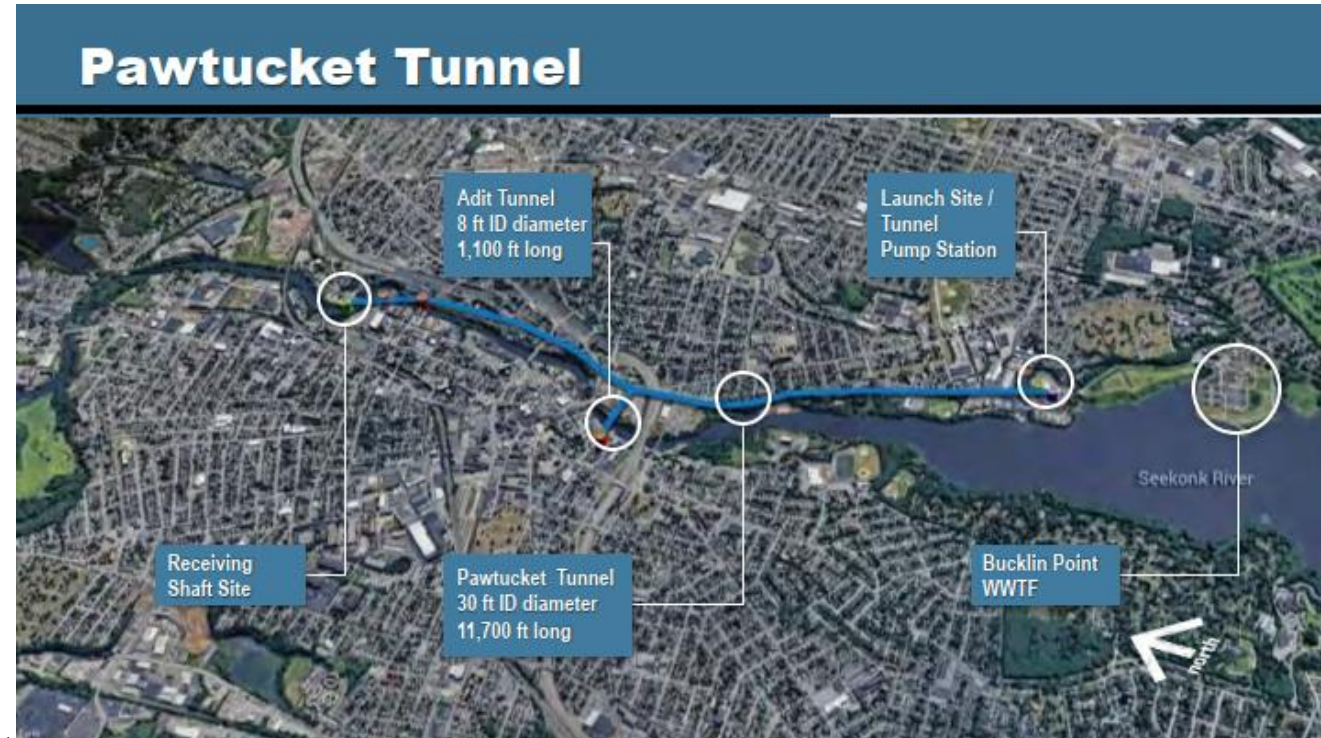
# Agenda

- Background
- Unique Project Features
  - Hybrid Rock TBM Tunnel – 30 ft ID, 11,700 LF
  - Four CSO Tangential Vortex Drop Shafts
  - Precast Segment Facility
  - Seekonk River Outfall
  - Tunnel Dewatering PS Shaft
- Project Challenges
  - Design Schedule
  - Schedule of Consolidation Conduits
  - 100-year Design Life
  - Groundwater Treatment
  - Tunnel Muck Management
- Schedule/Update

# Background

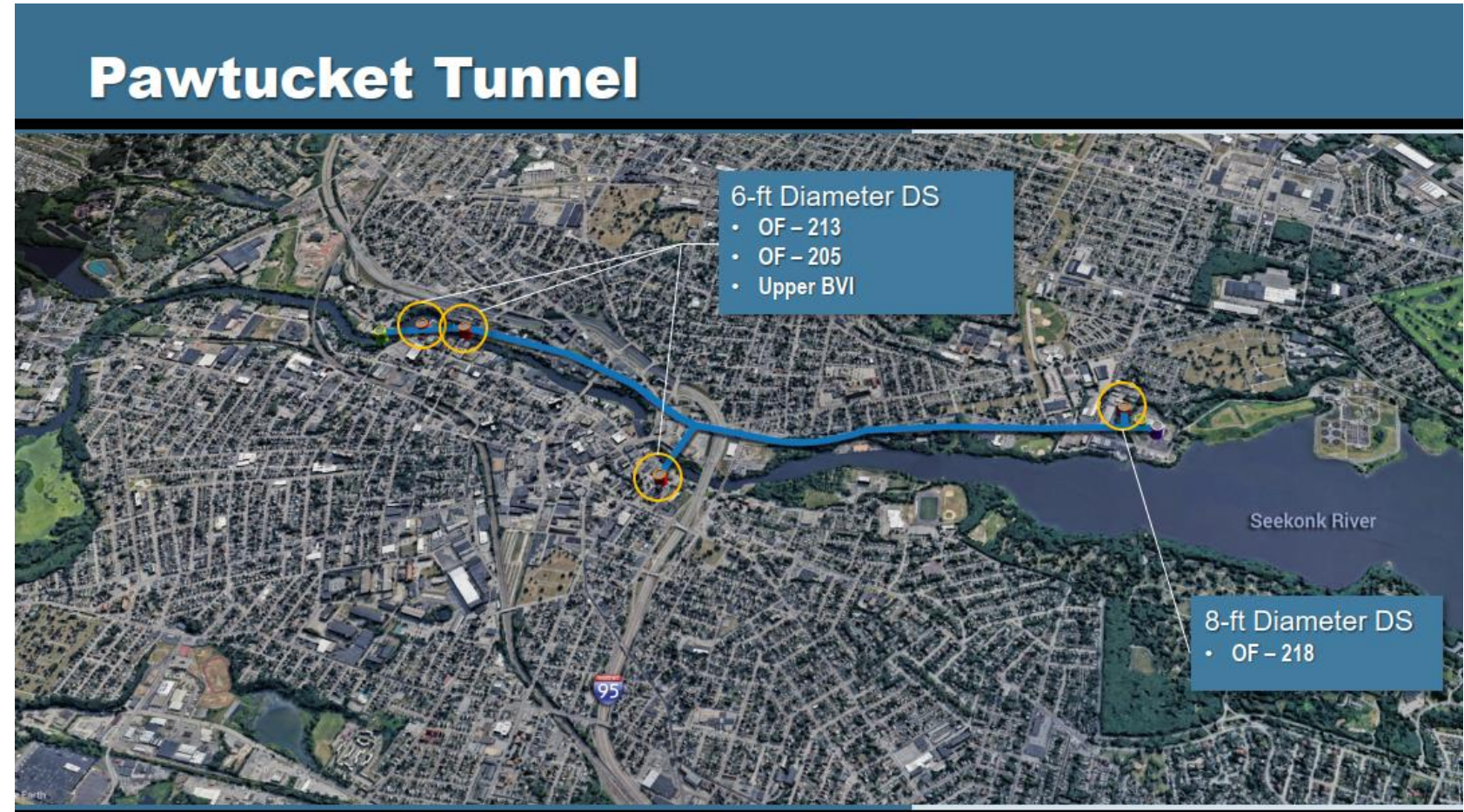
# Project Overview

- Narragansett Bay Commission (NBC) Phase III CSO Program
- Pawtucket Tunnel is part of the NBC CSO Consent Decree Program
- CSO Storage Tunnel designed to store up to a 3-month storm (61MG 30-foot finished ID main conveyance and storage tunnel, approx. 11,700 LF long
- 62-foot finished diameter launch shaft and 38-foot finished diameter receiving shaft
- 80-foot finished diameter tunnel pump station shaft
- Four tangential vortex drop shafts with Deaeration Chambers
- 8-foot ID Microtunnel TBM at OF-213 for the longest 1,100 LF CSO adit



# Pawtucket CSO Tangential Vortex Drop Shafts

- OF – 218 – 8 ft ID Drop Shaft
- OF – 213 – 6 ft ID Drop Shaft
- OF – 208 – 6 ft ID Drop Shaft
- OF – Upper BVI 6 ft ID Drop Shaft



# Project Team

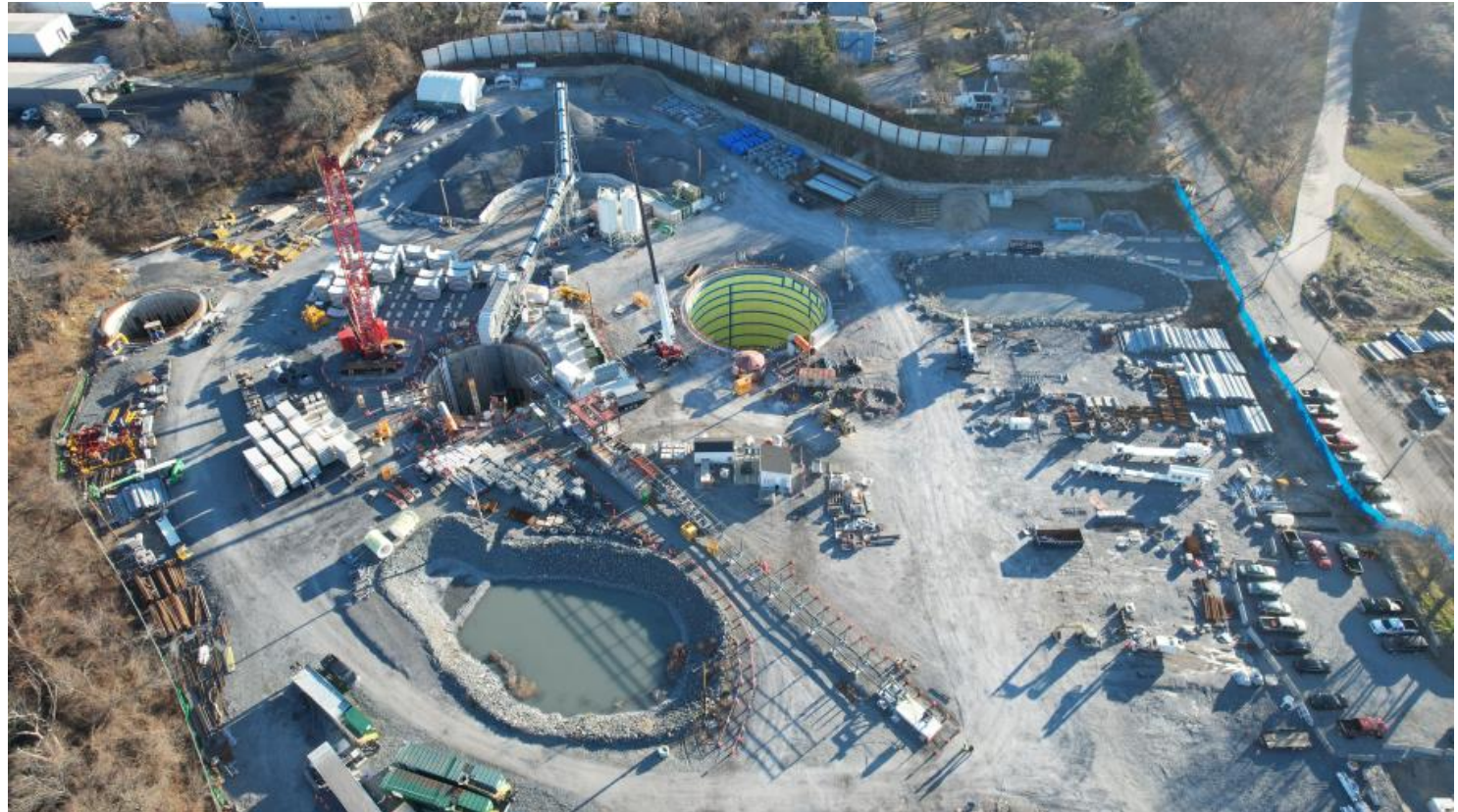
- Design-Build (DB) Project
- Project Owner - Narragansett Bay Commission (NBC)
- Owner's Project Manager- Stantec with Pare
- DB Contractor – Joint Venture of CBNA/Bouygues and Barletta (CB3A)
- Engineer of Record/Prime Designer - AECOM
- Subconsultants:
  - GEI Consultants
  - Gall Zeidler Consultants
  - Mueser Rutledge Consulting Engineers
  - BETA Group



# Unique Project Features

# Unique Project Features

- AECOM/Engineer of Record
  - Launch Shaft/Pump Station Shaft Design
  - Receiving Shaft Design
  - Vortex/ Drop Shaft Deaeration Chamber Designs
  - Main and Adit Tunnel Designer
  - GBR
- Coordination of activities on Main Site
  - Site/Civil Design after Tunnel constructed
  - Permanent Electrical Switchgear
  - Groundwater Treatment System
  - Future pump station fit-outs





# Unique Project Features- Hybrid Rock TBM

- 115 to 155 feet deep in sedimentary rock of Rhode Island Formation
- Hybrid TBM with precast concrete segmental lining
- TBM can operate in open or closed earth-pressure balanced (EPB) mode
  - Plan is to operate in open mode
  - Crossing of the Seekonk River to the Receiving shaft is most likely area for closed mode



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# Unique Project Features- Precast Segment Facility

- JV Built Precast Segment Facility
  - Located approximately 10 miles from site in Cranston, RI
  - On-site QA/QC Manager
  
- Advantages of the Precast Segment Facility
  - Less costly (including transportation)
  - More control of schedule and quality



# Unique Project Features- Seekonk Outfall

- Outfall to be used for groundwater treatment system discharge
- Design and Construction of a Temporary Outfall for Construction
  - ACOE and local permitting (navigable River)
  - Construction restrictions due to anadromous fish (November 16 – January 31)
  - Multiple alignment revisions
  - Design consideration for pipe buoyancy and diffusers



# Project Challenges

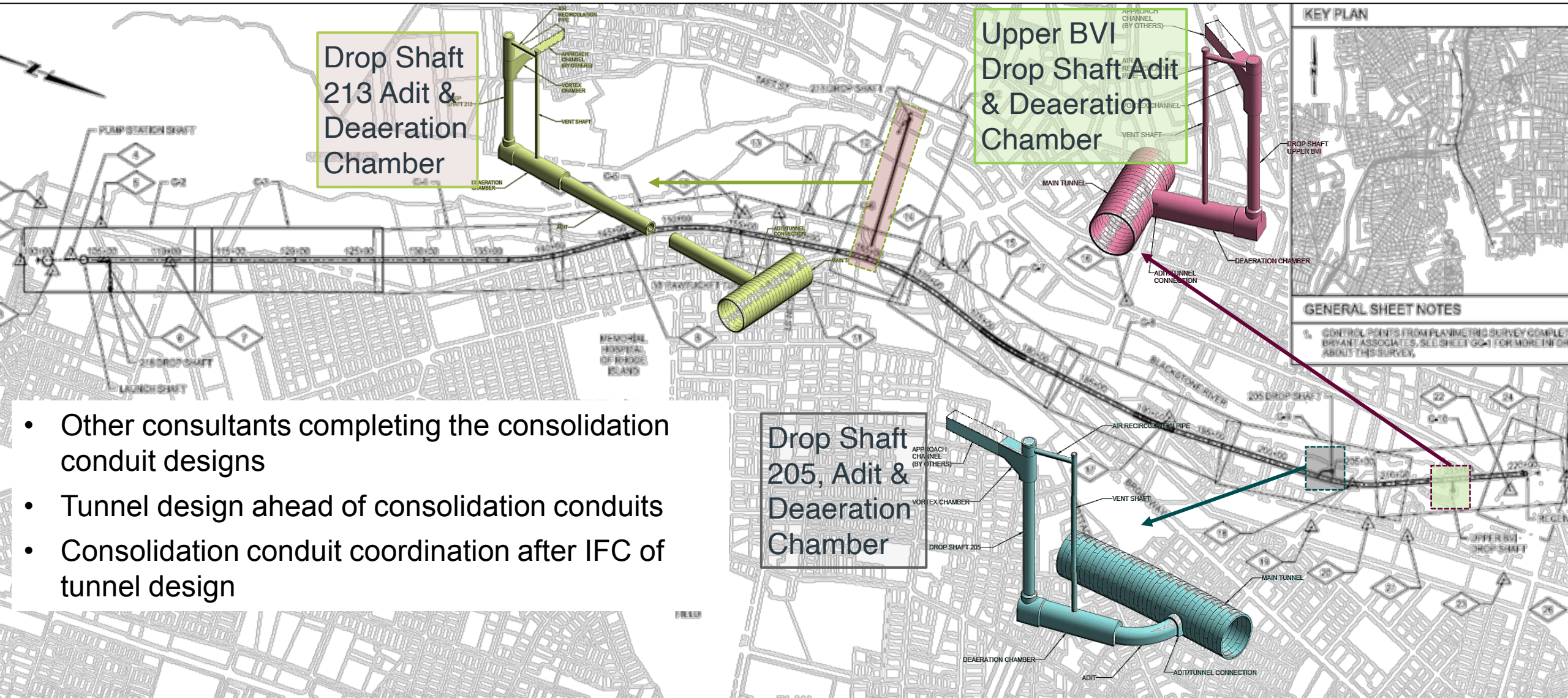
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# Project Challenges- Schedule

- Design schedule 15-months
- Started design Oct 2020 – during height of COVID
- 11 design packages with 4 subcontractors
  - Early works sub-packages
  - Coordination of site/civil package for the “final” condition of site
  - Interim site/civil packages for actual Tunnel design activities
  - Approval required at 90% from RIDEM
  - Design coordination/changes post-IFC



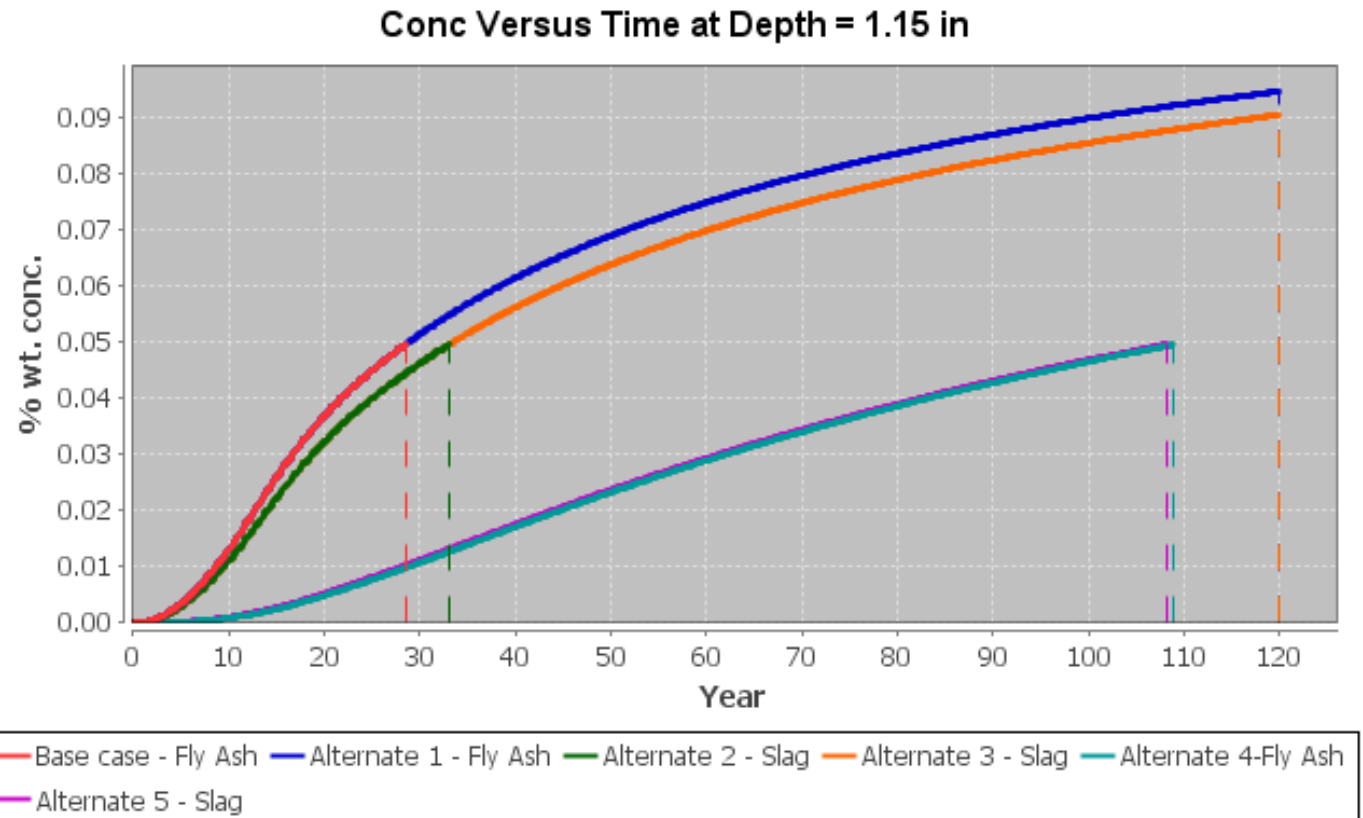
# Project Challenges- Consolidation Conduits



- Other consultants completing the consolidation conduit designs
- Tunnel design ahead of consolidation conduits
- Consolidation conduit coordination after IFC of tunnel design

## Project Challenges- 100-year Design Life

- Decisions on materials (pipe, concrete, coatings)
  - Review of materials with JV
  - Computer software Life-Cycle 365
  - Review inputs- wastewater vs CSO, salt, location
  - Coordination with technical designers
- During construction reviewed types of concrete with varying slag and bulk diffusion rates
- Review of shop drawing materials compared to the Life-Cycle 365 and specifications



## Project Challenges- Groundwater Treatment System

- Revised groundwater systems for lower dewatering rates
  - Observations during final design/borings
- Main Site Treatment Capacity 500 gpm
- Weekly sampling program
- Challenging system to operate



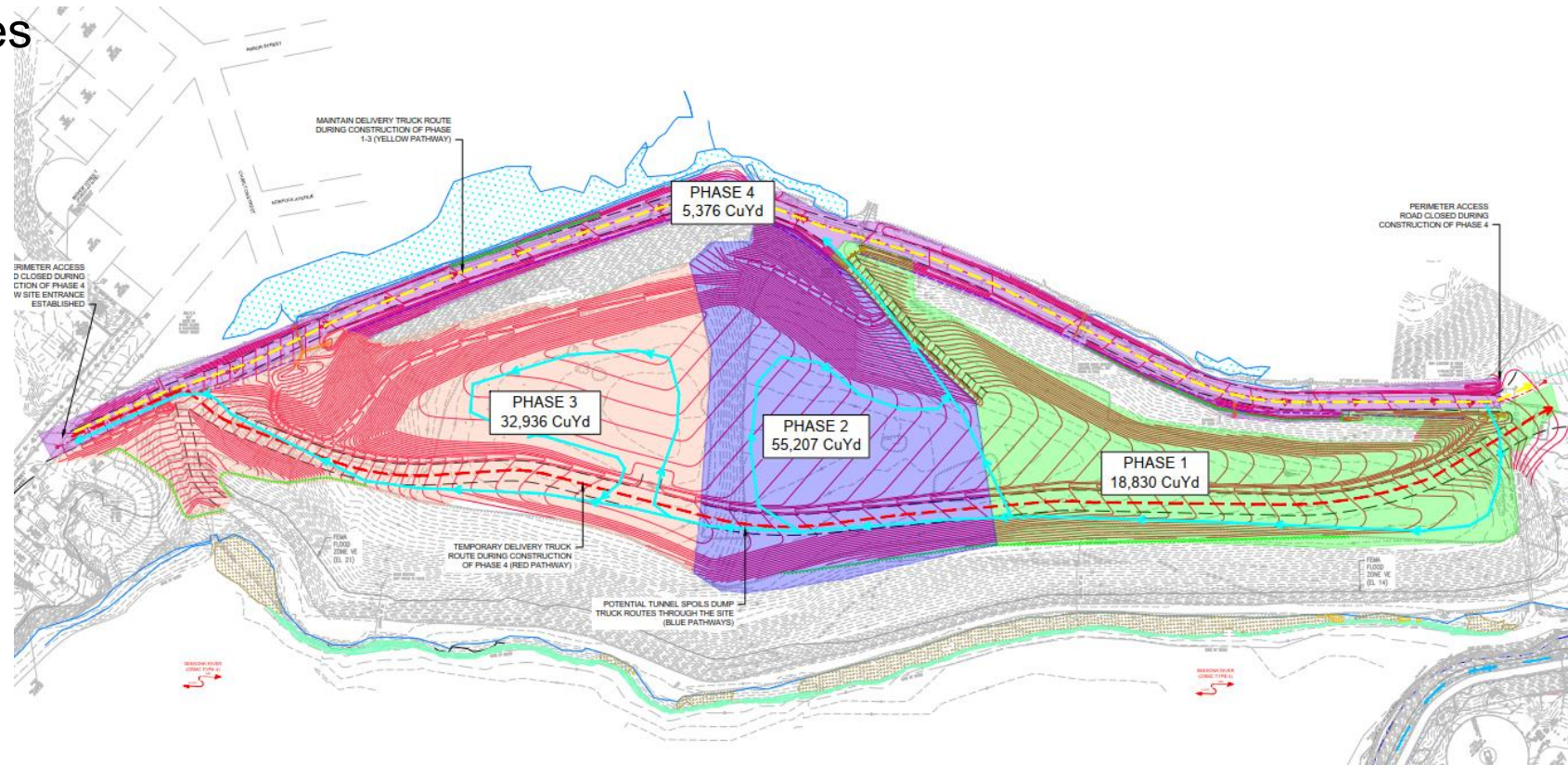


# Project Challenges- Tunnel Muck Management

- Large quantities of tunnel muck (approx. 600,000 cy)
- Characteristics of tunnel muck not suitable for construction activities
- Considerable cost in muck disposal at facility

## Options:

- Possible disposal at non-NBC sites
- Re-use on tunnel sites
- Re-use at the Bucklin Point WWTF



# Schedule/Update

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## Schedule/Update

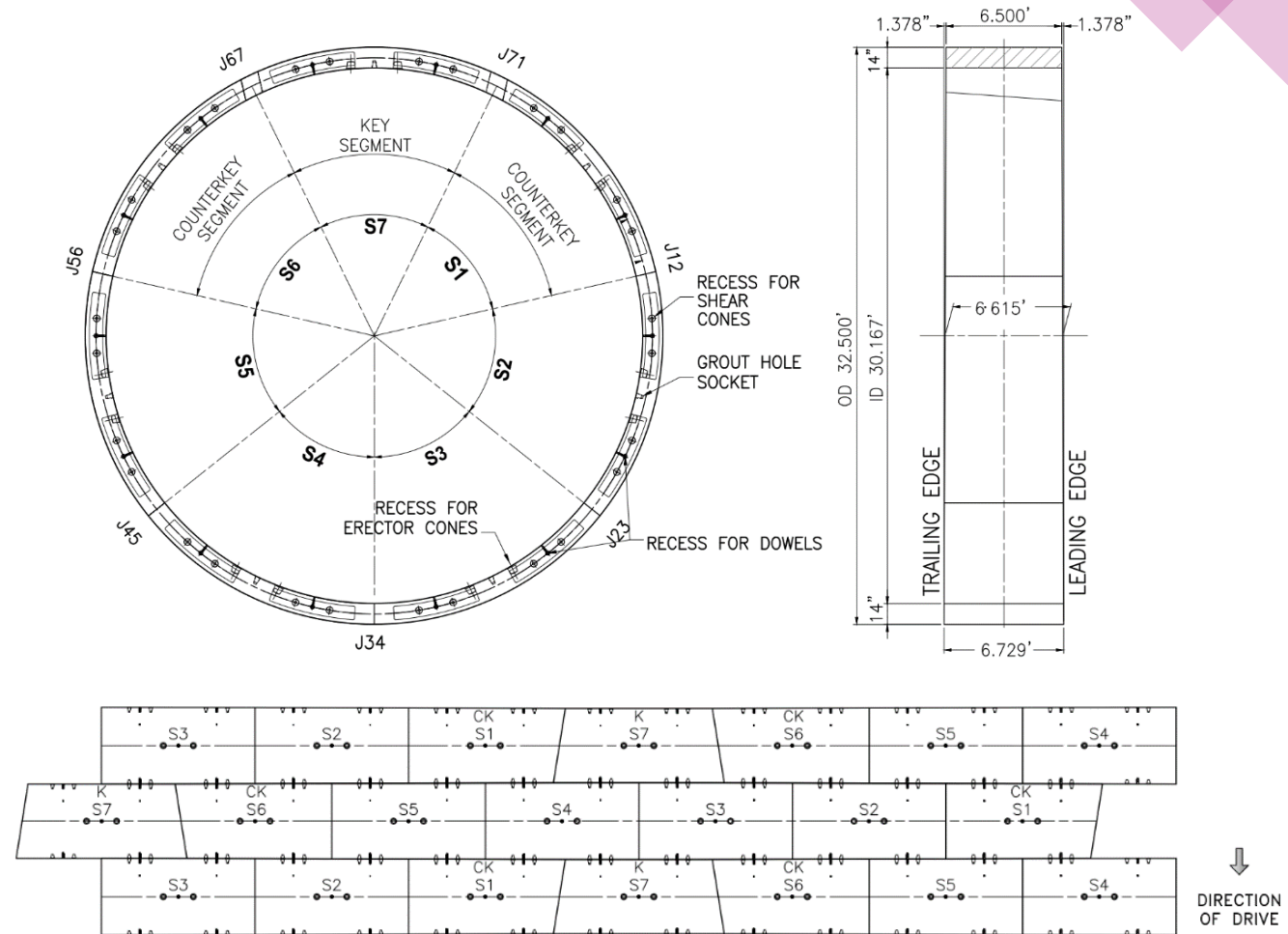
- Construction started March 2021 with TBM launch in November 2022
- TBM completed approximately 56 ft of tunnel prior to Holidays
- Muck conveyor set in late Dec./early Jan.
- TBM re-started week of Jan 16<sup>th</sup>
- Production Rates being tracked
- Substantial completion by December 2024



# Questions

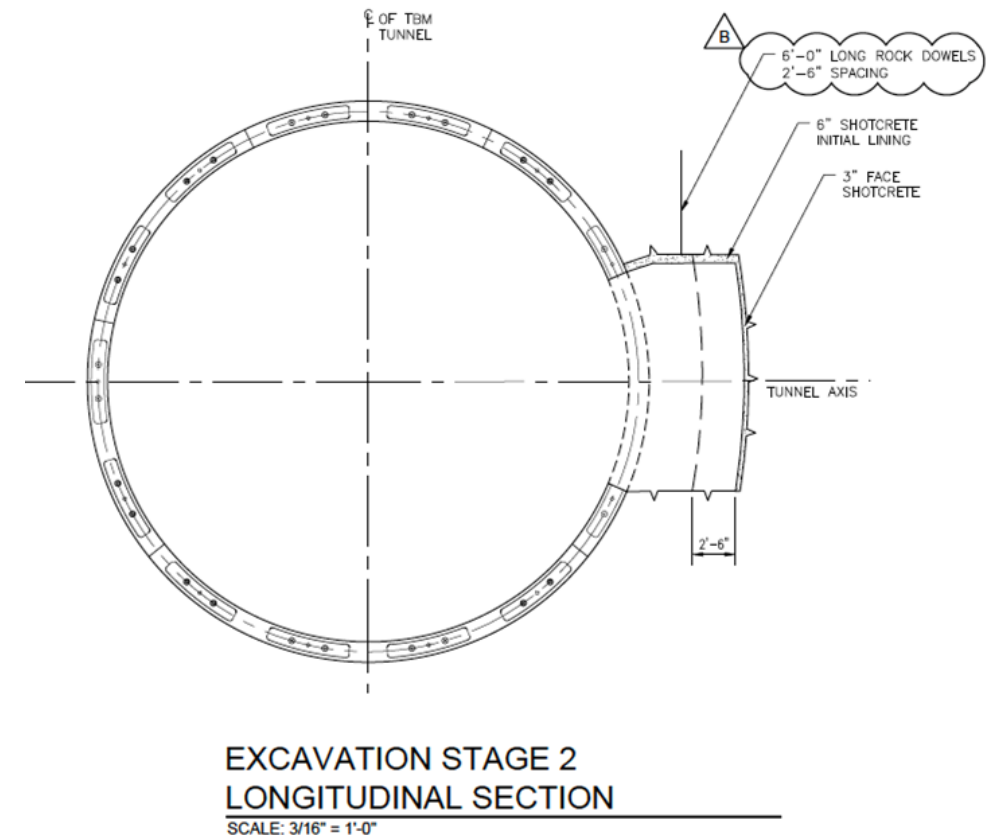
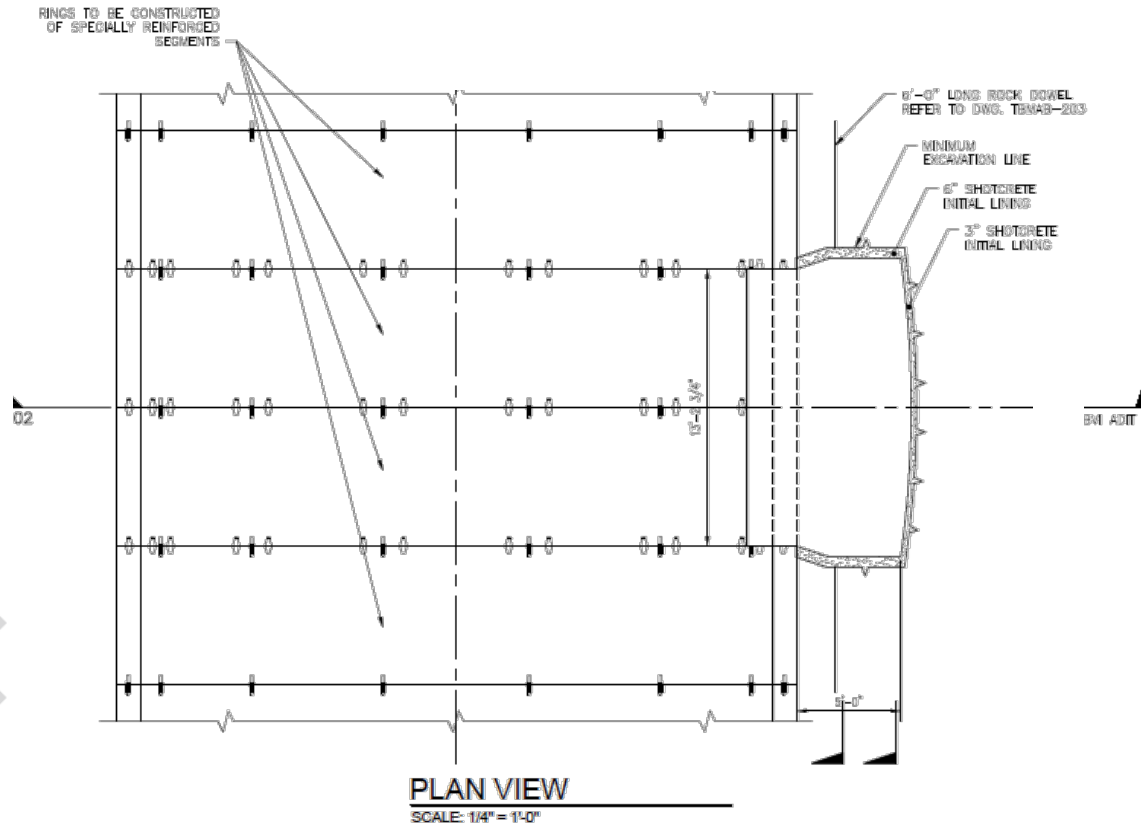
# Tunnel Lining Features

- 7-piece universal tapered ring system, 4 rectangular, 2 counter-key, and 1 large key segments
- 14" thick, 30'-2" internal diameter, 6'-7" length
- Segments size and length balance constructability and utility factors
- No bolts on longitudinal joints, dowels on radial joints
- Compression gasket designed for maximum 5 bars pressure
- Full steel fibers reinforced typical segments with 6,500-psi concrete
- Hybrid special segments with add rebar reinforcement and shear bicones for adit openings
- Allowance for sacrificial thickness over its 100-year design life



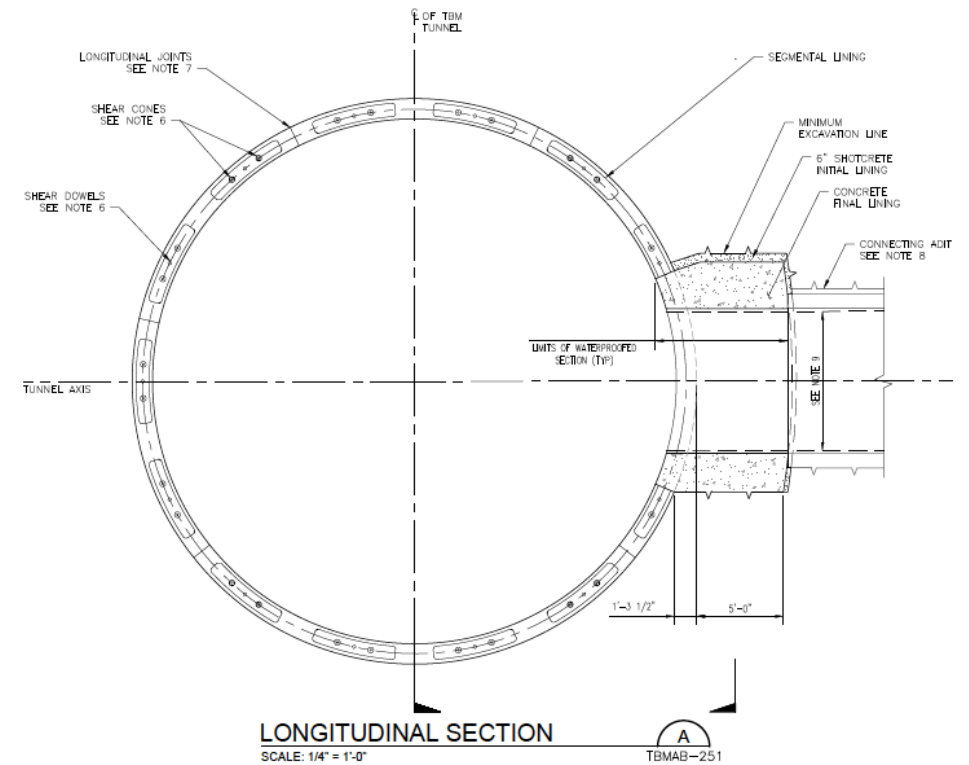
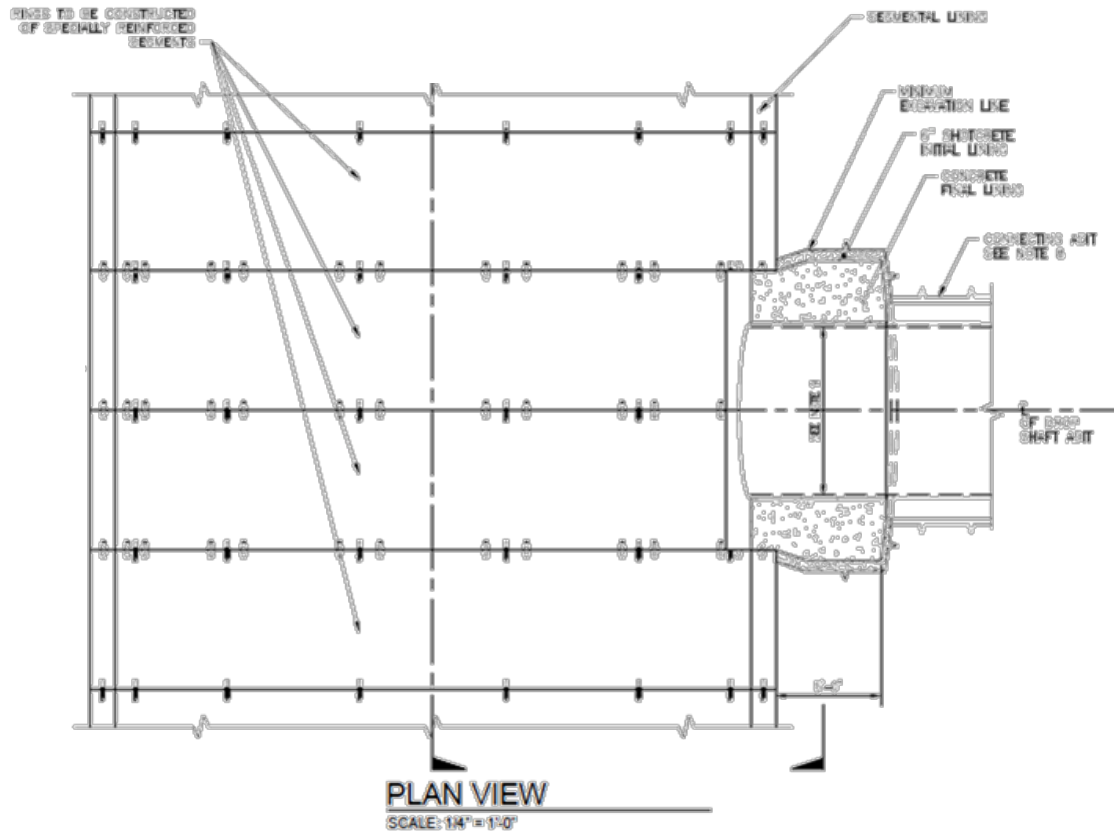
# Tunnel Lining Adit Cut

- SEM excavation to continue from tunnel to shafts for SEM Adits
- Excavation “catches” the MTBM at the DS-213 adit, i.e., MTBM launches from shaft
- No Framing - Bicones, connectors, and added rebar to take temporary loadings



# Tunnel Lining Permanent Adit Connection

- Final monolithic CIP collar to support TBM lining in long-term
- CIP Shape same at all adit connections
- Bicones & accessories contribute to long-term stability as well



# Specially Reinforced Hybrid Segments

- Segments are heavily reinforced using both rebar and steel fibers
- Large bicones (SoF 500 - 500 kN capacity) used

