ENGINEERING REBUTTAL TESTIMONY
TOPICS OF DISCUSSION

• Responses to previously identified concerns
  – Large tunnel projects
  – Levees and proposed CWF construction
  – Existing/planned facilities and proposed CWF construction
  – Water supply from existing diversions and CWF facilities
  – Sea Level Rise
TUNNEL PORTIONS OF PROGRAM

± 13 miles
28-40-foot tunnels

± 30 miles
2x40-foot tunnels
MAIN TUNNELS

- 100 year life
- Twin bore main tunnels
- 150 ft below grade
- Concrete segmental liner
- Pressurized face Tunnel Boring Machine construction
- 45 ft excavated diameter
- 40 ft finished internal diameter
REVIEW OF OTHER MEGA-TUNNEL PROJECTS

- The Eurasia Tunnel - Turkey
- Lee Tunnel - London
- Port Of Miami Tunnel - Florida
- East Side Access - New York
- Blue Plains Tunnel Project - District of Columbia
- Bay Tunnel - San Francisco
- Willamette River Combined Sewer Outfall Program - Portland
- Gotthard Base Tunnel - Swiss Alps
- SR-99 Alaskan Way Replacement - Seattle
THE EURASIA TUNNEL – TURKEY

2.1 miles

320 ft

Sand & Gravel

Bedrock

Seismic Joints

Bedrock

320 ft

Sand & Gravel

Bedrock

Seismic Joints

Bedrock

Sand & Gravel

Bedrock

Seismic Joints

Bedrock

Sand & Gravel
THE EURASIA TUNNEL – TURKEY

Project Information

- Transportation Tunnel
  45 ft Internal Diameter (ID) x 2.1 miles
- 320 ft deep
- Completed Dec 2016
  – 3 months ahead of schedule
- Challenges
  – Complex geology, seismic deformations, and high groundwater pressure
LEE TUNNEL - LONDON

Abby Mills Pump Station

Beckton Sewage Treatment Works
LEE TUNNEL – LONDON

Project Information

• 23.6 ft ID x 4.3 mile Combined Sewer Outfall (CSO) Tunnel
• 160 ft deep
• Completed December 2015
  – on schedule
  – Within budget

• Challenges
  – Groundwater contamination, complexity of Tunnel Boring Machine launch, and spoil removal
PORT OF MIAMI TUNNEL - FLORIDA
PORT OF MIAMI TUNNEL

Project Information
• (2) 39 ft ID x 4,200 ft Long Transportation Tunnels
• 120 ft deep
• Completion May 2014
  – On schedule
  – Within budget
• Challenges
  – Additional geotechnical investigations were critical to confirm the ground model
EAST SIDE ACCESS – NEW YORK

MANHATTAN TUNNELS & CAVERNS

63RD STREET TUNNELS

NORTHERN BOULEVARD CROSSING

QUEENS BORED TUNNELS
Project Information
- (4) 19 ft Railroad Tunnels
- 60 ft deep
- Completion June 2013
- Challenges
  - Small work areas, shallow ground cover, difficult ground conditions, active rail lines directly above tunnels
BLUE PLAINS TUNNEL PROJECT

Project Information

• 23 ft ID x 24,200 ft CSO Tunnel
• 160 ft deep
• Completed Dec 2015
  – 3 months ahead of schedule
  – Under budget
• Challenges
  – Institutional resistance to change, existing infrastructure above tunnel, and environmental permitting
BAY TUNNEL – SAN FRANCISCO
Project Information

• 15 ft ID x 5 mile water tunnel
• 110 ft deep
• Completed Oct, 2014
  – on schedule
  – Within budget
• Challenges
  – Variable ground, contaminated soil, disposal of tunnel material, long tunnel drive, and high ground water pressure (3.5 bar)
WILLAMETTE RIVER COMBINED SEWER OUTFALL PROGRAM – PORTLAND
WILLAMETTE RIVER COMBINED SEWER OUTFALL PROGRAM – PORTLAND

Project Information

• (1) 14 ft ID x 3.5 mile 120 ft deep and (1) 22 ft ID x 6 mile

• 150 ft deep CSO tunnels

• Construction Complete Feb 2012
  – 8 months ahead of schedule
  – Under budget

• Challenges
  – Schedule, existing infrastructure, groundwater, difficult ground conditions, soil modification, and subcontract changes
Project Information

- (2) 30 ft ID x 35 mile rail tunnel
- Up to 6,560 ft deep
- For the 2 main tunnels and the safety, ventilation and cross cuts, a total of 95 miles tunnel was bored
- Completed June 2016
  - within schedule (17 years)
- Challenges: Safety, geology
SR-99 ALASKAN WAY REPLACEMENT-SEATTLE
Project Information

• 53 ft ID x 2 mile transportation tunnel

• Construction schedule
  – approximately 2 year delay

• Challenges
  – Equipment malfunction, existing pile foundations and other infrastructure, difficult ground
LESSONS LEARNED

• Conduct an extensive and thorough geotechnical program
• Utilize TBM technology that is well understood and project-proven
• Select only experienced tunneling contractors
• Implement a comprehensive monitoring and inspection program
• Implement proactive risk management strategy at all stages
RELEVANT EXAMPLES OF PILE DRIVING AND LEVEE/STRUCTURE PERFORMANCE

• Alternative Intake on Victoria Canal
• Freeport Intake
• Sankey Diversion Facility
• Cosumnes Power Plant
• Several DWR projects in the Delta- Extensive Experience
ALTERNATIVE INTAKE ON VICTORIA ISLAND

- 2008-2009
- On the Victoria Canal North Bank
- Approx. 390 sheet and concrete piles driven
- Driven by impact hammer for foundation piles
- No observed damage
• 2007-2008
• On the Sac River East Levee Bank
• ~ 800 ft. from the West Levee bank
• Approx. 520 sheet and H piles driven
• Driven by vibratory and impact hammers
• No observed damage
SANKEY DIVERSION FACILITY ON SACRAMENTO RIVER

- 2010-2011
- On the Sac River East Levee Bank
- ~550 ft. from the West Levee Bank
- Approx. 270 piles driven
- Driven by impact and vibratory hammers
- No observed damage
COSUMNUS POWER PLANT

- 2004
- 1,800 feet from Rancho Seco plant
- Approx. 2,000 piles
- driven by impact hammer
- No observed damages
SHEET AND PILE DRIVING TECHNOLOGIES

• **Sheet Piles**
  – Used for coffer dam (in-water) construction
  – Vibratory hammers (70%)
  – Impact hammers (30%)

• **Foundation Piles**
  – Either Driven piles or Cast-in-drilled hole piles
  – Type depends on final geotech studies
DWR SHEET AND PILE DRIVING COMMITMENTS (ENVIRONMENTAL COMMITMENTS 3B.2.1.1-2)

• Perform pre-construction surveys to establish baseline conditions
• Collect subsurface data
• Perform geotechnical analyses
• Select appropriate pile types and installation methods
• Implement monitoring programs during construction
ENCROACHMENT INTO RIVER CHANNEL

- Under jurisdiction of USACE and CVFPB
- Modifications must meet USACE’s 408 requirements
- Safety assurance review by an independent panel of experts
- Must maintain “project” conditions, purposes or outputs
TRAFFIC ON LEVEES

• Very little project traffic is planned to traverse on levees
  – SR-160 is constructed on top of a levee
    • Suitable for H2O loading
    • Already experiences extensive traffic
LEVEE ROAD USAGE FOR WATERFIX

BACON ISLAND: 1.6 MILES
MANDEVILLE ISLAND: 4.6 MILES
TRAFFIC ON LEVEES

• **DWR’s commitments to levees and levee roads**
  – Preconstruction assessment
  – Ground stabilization, if needed
  – Monitoring during construction
  – Return roadways to preconstruction condition

• **Final EIR/EIS Commitments**
  – Mitigation Measures: TRANS-2a, 2b and 2c
  – Environmental Commitment 3B.2.1.2
    • Settlement Monitoring and Response Program
EXISTING WATER DIVERSIONS

• **Total number of effected water rights**
  – Temporarily effected: 10
  – Permanently effected: 5

• **Mitigations for temporarily effected diversions**
  – Prior to construction, extend pipes and adjust pump locations on landside
  – Provide new groundwater wells
  – Provide alternate water supply from a permitted source
EXISTING WATER DIVERSSIONS

• **Mitigations for permanently effected diversions**
  
  – Provide temporary mitigation measures until the mitigation measures below are completed:
    
    • Relocate existing diversions outside of the intake structure footprint
    
    • Provide a new turnout from the proposed CWF sedimentation basins
INTAKE 2 DIVERISIONS

• Diversion S021406
  – Falls outside of intake footprint
  – Within road relocation
  – Will not be permanently affected
  – Temporary impacts
  – Maintain quality and quantity of flow
INTAKE 3 DIVERGIONS

• Diversion S016915
  – Falls outside of intake footprint
  – Within road relocation
  – Will not be permanently affected
  – Temporary impacts
  – Maintain quality and quantity of flow
ISSUE: POTENTIAL IMPACT OF TUNNELING UNDER/NEAR EXISTING INFRASTRUCTURE

• EBMUD’s Concerns
  – Tunnel construction will undermine, cause settlement and reduce ground support of aqueduct foundation piles
  – CWF tunnel profile will intersect with existing and planned infrastructure
DWR COMMITMENTS
TO AVOID IMPACTS TO INFRASTRUCTURE

• Existing DWR Commitments, outlined in:
  – Appendix 3B, Section 3B.2.1
  – Ground treatment plan, ground settlement monitoring, and response plan

• Additionally, DWR Commits to:
  – Work collaboratively with EBMUD and other agencies on these issues during preliminary and final design
  – Provide contract specs and maintenance requirements to ensure safe tunneling
  – Provide appropriate levels of on-site inspection to ensure successful results
ISSUE: POTENTIAL IMPACT OF TUNNEL SEEPAGE ON EXISTING INFRASTRUCTURE

• Concerns expressed by protestants over potential leakage from tunnels
  – No estimates of potential leakage rates presented by protestants
  – No analysis of potential impacts presented by protestants
• **Findings**
  – Current CWF configuration minimizes potential for tunnel leakage
    • In most cases, tunnel internal pressure is less than external water pressures
  – For 73.5 miles of tunnel:
    • leakage rate estimated at 0.7 cfs
    • Inflow rate estimated at 3.7 cfs
    • Overall inflow rate: 3.0 cfs
SEATTLE TUNNEL INFLOWS
57-FOOT OUTSIDE DIAMETER TUNNEL
HONG KONG TUNNELS INFLOWS
46-FOOT OUTSIDE DIAMETER TUNNELS

Liantang Boundary Control Point Tunnel

Tuen Mun-Chek Lap Kok Tunnel
DWR COMMITMENTS
TO REDUCE TUNNEL LEAKAGE/INFLOW

• Specify high-quality concrete in segments, and ensure results with proper QA/QC
• Provide careful details for inserts and grout holes
• Provide high quality segment connections and gasket details
• Specify “tight” build tolerances
• Provide good field inspection to enforce superior construction builds
ISSUE: CONCERN OVER POWER LINES CROSSING AQUEDUCT

- Potential for induced current to lead to corrosion
- Potential for induced current to lead to shock hazard
- Potential for power line to fall and strike aqueduct
DWR COMMITMENTS
TO REDUCE POWER LINE RISK POTENTIAL

• Existing DWR Commitments, outlined in:
  – Appendix 3B, Section 3B.2.3, and Section 3b.4.30 (AMM 30)
  – Design and construction transmission lines in accordance
    with Electrical Power and Transmission Line Design
    Guidelines

• Additionally, DWR Commits to:
  – Work collaboratively with EBMUD and other agencies on
    these issues during preliminary and final design
  – Provide contract specs and appropriate levels of on-site
    inspection and on-going observation to ensure successful
    results
SEA LEVEL RISE FOR FLOOD PROTECTION

• Used 55 inches of SLR at Golden Gate Bridge
• SLR impact decreases farther inland
• 18 inches of SLR added above 200-yr flood level for intakes
• To be reviewed and updated during next engineering phase