Low Lake Level Pumping Station (Lake Mead)/Innovative Underground Space Concept
Las Vegas, NV USA

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Project Necessity

- Lake Mead part of Colorado River formed by Hoover Dam
- Southwestern USA has been experiencing severe drought conditions, affecting Lake Mead’s (Las Vegas, NV USA) water levels
- Colorado River supplies 90% of Las Vegas, NV (USA) water (2.2 Million population, 33 Million visitors annually)
Lake Mead Drought Impacts to SNWA
SNWA Response to Drought

- Low Lake Level Pumping Station (L3PS)
- Objective to complete in the swiftest feasible timeframe
- $650 Budgeted Cost
- Owner: SNWA
- Design Engineer: Jacobs and Stantec Joint Venture
- Program Manager: Parsons
- Contractor: Barnard of Nevada, Inc.
- Drilling Subcontractor: North American Drillers, LLC
Low Lake Level Pumping Station (L3PS)
Early Contractor Involvement (ECI) and Construction Manager-at-Risk (CMAR) Contract

- Limited Underground or Tunnel Projects in the USA have utilized ECI or CMAR Contracts
- Two-stage RFP Selection Process based on qualifications, approach, and personnel
- Allowed collaborations between Owner, Design Engineer and Contractor
  - Drawings and Specifications
  - Geotechnical Baseline Report
  - Budget and Schedule
  - Contract Terms and Conditions
  - Best Value Subcontractor and Materials Selection
L3PS Project Overview

- Riser Shaft
- Connector Tunnel
- Riser Shaft
- Forebay
- Well Shafts
- Access Shaft
L3PS Project Overview

- **Well shafts** - 34 ea steel-lined 6 ft. diameter, 500 ft. deep
- **Access Shaft** - 26 ft. diameter, 527 ft. deep
- **Riser Shaft Connector Tunnel** - 20 ft. long by 20 ft. wide by 20 ft. high D-shape
- **Riser Shaft** - 26 ft. diameter 45 ft. deep
- **Forebay** - 33 ft. wide by 36 ft. high by 377 ft. long horseshoe-shaped Cavern
Modeling of Large Forebay Cavern, Well Shafts & Pumps

• **Purpose:** Verify compliance with Hydraulic Institute standards at pump inlets
• **Participants:** Owner and Operations, Engineer, Contractor and Pump Manufacturers
Submersible Pumps Test Procurement

- **Purpose:** Test pumps from 3 different manufacturers to verify capability and pump operation
  
  *(Note: All 3 manufacturers have different design)*

- **Indar pump**
- **Andritz pump**
- **Ebara pump**
Underground Geotechnical Challenges
Pre-exavagation Grouting
Pre-extraction Grouting - Underground

- Contractor implemented Pre-extraction Grouting Plan
- 5 each 100-foot Pre-extraction Grout Covers in Access Shaft
- 7 each Pre-extraction Grout Covers in Forebay/Tunnels
- Superfine and Type III cement grout
- Air track drill & Robodrill Jumbo
- Surface operated grout plant
Contractor Pre-extraction grouting program:

- Primary - Pre-grout holes were grouted in 100 ft stages starting from the bottom and moving upward.

- Secondary - 3D Model and heat map of the formation were used to focus on specific areas that still appeared to be unstable. Grout holes were placed in strategic locations.

- Tertiary - Target holes were strategically positioned to reach areas that remained unstable.
Pre-excitation Grouting – Well Shafts

- 200 Grout Holes to 550 ft Deep
- Drilled 145,000 ft
- Injected 2,600 tons or 100 truckloads of Cement
- Lasted 4 Months
Well Shafts – Surface Casing

- Surface Casing Excavation
- Auger
- Installing Surface Casing
- Pouring Working Pad
Well Shafts – Pilot and Blind Bore Drilling

Pilot Hole Rig - Directionally Drilled 8” dia.

Large Dia. Reaming Rig – 91”
Well Shafts – Casings and Survey

Well Casing (72” dia, 1” thick)

Mandrel (Survey Alignment)
Well Shafts – Completed Casings
Access Shaft – Excavation
Access Shaft – Excavation
Access Shaft – Concrete Lining
Forebay Cavern – Excavation
Forebay Cavern – Excavation
Forebay Cavern – Excavation
Forebay Cavern – Excavation
Pumping Station – Aboveground Construction

- Gantry Crane
- Hydropneumatic Surge Tank
- Exist. Surge Shaft
- Access Shaft
- Electrical / Maintenance Building
- Surge Tank
- Valve Vaults
Pumping Station – Aboveground Construction
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Project Budget, Schedule, and Safety

- Project is on schedule for April 2020 Final Completion
- Underground Excavation completed on schedule and under the original contract amount
- No disputes and claims
- Excellent Project Safety Record
Special Thanks to All Involved in the Project!