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Low Lake Level Pumping Station (Lake Mead)/ Innovative Underground Space Concept

Las Vegas, NV USA

Presented by :

Erika Moonin, Southern Nevada Water Authority Project Manager

Jordan Hoover, Barnard Project Manager

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)



1983



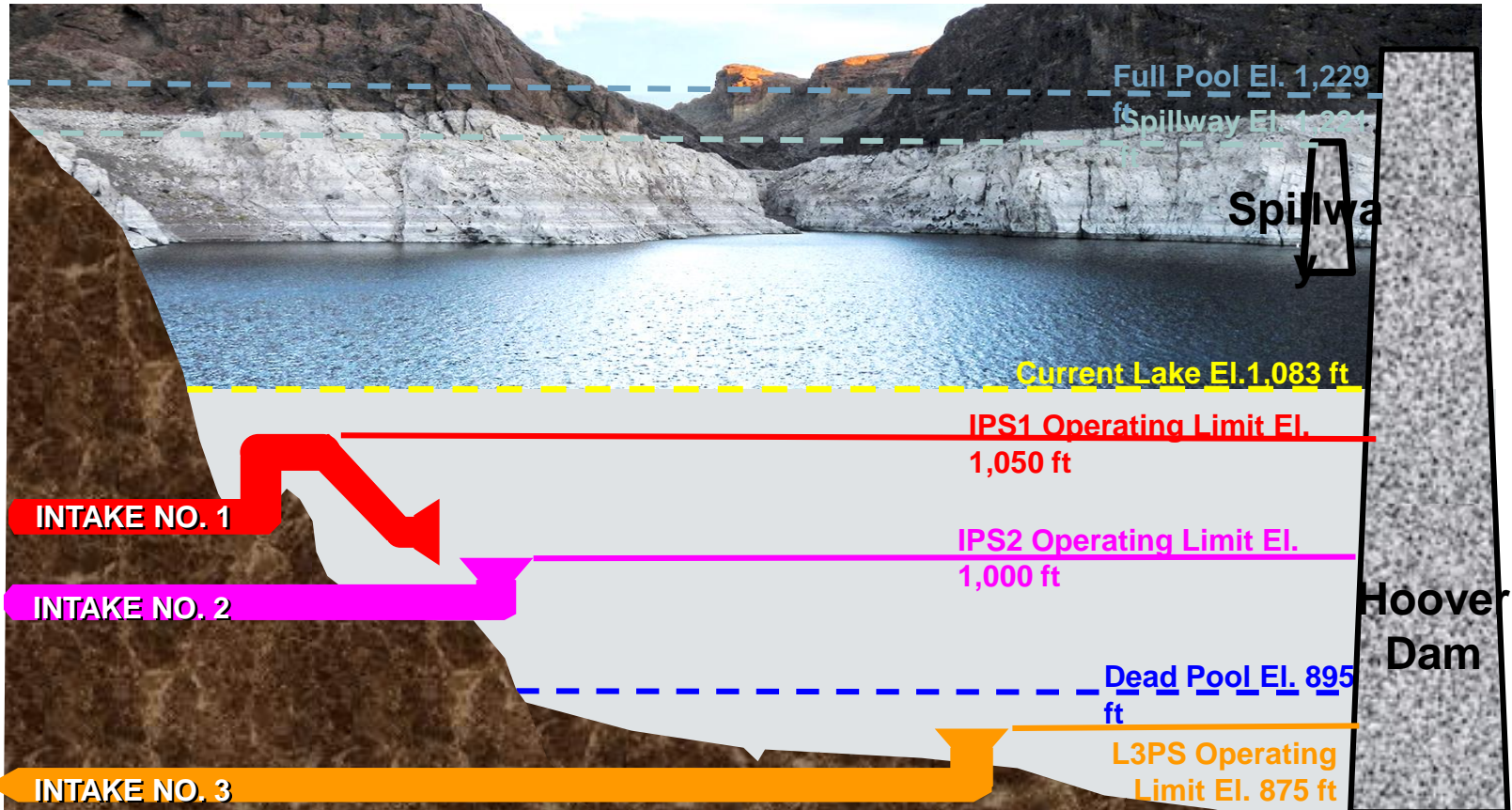
2015



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Lake Mead Drought Impacts to SNWA



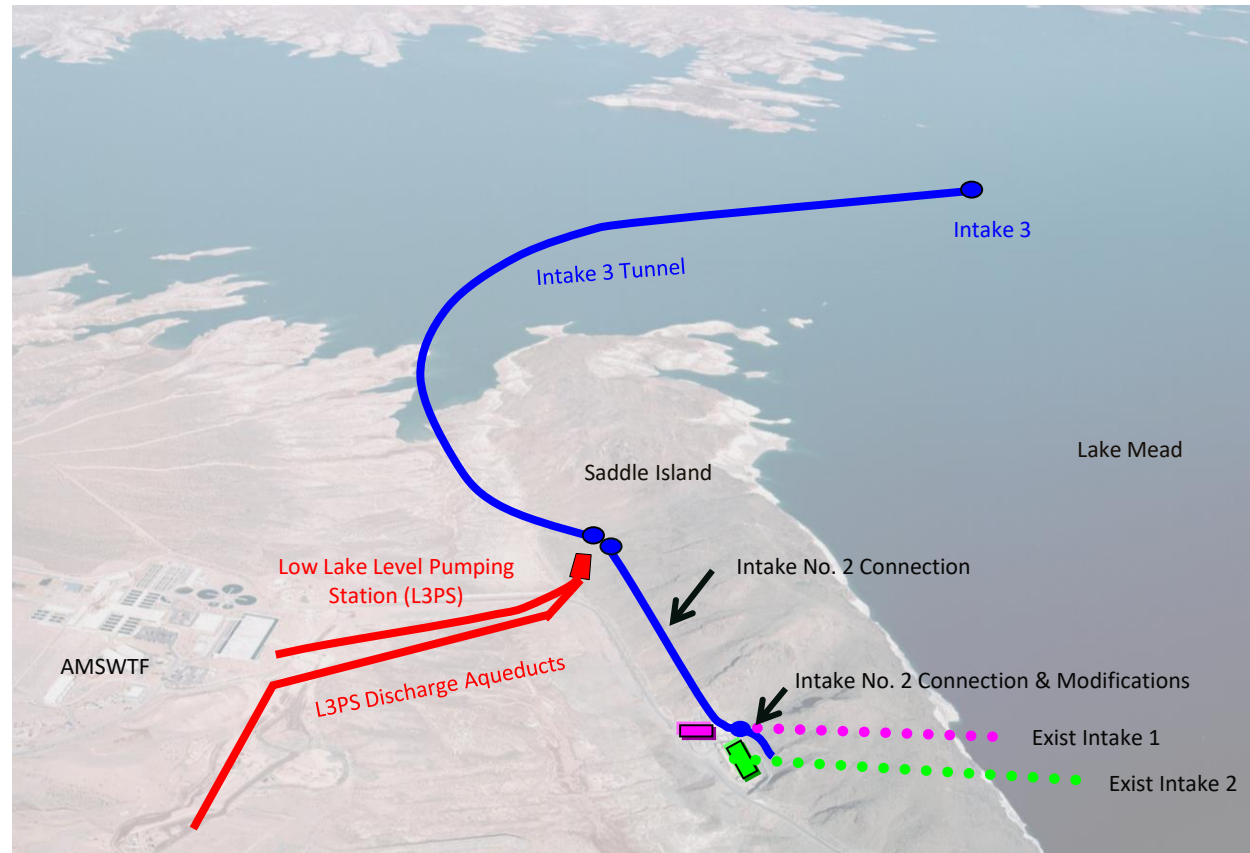


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SNWA Response to Drought

- 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





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Low Lake Level Pumping Station (L3PS)





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Early Contractor Involvement (ECI) and Construction Manger-at-Risk (CMAR) Contract

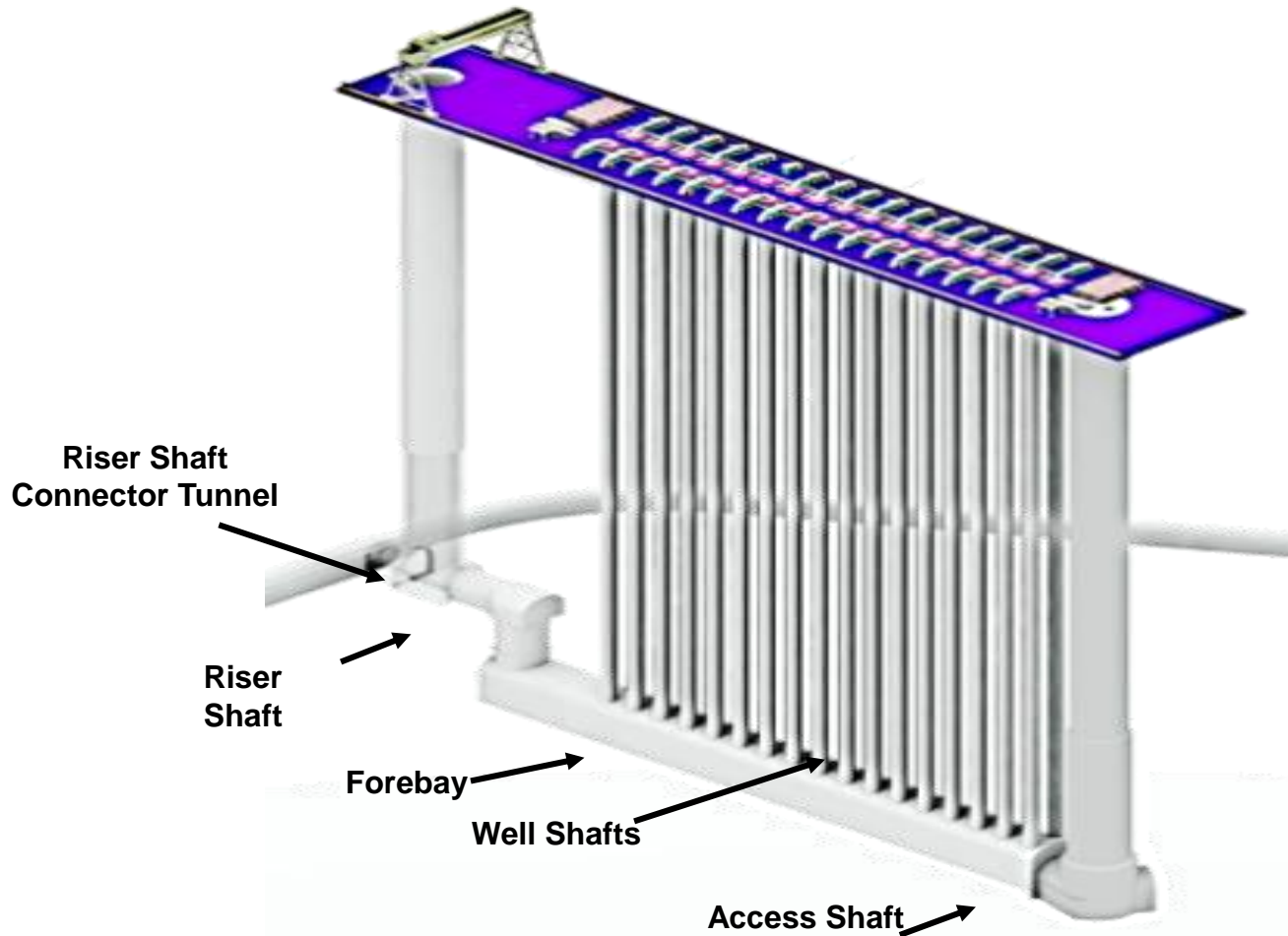
- Limited Underground or Tunnel Projects in the USA have utilized ECI or CMAR Contracts
- Two-stage RFP Selection Process based on qualifications, approach, and personnel
- Allowed collaborations between Owner, Design Engineer and Contractor
 - Drawings and Specifications
 - Geotechnical Baseline Report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



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L3PS Project Overview



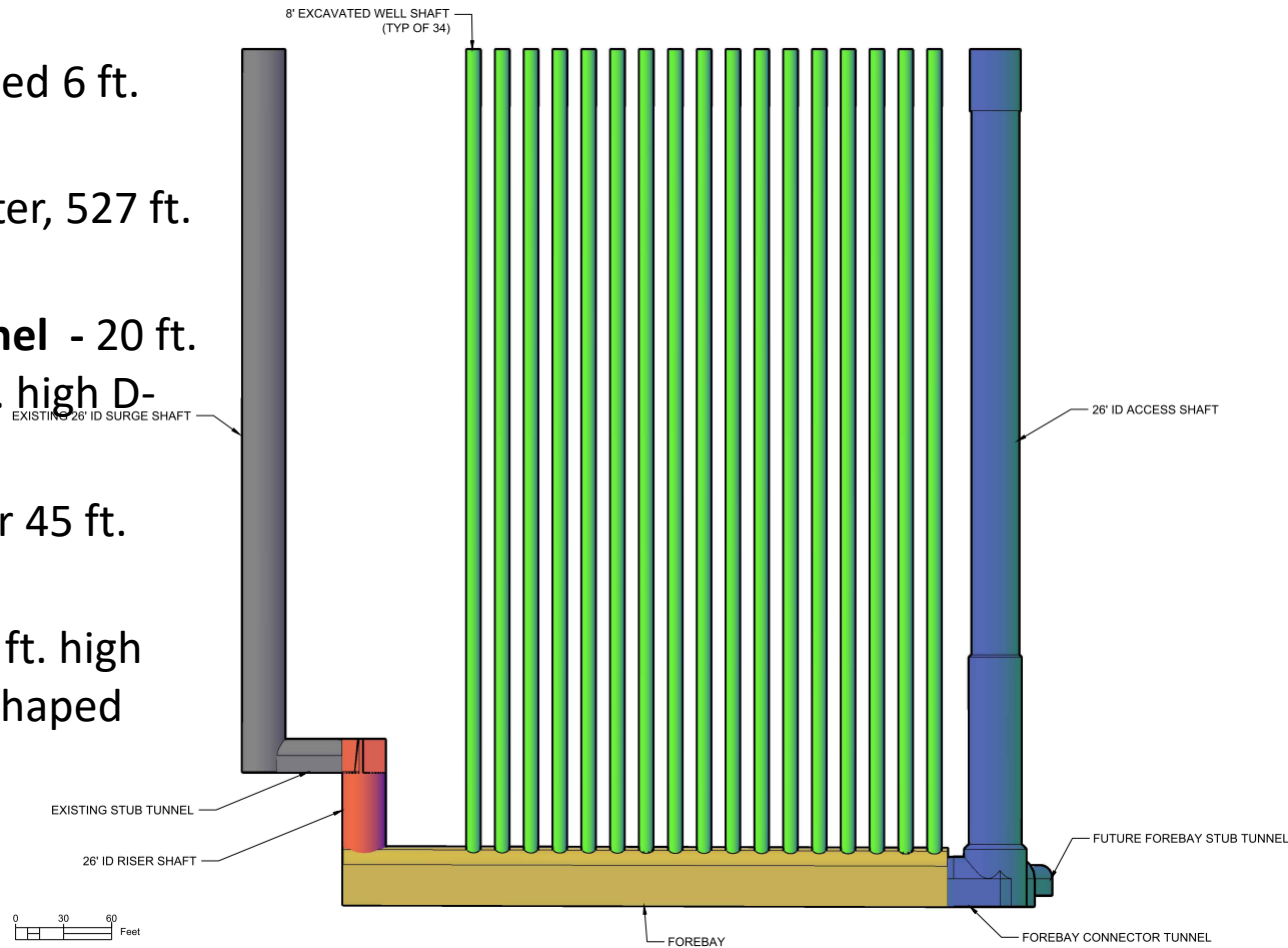


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L3PS Project Overview

- **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





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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





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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



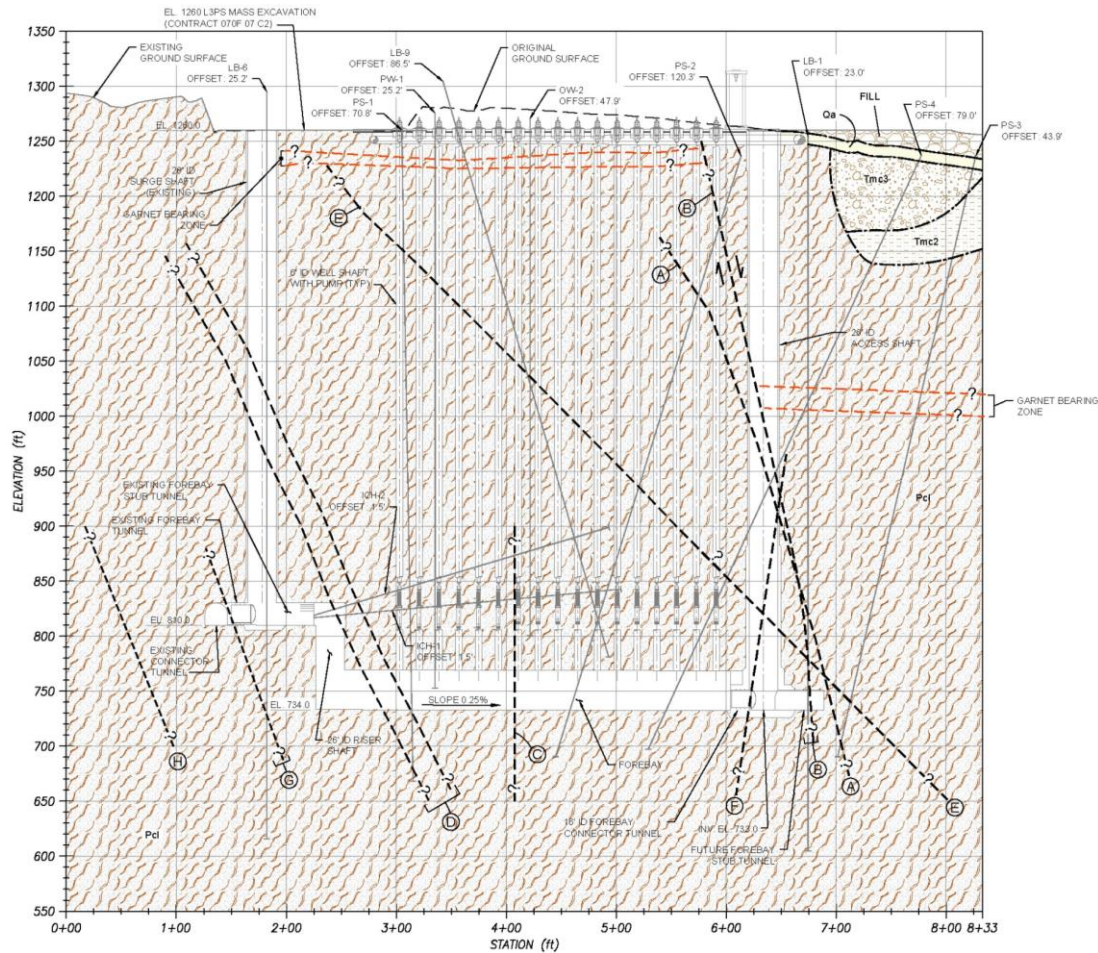
Ebara pump



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Underground Geotechnical Challenges



LEGEND

- FILL
- Oa OVERBURDEN
- Tmc2 MUDDY CREEK FORMATION INTERBEDDED SILTSTONE, SANDSTONE, MUDSTONE, CONGLOMERATE
- Tmc3 MUDDY CREEK FORMATION CONGLOMERATE
- Pcu SADDLE ISLAND, UPPER PLATE SCHIST, AMPHIBOLITE, GNEISS, FEGMATITE, DACITE INTRUSIVES
- Pcl SADDLE ISLAND, LOWER PLATE AMPHIBOLITE, SCHIST, GNEISS
- GARNET BEARING ZONE (DASHED WHERE INFERRED)
- GEOLOGIC CONTACT (DASHED WHERE INFERRED)
- FAULT (DASHED WHERE INFERRED) ARROWS INDICATE RELATIVE SENSE OF MOVEMENT

NOTES:

1. THE NUMERICAL DESIGNATION FOR THE SUB-UNITS MUDDY CREEK FORMATION DOES NOT IMPLY DEPO: SEQUENCE OR STRATIGRAPHIC RELATIONSHIP
2. BOREHOLES ARE PROJECTED ONTO THE PROFILE A



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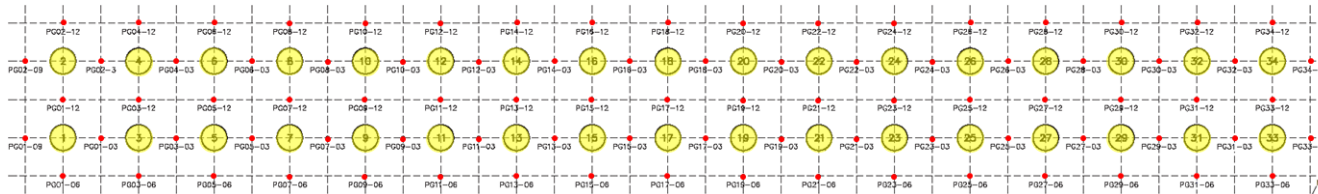


Pre-excitation Grouting





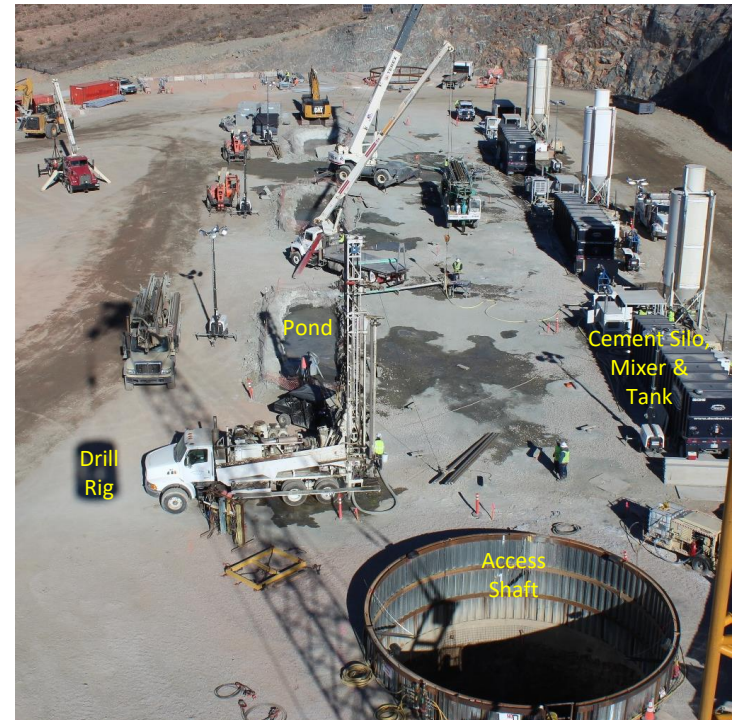
Pre-excavation Grouting – Well Shafts



Primary Grout Hole Layout

Contractor Pre-excavation 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

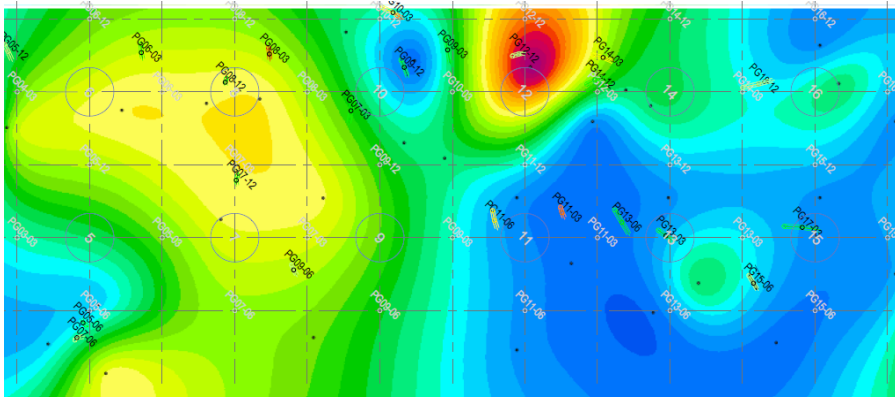
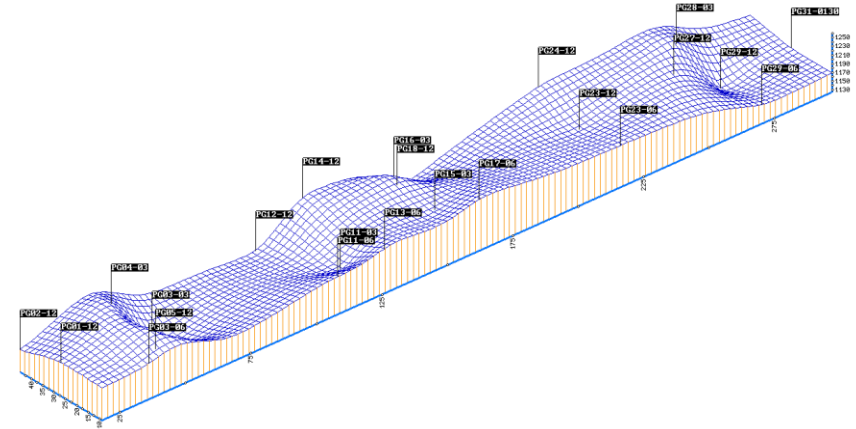
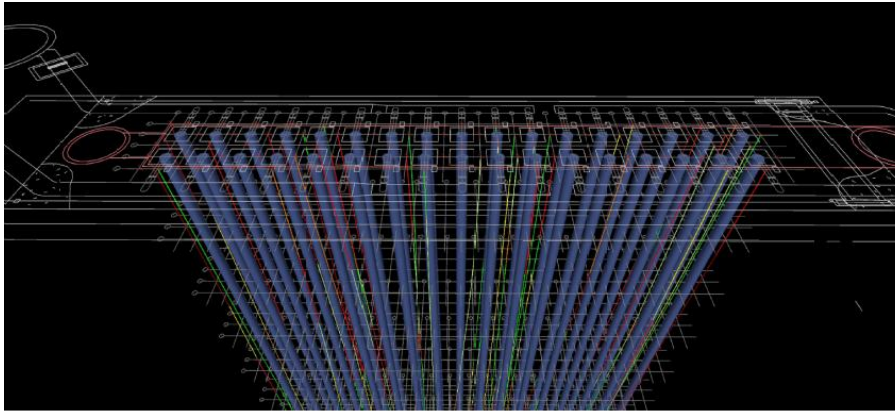




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Pre-excavation Grouting – Well Shafts



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



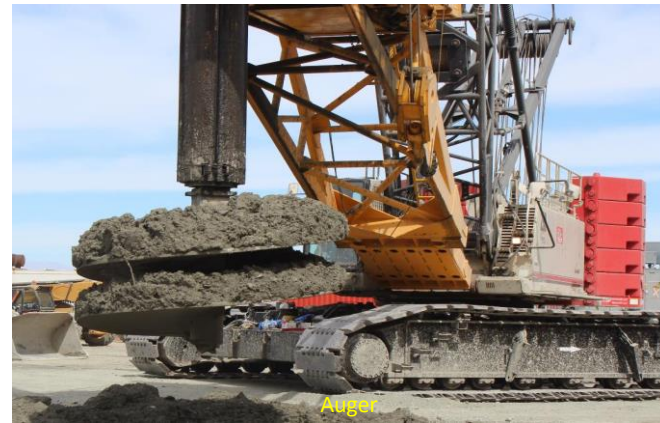
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Well Shafts – Surface Casing



Surface Casing Excavation

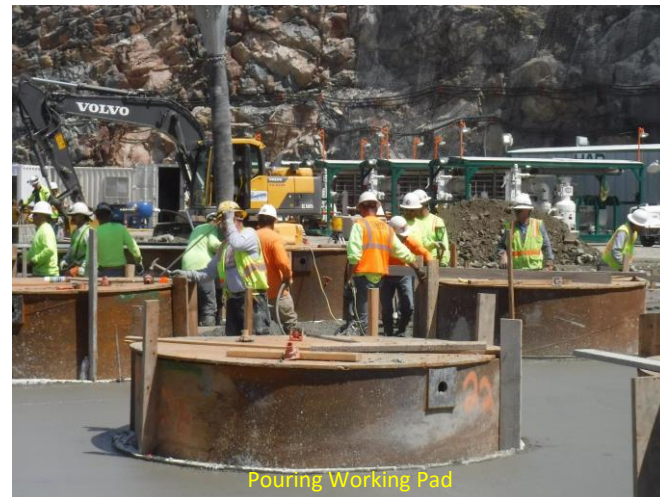


Auger



Installing Surface Casing

2016. 4. 1 7:00



Pouring Working Pad

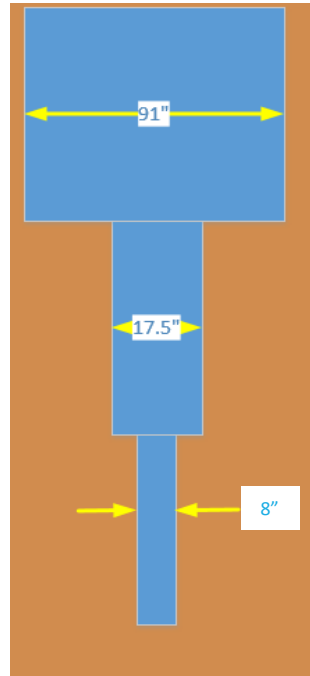


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Well Shafts – Pilot and Blind Bore Drilling

Pilot Hole Rig - Directionally
Drilled 8" dia.



Large Dia. Reaming
Rig – 91"





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Well Shafts – Casings and Survey

Well Casing (72" dia, 1" thick)



Mandrel (Survey Alignment)





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Well Shafts – Completed Casings





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Access Shaft – Excavation

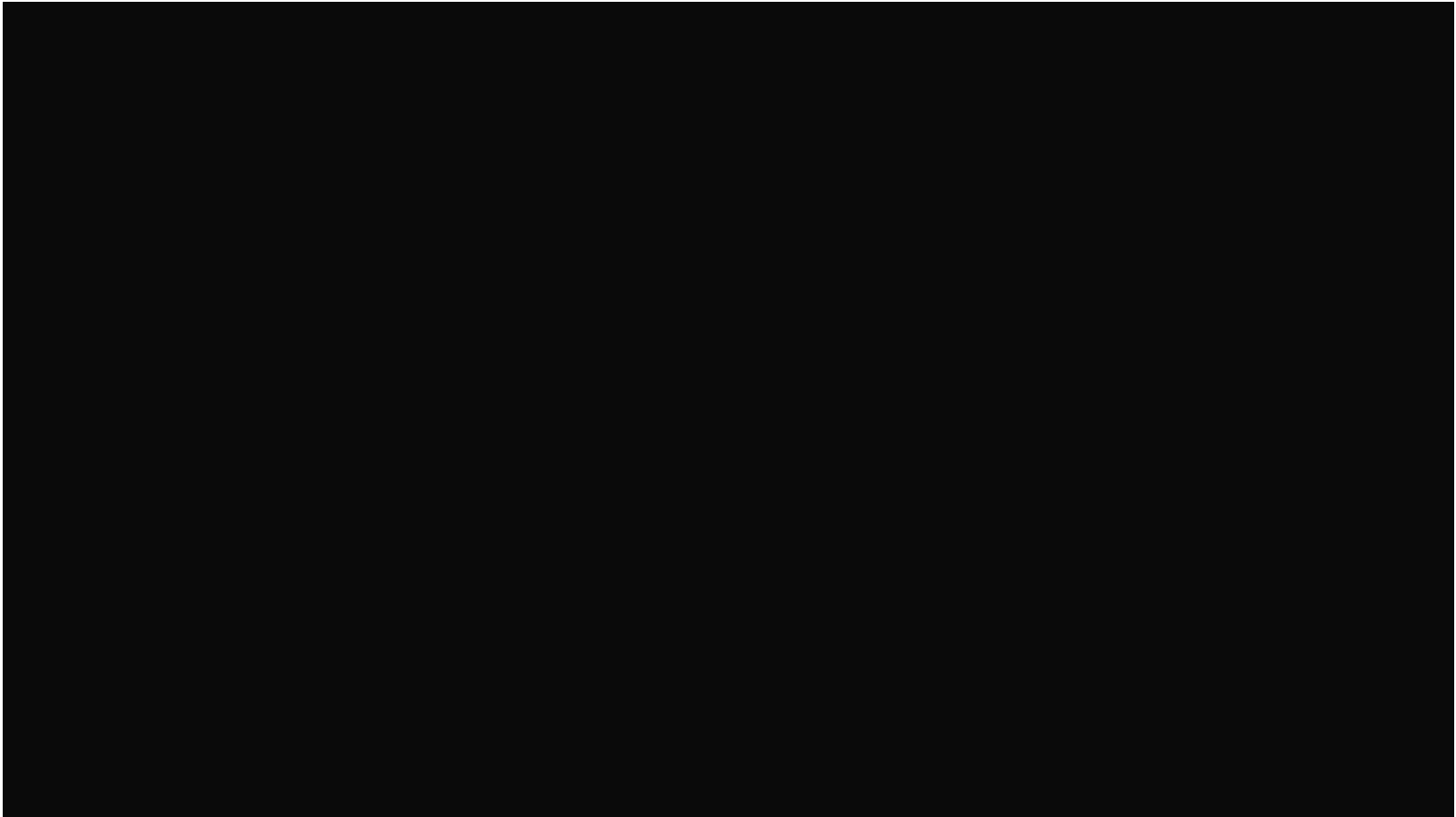




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Access Shaft – Excavation





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Access Shaft – Concrete Lining





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Forebay Cavern – Excavation





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Forebay Cavern – Excavation





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Forebay Cavern – Excavation





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Forebay Cavern – Excavation

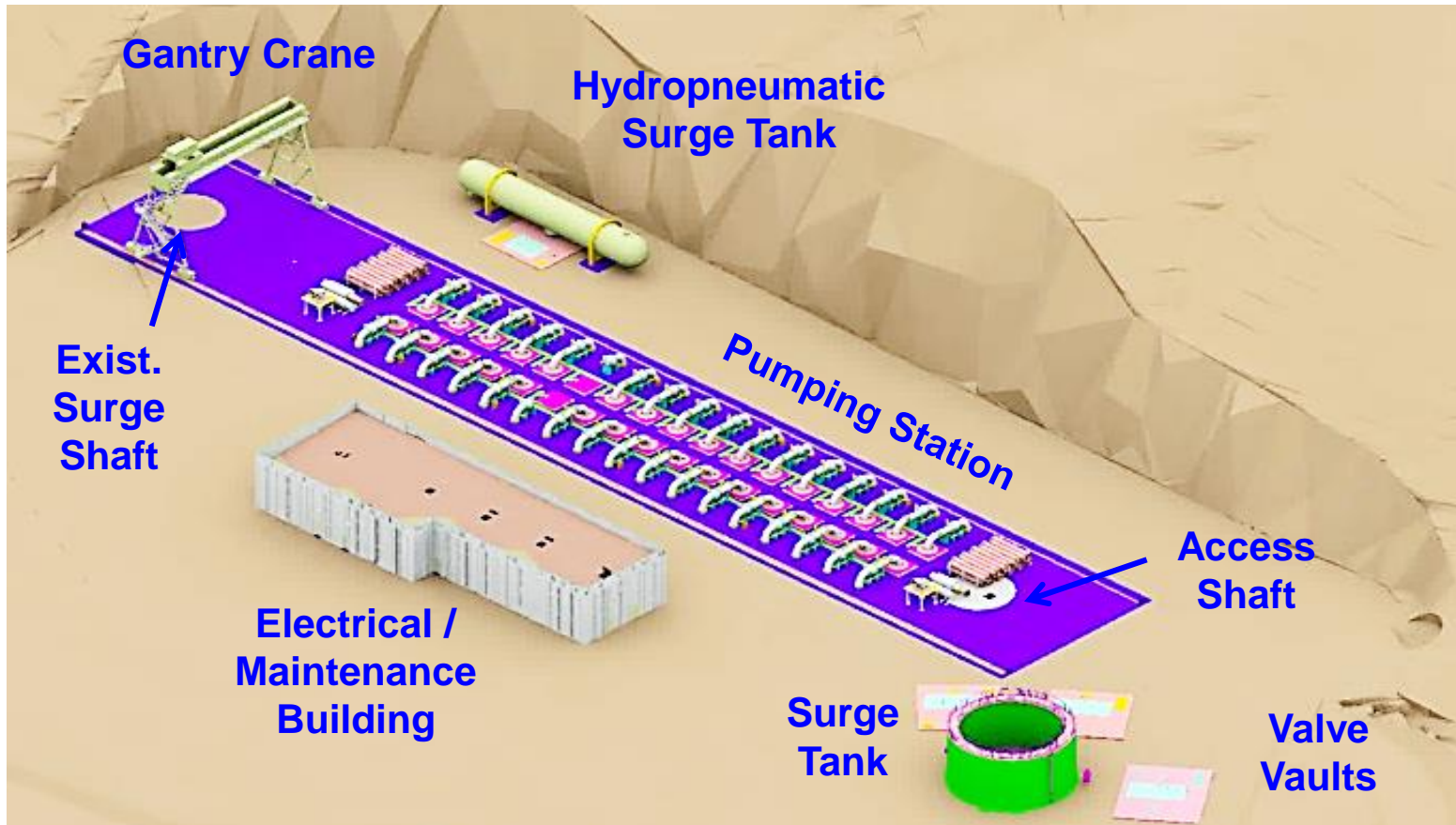




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Pumping Station – Aboveground Construction





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Pumping Station – Aboveground Construction

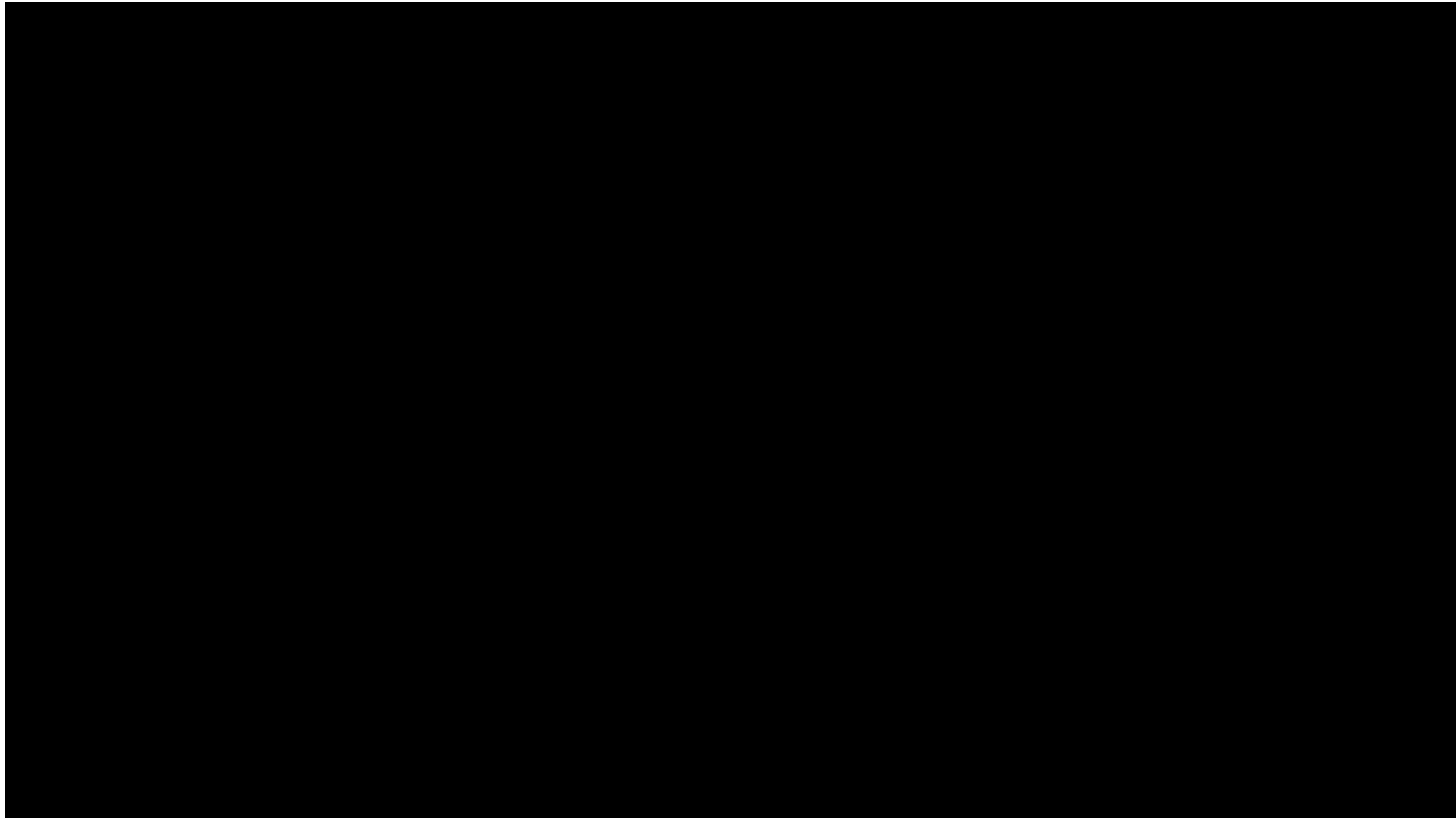




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Pumping Station – Aboveground Construction





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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



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Special Thanks to All Involved in the Project!

