SELECTION AND IMPLEMENTATION OF A POST-CLOSURE MINE DEWATERING SYSTEM

CHEVRON MINING INC, QUESTA MINE, NEW MEXICO

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Mine Design, Operations, and Closure Conference
Butte, Montana
May 2017

Presentation Outline

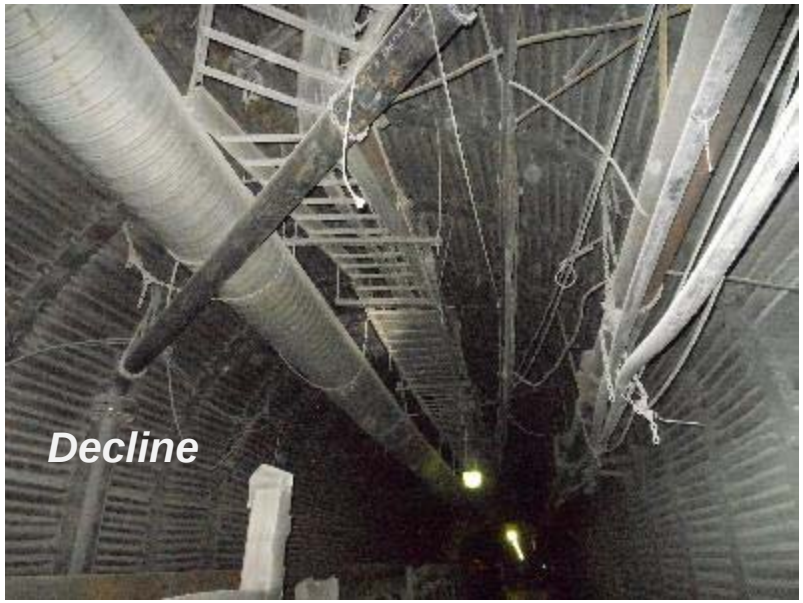
- Background
- Mine Dewatering Alternatives and Evaluation
- Selection of Dewatering Alternative
- Borehole Drilling
- Well Installation and Perforation
- Water Conveyance
- Summary

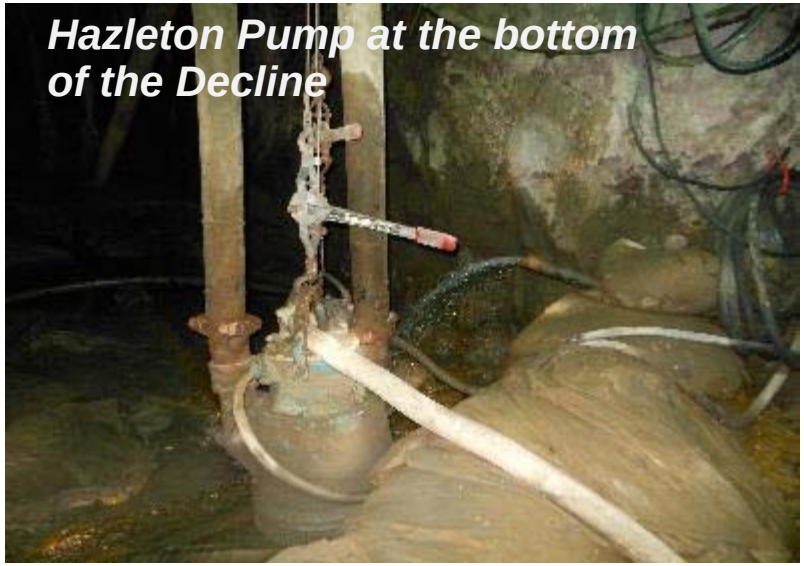
The Questa Mine

- Surface Open Pit and Underground Molybdenum Mine, near Taos, New Mexico
- Began as an underground mine in the early 1900's, Open Pit in the mid 1960's, then back to underground mining in the mid-1980's

Background

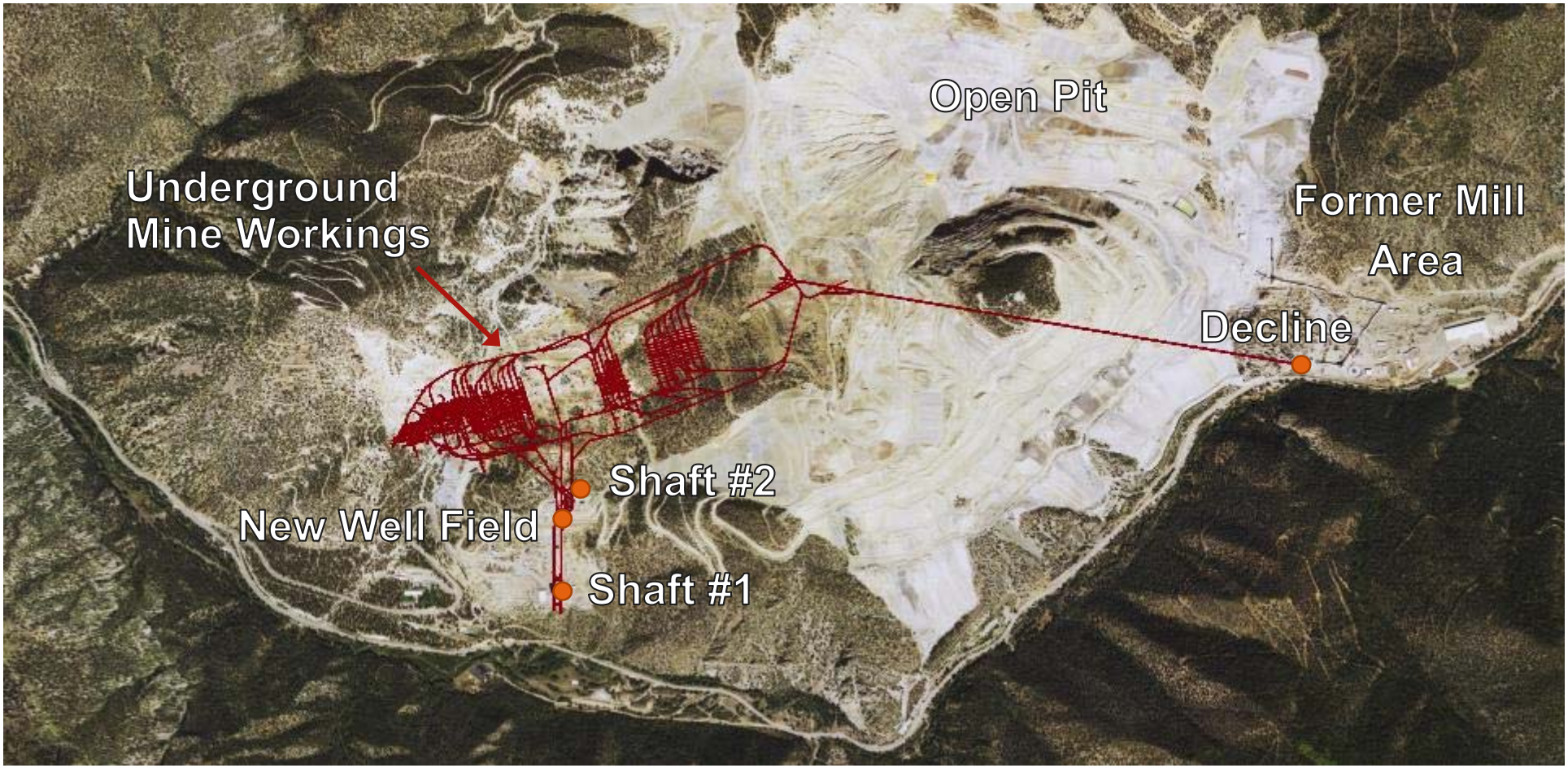
- Previous underground mine dewatering included pumping via a decline (6,000 ft) to the surface
- The mine was closed in June of 2014, which included permanent closure of the underground workings
- A new surface-based method of maintaining water levels in the underground mine was needed


Decline


Hazleton Pump at the bottom of the Decline

Mine Dewatering Alternatives

- Installing Pumps in Existing Shaft #1
- Installing Pumps In Existing Shaft #2
- New System in the Decline
- New Well Field



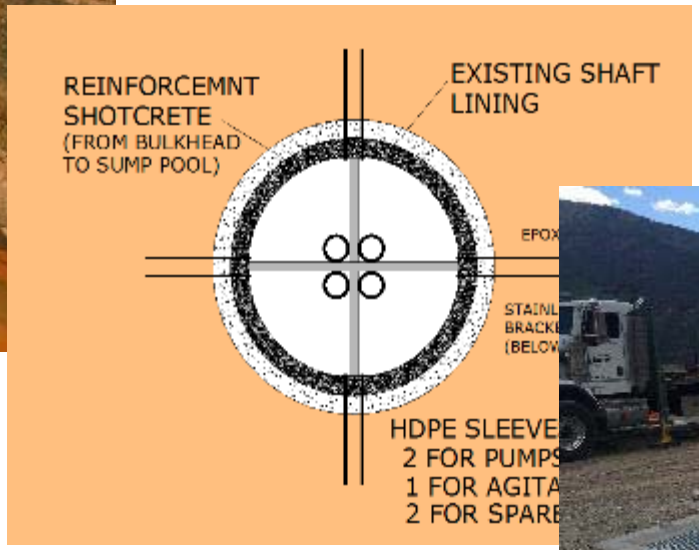
Evaluation of Dewatering Alternatives

- The four alternatives were evaluated for:
  - Capital Expenditures (CAPEX)
  - Operational Expenditures (OPEX)
  - Pump and piping considerations
  - Safety of the system
  - Timing for closure of the underground
  - Likelihood of overall success

Dewatering Alternatives

Decline

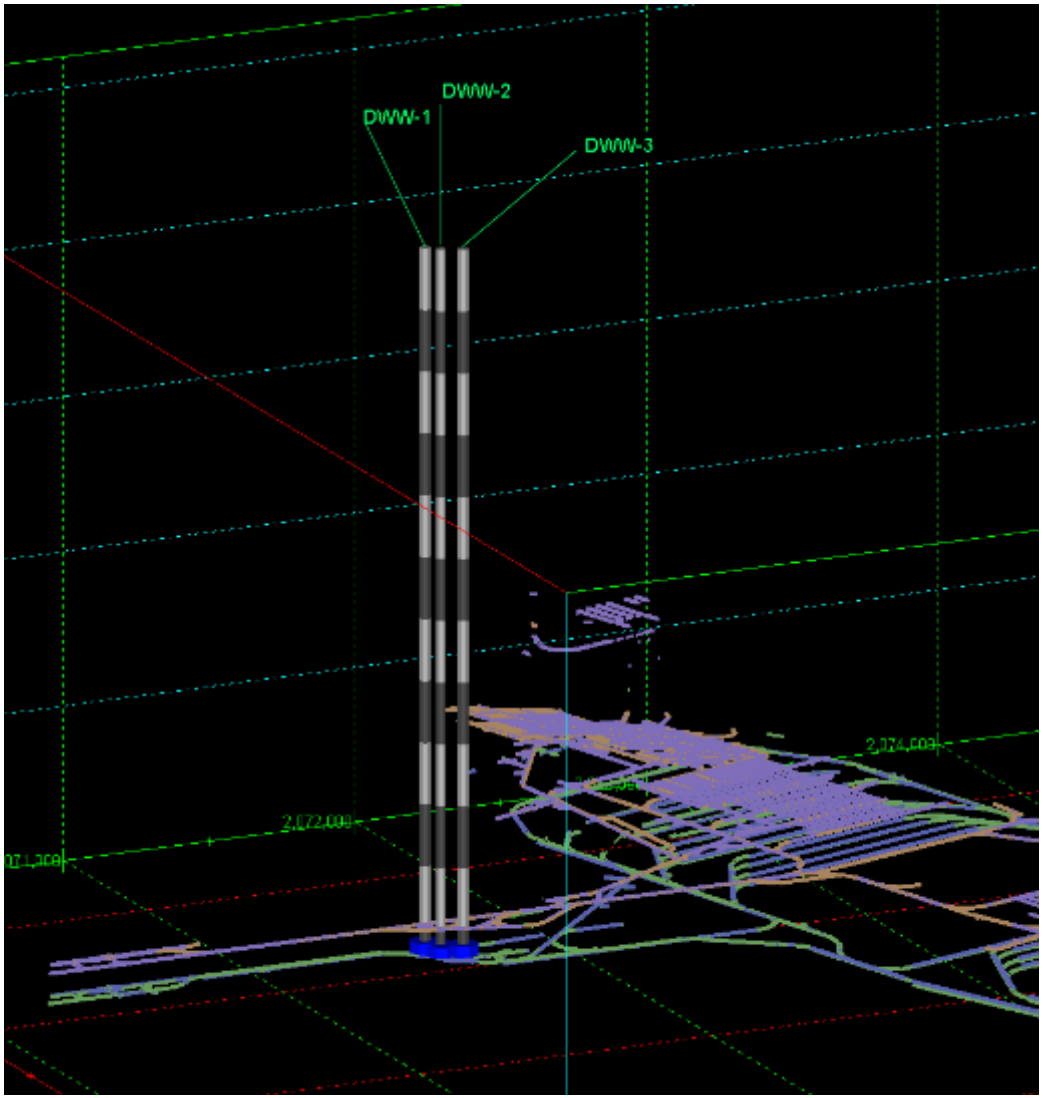
Pumping for Shafts #1 or #2



New Well Field

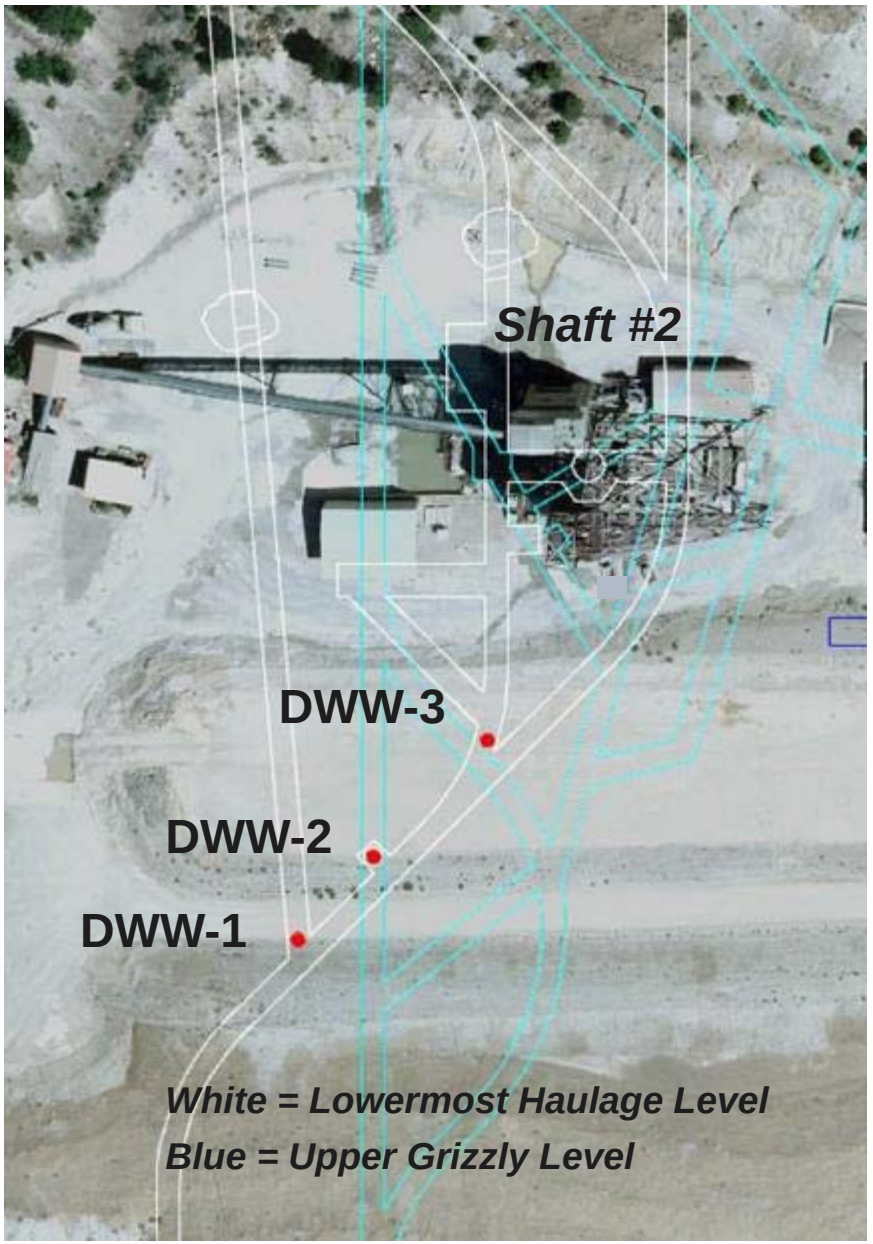
Selected Approach – New Dewatering Well Field

- Capital costs comparable or less than other alternatives
- Lower operational costs
- Reliable technology - well and pump components
- Could be installed quickly, allowing the underground mine to close sooner
- Required no personnel in the underground mine
- Used proven drilling technologies



New Dewatering Well Field

- The location of the well field was near Shaft #2
- Three wells equipped with electronic submersible pumps would be installed in the lowermost Haulage Level of the underground mine
- Three wells were installed to provide redundancy
- Well screens and pump depths coincide with the lowermost Haulage Level, approximately 1,200 feet below grade



Dewatering Well Drilling Plan

- Advance borehole using conventional mud rotary and reaming techniques through unconsolidated material and weathered bedrock
- Pilot borehole driven using real-time measurement-while-drilling (MWD) instrumentation and directional tooling
- Ream piloted borehole to prescribed diameter to the Haulage Level
- Below the Haulage Level, the borehole was advanced using air/foam mud mixtures


Drilling Rig


PDC Pilot Bit

Borehole Drilling

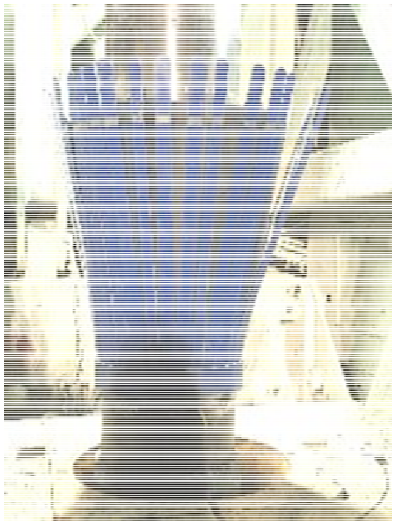
- Pilot boreholes used real-time directional drilling to ensure that the borehole was advanced into the Haulage Level within a 4-foot diameter target

10.75-inch pilot bit and 17-inch reaming reamer in the Haulage Level

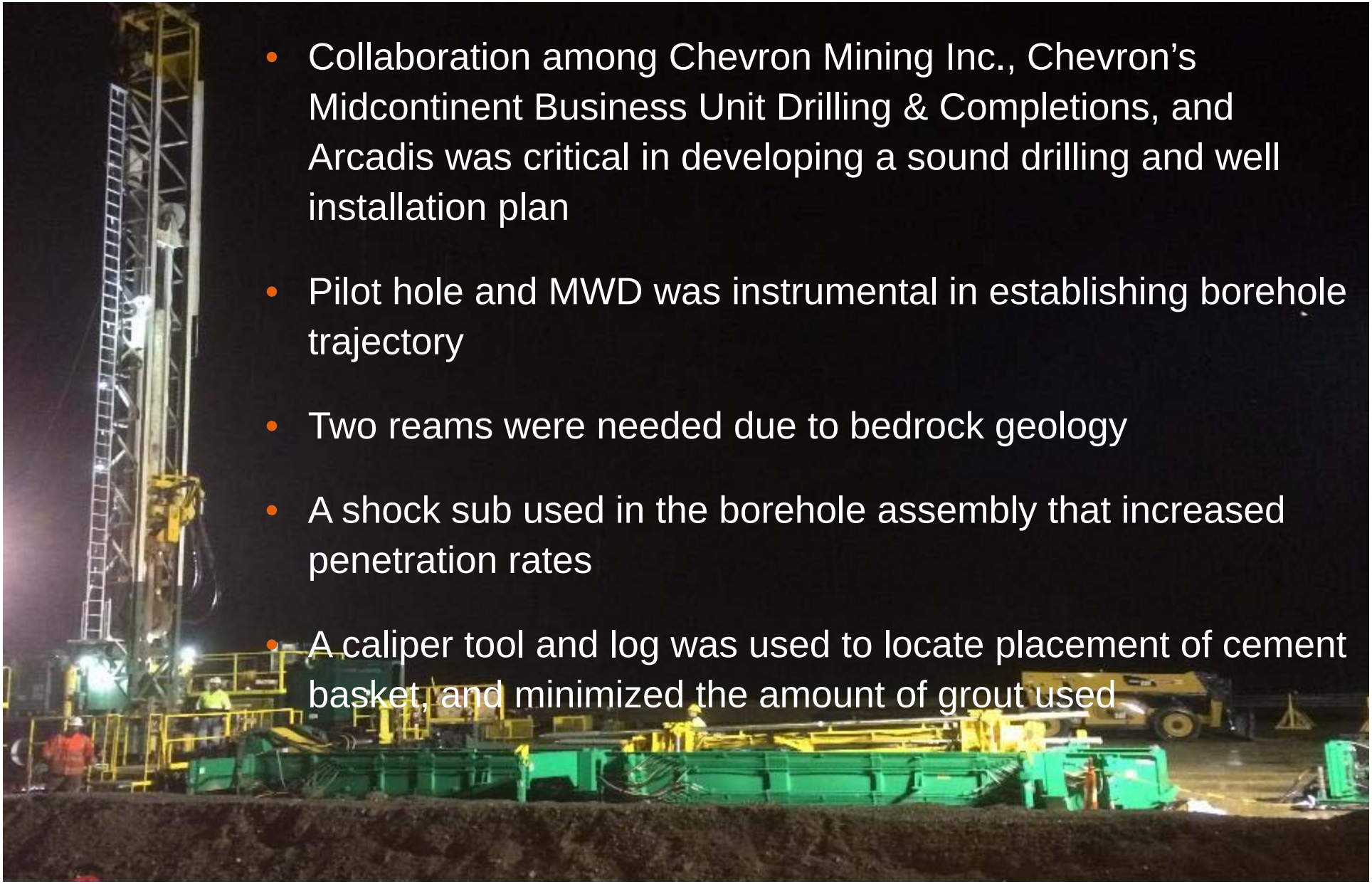
Well Casing Installation

- 9.625-inch LTC production casing and guide shoe inside 18-inch surface/ conductor casing
- Cement baskets were placed at intervals after review of caliper logs
- The upper 500 feet of borehole annulus was grouted

Casing and Guide Shoe



Drilling Lessons Learned



- Collaboration among Chevron Mining Inc., Chevron's Midcontinent Business Unit Drilling & Completions, and Arcadis was critical in developing a sound drilling and well installation plan
- Pilot hole and MWD was instrumental in establishing borehole trajectory
- Two reams were needed due to bedrock geology
- A shock sub used in the borehole assembly that increased penetration rates
- A caliper tool and log was used to locate placement of cement basket, and minimized the amount of grout used

Well Perforation

- Wells casings were perforated at the interval within the Haulage Level, about an 18-foot long interval
- Prior to perforation, wells were fitted with a bridge plug, filled with water, and then perforated
- Wells were perforated using an 18-foot long perforation gun, 216 perforations or a 12-shot per foot geometry

Unfired Perforation Gun

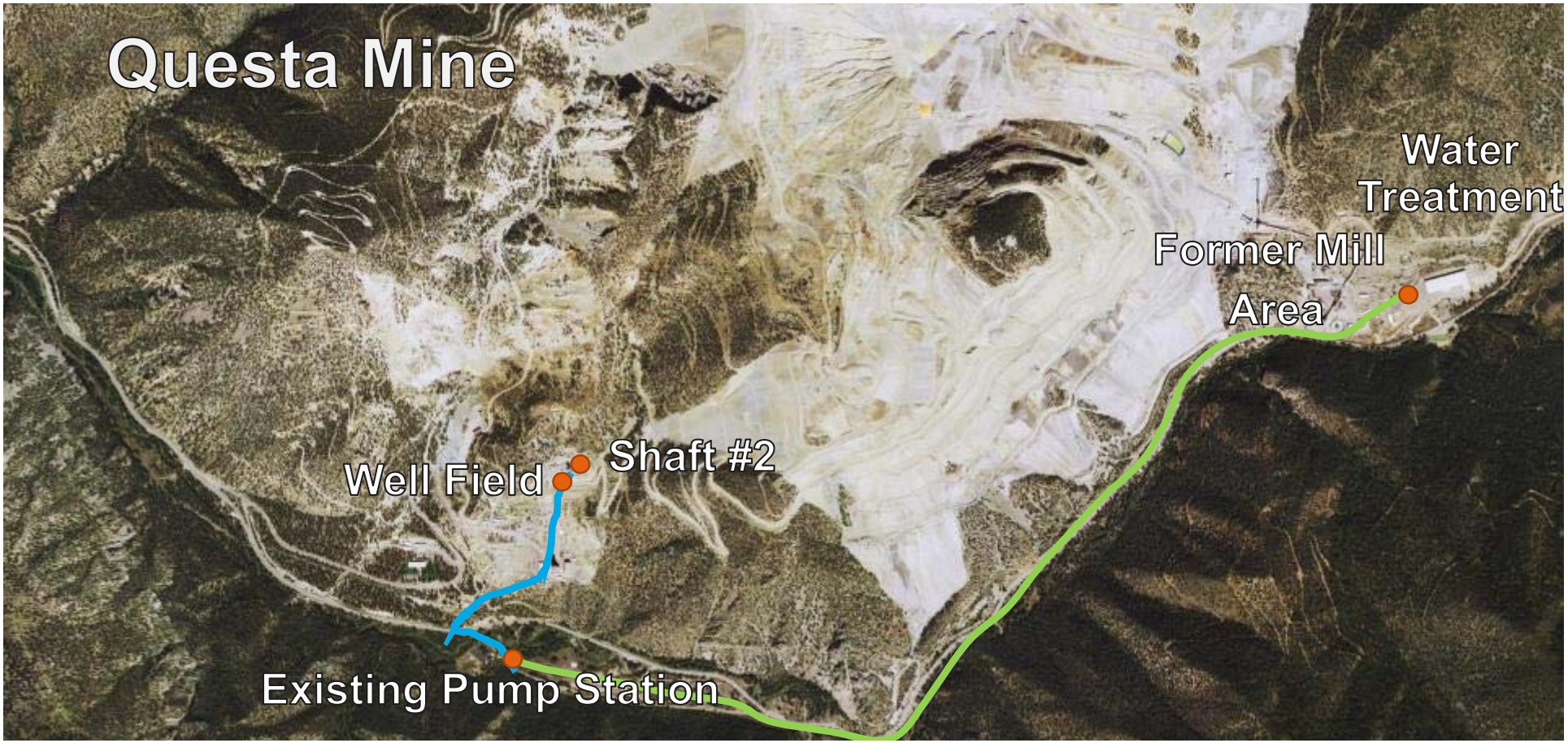
Pump Installation

- The historical inflow to the underground mine was 250 gpm - each well was designed to pump at that rate
- 14-stage Baker Hughes HC10,000 electrical submersible pumps were installed with 4.5-inch coupled, internally plastic coated tubing
- Each pump was fitted with a well lift gauge (transducer) to measure water levels
- Pumps were placed just below the Haulage Level

Pump Assembly Prepared for Installation

Water Conveyance

- The three wells are connected to a manifold and HDPE discharge pipeline
- The discharge pipeline conveys water from the well field down to an existing pump station where it is pumped up to the former mill for treatment



Summary

- The new well field met all evaluation considerations and lead to the successful and timely shut down of the underground mine
- A collaborative effort combining directional and conventional drilling techniques ensured that each borehole reached its target
- The new dewatering system allows for safe, surface-based, and long-term management of water levels
- The wells were started in August 2016 and are successfully pumping to manage water in the underground mine