LOWER BEAVER BROOK DAM

Evergreen, CO

WHY THIS PROJECT IS RELEVANT

- Roller compacted concrete
- High hazard dam
- Environmentally sensitive area
- Same project team including subcontractors
- Spans seasons

PROJECT SIZE

Roller Compacted Concrete – 6862 CY
Dental Concrete – 746 CY
Hydraulic-Operated Gate – 2 EA
Outlet Works Piping – 210 LF
Rock Excavation – 1528 CY
Drilled Foundation Grouting – 808 LF
Rock Fill – 5525 CY
Riprap – 900 CY
Measurement Flume Structure – 3 EA

INITIAL/FINAL COST

$5,039,534/$5,172,743

CHANGE ORDERS

$207,000/Added 3 flume structures, silt removal, riprap facing

SCHEDULE

04/2021 - 04/2022

PROJECT TEAM

Nathan Everett
Dan Sewczak
Jesse Sewczak
Mike Sewczak

Zak Dirt was contracted by Lookout Mountain Water District to replace their 100+ year old dam located at 1345 Beaver Brook Canyon Road in Evergreen Colorado, which no longer met modern safety requirements. The project included dewatering the reservoir; demolition of the old dam; foundation grouting and preparation; construction of a new roller-compacted concrete dam; construction of inlet and outlet works; and placement of rock-fill embankment.

Lookout Mountain Water District actively treats water from Lower Beaver Brook Dam and supplies it to more than 500 clients. Before construction began, with the reservoir to be empty during construction, Zak Dirt was required to construct a temporary cofferdam upstream and tie a 1200’ bypass line of 8” HDPE piping into the existing treatment plant in order to supply water during construction. Because the mountainous topography prevented equipment access, Zak Dirt devised a block-and-tackle system and winched the pipe into position.

Certain wetlands adjacent the dam were designated as requiring protection. Because of the site layout, these wetlands were in areas where access roads had to be installed. Zak Dirt carefully pruned existing wetland vegetation, separated the wetland area from fill using geotextile barrier, and protected the wetlands with felled timber mats and straw blanket before building necessary access roads. The wetlands were successfully uncovered and reclaimed after construction.

LOWER BEAVER BROOK DAM (Continued)

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REFERENCES

OWNER

Dean Snyder
Board Member/Project Manager
Lookout Mountain Water District
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303-910-7311

ENGINEER

Chad Masching
Project Design Engineer
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SELF PERFORM

90%

All scopes of work
except concrete batching,
foundation grouting and seeding

6,860 cubic yards of roller-compacted concrete were placed during construction of the Lower Beaver Brook Dam. An AccuMix 600B Mixing Plant with self-erecting silo, twin-shaft sixty-paddle pugmill, and 30" discharge belt with 1.5 cubic yard gob hopper was used to produce the concrete. Placement equipment included use of conveyor belts, a remote controlled Telebelt, tracked construction equipment, and a vibratory roller.

The dam structure measured approximately 50' tall and 200' wide, with a formed vertical upstream face and stepped downstream face. The formed vertical upstream face employed ready-mix concrete poured in a 2.5' wide strip and "blended" with the downstream RCC using vibrators to create a smooth face and monolithic lift. Lift thickness was 12" and two lifts (one step) were installed each day. Initially the steps were formed, but later a sloped face was permitted after it was demonstrated to the engineer's satisfaction that grade and compaction could be accomplished using a hoe-mounted tamper plate to compact the downstream RCC face. The final 12 lifts, at which point the dam structure was just 16' thick, were formed vertically on both the upstream and downstream sides. A wet grout bedding layer, batched using a colloidal mixer, was placed at the start of each shift for adherence to the previous day's placement based on joint maturity. Placement of 50 lifts (6860 CY) of RCC took place over the course of 29 work days between 10/5/22 and 11/12/22. Tickets generated by the calibrated RCC plant were printed daily and submitted to the engineer. A VeBe of 12-14 seconds was typical for the RCC mix batched for this particular project. The RCC was wet cured using moisture-retaining blankets, and for the latter half of the placement timeframe, insulated curing blankets were used for overnight heat retention based on site temperatures.

LOWER BEAVER BROOK DAM (Continued)

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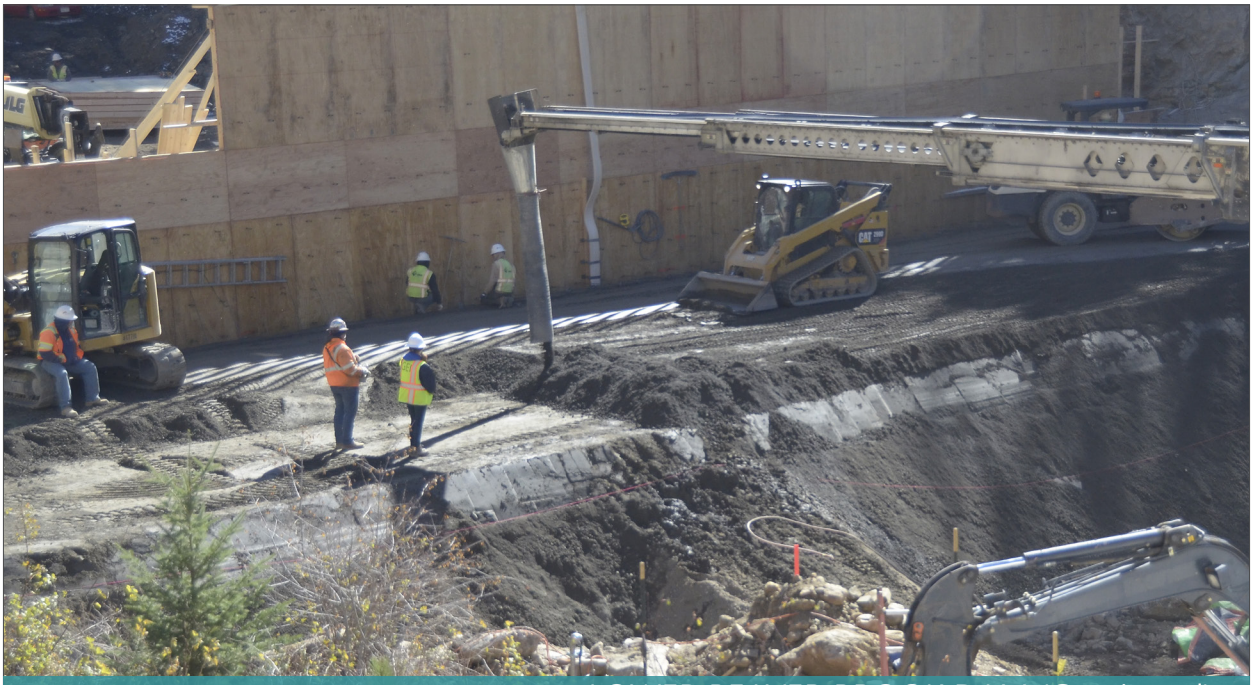
Foundation preparation was essential to the performance of the Lower Beaver Brook Dam. After demolition of the existing dam, excavation continued until competent bedrock was exposed along the length of the dam footprint. Bedrock was meticulously cleaned with high pressure air and water. Small tools and hand labor were used to chase material out of small joints, which were then slush grouted. Dental concrete was used to fill anomalies and overhangs, and in two locations sloped concrete walls were formed and poured against the mountainside to mitigate inverted bedrock shapes. A subcontractor, Drill Tech Drilling and Shoring Inc., performed rock drilling and grout injection to create a grout curtain extending 20’ below bedrock surface, thereby reducing water migration through bedrock fissures. Before RCC placement began a conventional concrete leveling slab was installed.

Quality Control Testing was used daily throughout RCC placement to confirm adherence to the specifications and assure consistent quality. Each morning RCC production began with a stock-pile moisture assessment and VeBe testing of an initial concrete batch. VeBe requirements for the project ranged from 6-18 seconds, but an RCC test-section placed prior to actual construction revealed a VeBe of 13-14 seconds worked well for the approved project mix to reduce pumping while avoiding compaction challenges. Zak Dirt built a dedicated testing station with a concrete slab, 110v power supply, and cylinder curing chest in order to provide testing personnel with a proper work area. After confirmation of appropriate VeBe times, mix moisture was monitored constantly throughout the day and adjusted as necessary at the plant to maintain mix characteristics during daily temperature and humidity shifts. A compaction study was performed during placement of a test-section, and again during placement of the second RCC lift. The resulting curve assisted in determination of a target compaction density. Density testing with a nuclear gage during compaction was used to assure compaction efforts met the determined requirements. Twelve RCC cylinders were taken daily for testing purposes, and all fifty RCC lifts placed were found to meet compressive strength requirements after 56 days.



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Passage of outlet works piping was through a tunnel hewn in the bedrock that passes under the East dam abutment. This tunnel was created a century ago when the tunnel was originally built. An important part of new dam construction was to close off and seal the tunnel. Before installation of steel outlet works piping, the irregular rock tunnel floor was cleaned and sealed with concrete. After installation of piping, a bulkhead and water stop were installed at the reservoir tunnel entrance. After bid time, the state dam safety engineer determined the tunnel needed to be backfilled with cementitious material to further reduce risk. The design engineer envisioned accomplishing this using flowfill, but after tunnel access was available, they realized that the tunnel roof was higher in elevation than the entrance, meaning that normal flowfill placement would result in a large void near the tunnel roof. Zak Dirt assisted the engineer in creating an alternative fill plan that would not leave a void. We devised a system of slick lines and vent pipes that could be bolted to the tunnel ceiling and pass through the bulkhead, allowing the tunnel to be pumped full of a cellular grout from the tunnel high-point, ensuring a complete backfill condition.

Functional and well-maintained equipment aided in the success of the project. Zak Dirt owns and maintains a wide range of heavy construction equipment. For excavation, demolition, and general construction Zak Dirt mobilized three excavators, a mini-excavator, a bulldozer, two loaders, two skidsteers, two water trucks, and three off-road haul trucks. A tracked rock crusher and stacker belt were used to process concrete debris as well as produce crushed rock aggregates for use in RCC. Tracked skidsteers, a mini-ex with tamper plate attachment, a vibratory roller, and walk behind plate tampers were used during placement and compaction of RCC. Conveyor belts and a truck-mounted remote control conveyor belt (Telebelt) were used to convey RCC. An advanced-mobile-continuous-mixing pugmill supported by an auxiliary silo and two dry bulk storage trailers were used for production of RCC. A colloidal grout mixer was used for RCC grout bedding, injected foundation grout, and slush grout production. Two rock drills and grout injection and testing equipment were utilized by our foundation grouting subcontractor for foundation grouting. A fuel tank was setup onsite for on-site fuel supply.