This photo shows the final stages of construction at Glen Canyon Dam. It has a date of May 6, 1963 — about four months before the last bucket of concrete was poured.
Courtesy of U.S. Bureau of Reclamation

HUGE UNDERTAKING

It's hardly the largest dam in the world. It's not even in the top 10. However, Glen Canyon Dam is still pretty big. It's taller than the Washington Monument, and it weighs in at about 10 million tons. **BY GARY LADD**

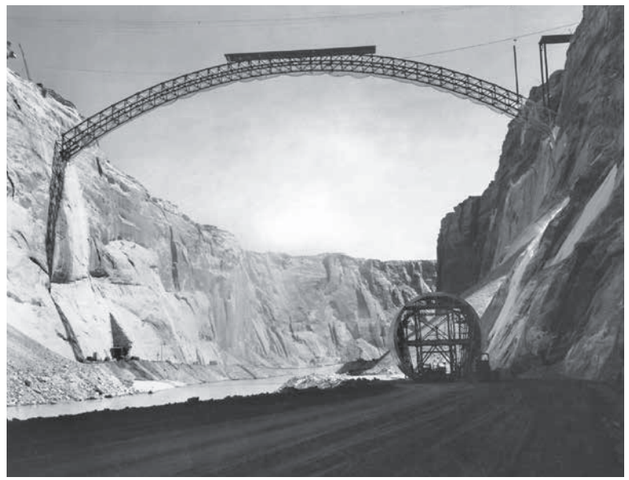
It seems unlikely that a 710-foot monolith weighing about 10 million tons could be overshadowed by anything. But in Northern Arizona, where the canyons are grand and the sky is even bigger, that's how it is for Glen Canyon Dam. Most people ignore it.

Sixty years ago, however, the vibe was different. The new town of Page, Arizona, a U.S. Bureau of Reclamation construction camp, was fully focused on the rise of the dam. For seven years, up to 2,500 men were at work down in "the hole," the stark, noisy, gaping void between protective cofferdams.

Construction began in the fall of 1956, when President Dwight Eisenhower pressed a telegraph key in Washington, D.C., sending the signal to set off the first blast at Glen Canyon.

The explosion, echoing through the canyon, was the beginning of four years of drilling, tunneling and excavation needed to divert the river and prep the site for the big dam. Two 3,000-foot-long river diversion tunnels bypassing the dam site were blasted through the adjacent sandstone cliffs. The tunnels, more than 40 feet in diameter, were lined with concrete and equipped with river control gates.

By 1959, the tunnels were ready. An ugly, oozing bulwark of boulders, sand and construction junk dumped and bulldozed into the river torrent for three days diverted the river into the west tunnel. This pitiful dirt levee was the start of an upstream cofferdam that eventually climbed 300 feet above the



CLOCKWISE FROM TOP LEFT:
This October 15, 1956, photo shows the first detonation, triggered by President Dwight Eisenhower, in the Glen Canyon Dam construction process. Four years of drilling, tunneling and excavation would follow.
Arizona Historical Society
An aerial photograph from around 1959 shows the sprawling construction site around the rising dam.
Arizona Historical Society
Workers install equipment in one of the dam's massive diversion tunnels.
Courtesy of U.S. Bureau of Reclamation
Above the concrete form for one of the diversion tunnels, the Glen Canyon Dam Bridge takes shape in the late 1950s.
Courtesy of U.S. Bureau of Reclamation

deepest excavation, guarding it from spring floods while the dam took shape.

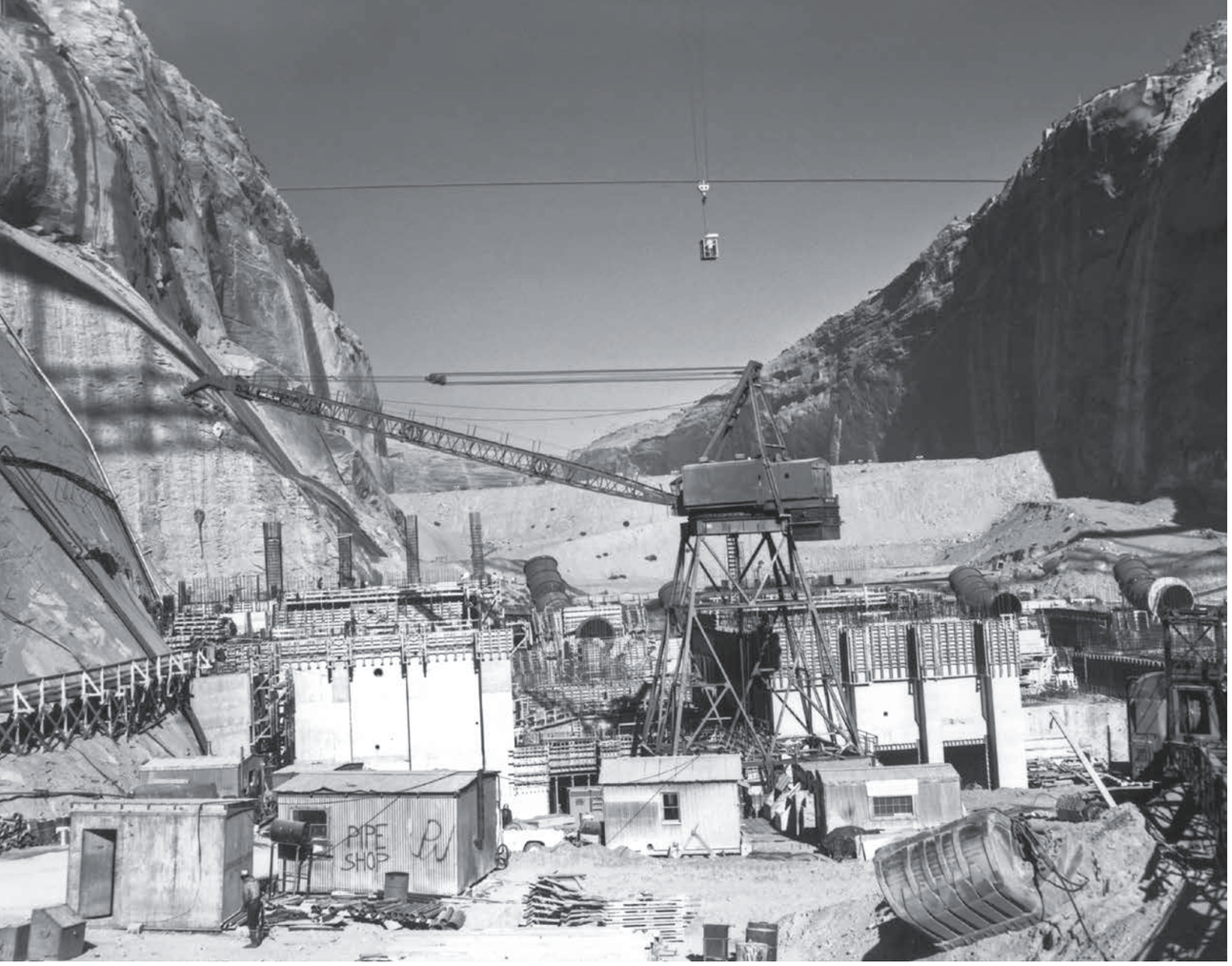
The diversion tunnels were used until 1963, then were permanently sealed.

With the river diverted and the two huge earthen cofferdams beginning to rise upstream and downstream, crews began the real work — the removal of every trace of loose debris and suspect bedrock beneath and adjacent to the future structure. This process alone took two years.

By mid-1960, the site had been fully excavated, cleaned and groomed. It was ready for "mud." The first 12-cubic-yard bucket of wet concrete plopped down on raw bedrock about 130 feet below the old river bottom. For the next three years, overhead cableways ferried buckets from a concrete batch plant near the rim to the dam below. The batch plant could prepare 8 cubic yards of concrete every minute, keeping the cableways whirring.

Even before the first concrete was placed, a canyon-spanning highway bridge was built just downstream. From 1959 through 1963, drivers on this new segment of U.S. Route 89 could pull over to stroll on the bridge's sidewalk for an "aerial" view of the dynamic, resounding scene below: the river diversion, the excavation and, eventually, the incremental rise of the dam.

Glen Canyon Dam was assembled in thousands of interlocking blocks, each block a standard 7.5 feet high. But the



ABOVE: This photograph, circa 1961, shows some of the machinery used to construct Glen Canyon Dam. *Northern Arizona University Cline Library*
OPPOSITE PAGE: Once the dam was completed, water began flowing through its hydroelectric plant, as shown in this Josef Muench photo from the 1960s. *Northern Arizona University Cline Library*

blocks varied in width and length as the dam climbed higher; the largest were 60 by 210 feet. To avoid air pockets, every cubic foot of each block was vibrated into place by three-man teams. (These guys held jobs known as the most brutal and absolute worst of the project.)

The scale of making so much concrete is almost unimaginable. Approximately 300,000 round-trips were made by truck to bring aggregate to the dam site from a gravel pit a few miles away. Tens of thousands of truck trips were needed to supply bulk cement from a plant in Clarkdale, some 200 miles away.

Back on the rim, a refrigeration plant produced ice used in the concrete mix and chilled water for circulation through tubing within the blocks to reduce curing time, speed concrete placement and minimize expansion and subsequent contraction of the huge mass.

At the same time, a 1,320-megawatt-capacity hydroelectric power plant was fabricated near the foot of the dam.

In September 1963, after more than 400,000 buckets of concrete had been placed, Glen Canyon Dam topped out at 710 feet tall. About 5 million cubic yards of concrete blocked the Colorado River. Lake Powell began to materialize — it would take 17 years to top off.

Today, when viewed from the highway bridge, the dam looks immense. It looks even bigger when viewed from below. If the Washington Monument were relocated to the lawn at the foot of Glen Canyon Dam, its apex would fail to clear the crest of the dam. More remarkable, the most massive 150-foot section of the dam's 710-foot height is hidden below the grass at the dam's apparent base. The entire monolith weighs about 10 million tons.

So, how's the dam doing? Good, mostly. But the summer of 1983 was famously traumatic. An unanticipated snowmelt flood forced the use of the dam's two spillway tunnels, which were known to harbor design flaws that were still under study.

The overflow ripped through the tunnels, tearing out sections of concrete lining. Then it hollowed out room-sized voids in the surrounding sandstone. In response, the tunnel gates were modified and flows adjusted. The crisis passed, narrowly. Glen Canyon Dam, however, was left unscathed. Tunnel redesign and repair was completed within one year. Experimental high-volume test flows demonstrated that the tunnel modifications had solved the problem.

Otherwise, Glen Canyon Dam is stable and boring. *Very* stable and *very* boring. The dam's curving shape braces it against the ceaseless pressure of the reservoir, its concrete under compression, the thrust transferred to the ancient canyon walls. And even if the surrounding rock somehow spontaneously disappeared, the enormous mass of the dam would be enough to hold it steady, not swept aside or overturned.

Still, the behemoth is continually scrutinized. Sensors are embedded within to measure internal stresses, strains and temperatures. Other sensors keep tabs on water seepage and uplift pressure. And should a problem develop, interior passageways ensure a ready approach to any trouble spot.

Eighteen years of severe drought have sucked Lake Powell's surface elevation down to levels not imagined when the dam was conceived, to around 100 feet below "full," give or take — a new normal.

But the big brute of a dam still waits for the Colorado's next freakish, inevitable flood, routinely releasing water to downstream cities and farms year after year, its power plant steadily generating electricity every day. AH