Glen Canyon Dam Is Broken

by John Weisheit

The river left spillway at Glen Canyon Dam failed on June 22nd in the flood year of 1983. Several cavitation holes were excavated in the spillway tunnel, the largest being 30 feet deep and 150 feet long. In an emergency effort to save the dam they, the Bureau of Reclamation (BuRec), purchased 3/4 inch thick sheets of plywood from a Page, Arizona, lumber yard and proceeded to stack them on top of the spillways much like a building contractor would to prepare basement walls for a concrete pour. On June 29th the peak discharge, measured at the Lees Ferry gauge, was 92,600 cfs. By July 4th they had installed more dependable steel flashboards on top of the spillways. With the generators cranking, the bypass tubes blasting, and even with a damaged spillway dumping, the lake elevation finally stabilized at 3708.4 feet above sea level (asl) on July 14th, with the discharge at the Lee's Ferry gauge reading 55,200 cfs. The normal high pool elevation is 3700 ft asl.

I believe that it is possible to have Glen Canyon Dam removed in our lifetime. If the membership of Grand Canyon River Guides and Colorado Plateau River Guides persisted on this issue, we could effect the legislation needed to begin its demolition and start a process of developing alternative energy resources.

This is what Russell Martin said about the spillway failure in his book, A Story That Stands Like a Dam:

"...Bureau officials conferred and finally decided to open the east [left] *spillway gate slowly and to begin bypassing large quantities of water around the dam, the first time either spillway had been pressed into flood-control service. For more than a week, water poured into the 41-foot-diameter tunnel, its volume steadily increased until—at 32,000 cubic feet per second—the water exiting the tunnel, pouring over the deflector bucket at the tunnel outlet and spewing into the riverbed, began to turn orange, began to spit out sandstone grit, pebbles, whole boulders, even, the tunnel's concrete lining.."*

Bryan Brown and Steve Carothers, in their book The Colorado River Through Grand Canyon, reported that after the inspection of the damage, it was necessary to reopen the left spillway. **Even with parts of left spillway no longer lined in concrete, BuRec still placed trust in the left spillway; even when the right spillway still had its concrete tunnel intact.**

This is what Tom Wolf said in an article that appeared in High Country News on December 12, 1983:

"June 7. The team brings the power plant flows up to 38,000 cfs, 20 percent over normal capacity. They hold the river outlet works to 15,000 cfs (the couplings on those steel tubes were leaking). That keeps water speed down to only 50 miles per hour. And they hold the right spillway to 4,000 cfs. They want to keep it low because it occupies a dangerous position upstream from the dam's foundation. If the right spillway tunnel broke through to bedrock, it would threaten the dam's foundation."

Twenty million dollars was the cost to repair and modify the spillways; a cost that included the installation of air slots to reduce the effects of imploding vapor bubbles. They tested the left spillway at a maximum flow of 50,000 cfs (for one hour) in August of 1984. **They did not test the right spillway.**

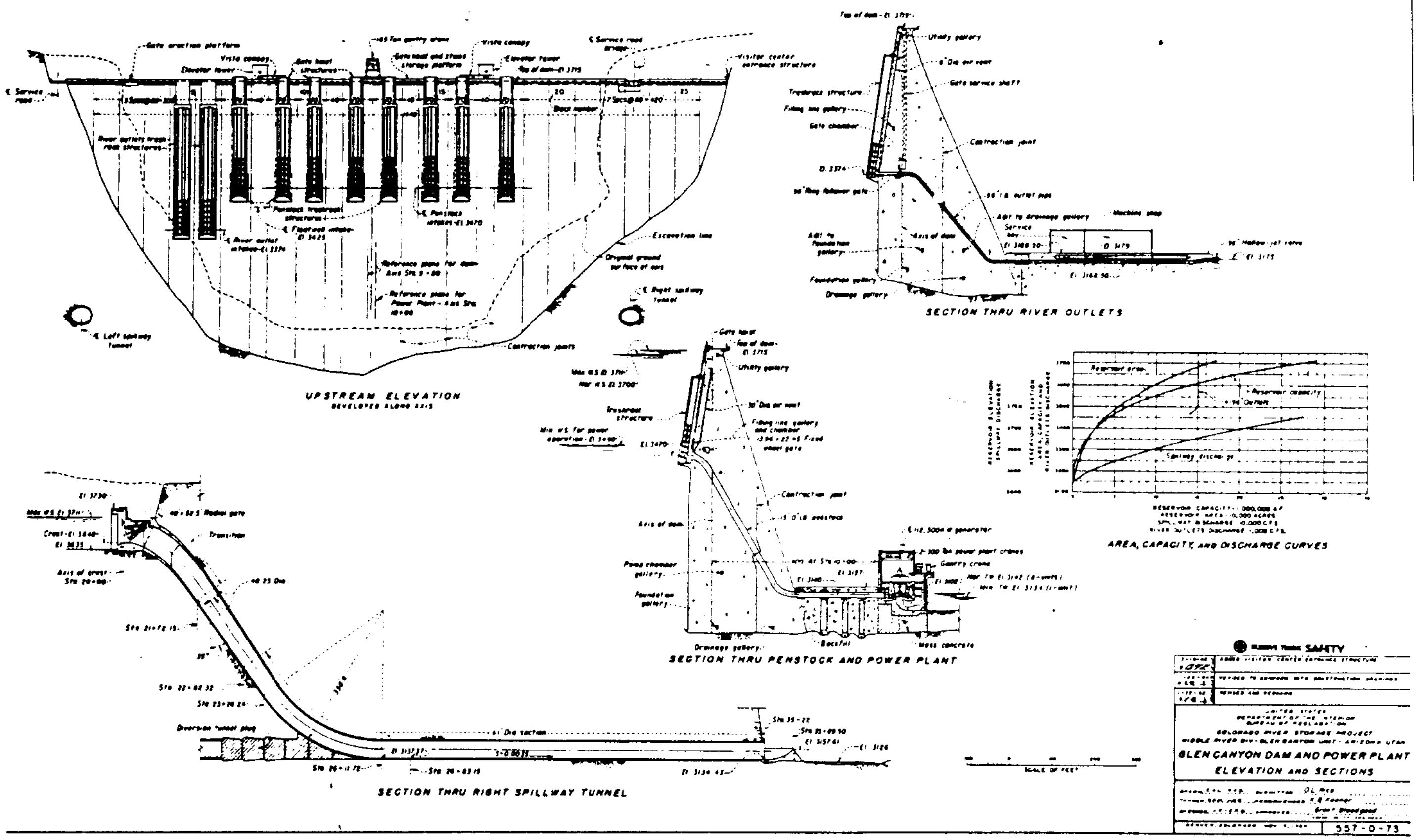
This report admits there is a structural anomaly in the shale units of the Navajo sandstone on the dam's right abutment, or keyway. I'll quote page 14:

"The Navajo Sandstone is remarkably uniform and homogenous over wide areas and nearly identical samples can be obtained from areas separated by many miles. Two thin, shaly layers, encountered at elevations 3065 and 3115 in the right abutment keyway excavation were the only changes in the lithology in the entire excavation area."

I will now quote page 24, which discusses their remedy to solve this problem:

"The seam at elevation 3115 varied from one-eighth of an inch to about 4 inches thick and had a waterflow of two to three gallons per minute. A 5- by 7-foot drift following the seam was excavated near the heel of the dam to a depth of 73 feet into the abutment to a point where the flow of water disappeared. The seam at elevation 3065 varied from a thin shale parting in the sandstone to a shale layer 1 to 2 inches thick and had a waterflow of 75 gallons per minute. A 5- by 7-foot drift following this seam was excavated near the heel of the dam to a depth of 215 feet into the abutment. The flow of water decreased with depth and at the end of the drift was just a small trickle. Both drifts were backfilled with concrete and grouted to form a barrier to seepage through the foundation."

If 3065 feet asl is the elevation at the heel of the dam, what feature is constructed at 3115 feet asl? I looked at the schematic diagrams and found a startling answer. 3115 feet asl puts you about 20 feet under the right spillway, where you will also find the concrete plugs that seal-off the original diversion tunnel. During construction this tunnel was not used to divert the normal flow of the Colorado River; being built at a higher elevation, it was used only to handle the top peak of the snowmelt.



Glen Canyon Dam and Powerplant. Elevations and sections. Courtesy of the Bureau of Reclamation.

It is reasonable to conclude that Navajo sandstone will not hold up to dynamic stress loads, such as a spillway dump; especially on the right side where there are nonconformable breaks in the rock unit. Stress loads were acknowledged as a problem in this report. I'll quote again from page 24:

"Although Navajo sandstone is remarkably uniform and yeilds remarkably smooth excavation surfaces, it has two principal characteristics which contributed to design problems. The stress-relief jointing parallel to the canyon walls showed a tendency to open slightly with time and slab or peel off onionskin fashion. The second defect is that the rock has a fairly large percentage of "set" or unrecovered strain occurring during the first loading of the sandstone. Special grouting design was developed to offset these characteristics."

There are three episodes of stress related activities for the history of Glen Canyon Dam: 1) the stress that occurred while the lake was filling when the diversion tunnels were closed in 1963, 2) when BuRec first tested the spillways in 1980, after Lake Powell finally filled, and 3) while using the right spillway in the 1983 emergency. Perhaps one or all these stresses have caused keyway damage that cannot be repaired—that is unless you drained the lake.

It is impossible to drain the lake entirely since the intake gates for the bypass tunnels are at an elevation of 3374 feet asl. Theoretically to make an effective repair of the right keyway, if such a repair could be made, you would have to reopen the original diversion tunnels. It would be like starting all over. Such a decision would seriously cripple the electrical needs of the Southwestern grid with a loss of electrical power generation from both Glen Canyon Dam and Navajo Generation Station near Page; not to mention the loss of stored water for the farmers and municipal users. **BuRec obviously has a no-action policy concerning this particular problem.**

The 1983 flood that broke Glen Canyon Dam was-a twenty-five year flood that occurred early in its history. Sediment fill (aggradation) in 1983 accounted for only a 3% loss in Lake Powell's flood control potential. In 200 years Lake Powell will lose 30% of its flood control capacity due to sediment aggradation. Under these conditions the efforts that saved the dam in 1983 would have failed.

By the year 2183 Glen Canyon Dam will encounter eight 25-year floods, two 100-year floods, and one 300-year flood. Who knows when the 500-year or the 1,000-year flood is coming? One of these floods will force extended spillway use beyond the levels of 1983. The bedrock will once again fail, the diversion tunnel plugs will be hydraulically excavated, and then over 20 million acre feet of water will come racing through the Grand Canyon and into Lake Mead. If Hoover Dam were to fail, so too would Davis and Parker dams. The entire electrical grid of the lower basin would be destroyed, the aqueducts would run dry, and productive farmers would no longer grow food or cotton.

This is what I think should be done to avoid this ultimate National disaster: **1)** Congressional leaders should conduct a formal hearing with BuRec to determine the safety of Glen Canyon Dam. **2)** If the dam is considered unsafe, then it should be removed; never to be replaced. **3)** That Glen Canyon should be reclaimed and made into a national park. **4)** That alternative energy resources should be implemented into the Western Area Power Administration grid. Alternatives such as: geothermal, wind and solar resources, which are available in great abundance throughout the Great Basin desert.

In conclusion, I insist that the lifetime of Glen Canyon Dam should not be considered in hundreds of years. It is at risk today—right now! The sandstone abutments of Glen Canyon Dam are becoming structurally weaker with each passing decade and the "special grouting design's" incorporated into the construction of Glen Canyon Dam are not working.

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