One's Engineering Career Doesn't Have to End with Retirement ...

Digitizing Mud Mountain Dam Construction Photos – Art Storbo

In May 2021, as a board member of the Enumclaw Plateau Historical Society Museum (Museum), I was contacted by staff at Mud Mountain Dam (MMD). MMD lies in the Cascade foothills 4 miles from the Enumclaw farm where I grew up. Their question: Did I know anyone who could digitize old construction photos?

Mud Mountain Dam, upstream side

These were 8x10 black and white prints, taken between 1937 and 1948, with good detail – 4,000 of them. The photos were pasted onto 11x15-inch black album pages, 200 photos per volume, 22 volumes – the only set of construction photos the U.S. Army Corps of Engineers (Corps) had of the project. They wanted the digital copies to preserve the photo record, allow the originals to be safely stored, capture fine detail that photocopying didn't, and facilitate copy distribution to others. These are important "as-built" documents, showing geologic conditions where the dam was built, as well as people, procedures, and equipment available at the time.

This was an opportunity I couldn't pass up, so I said, "Yes, I can do that!" I began working for the Corps under a volunteer service agreement. No pay in $$, but a great learning opportunity; and the Museum would receive a copy of the digitals to bolster their photo collection.

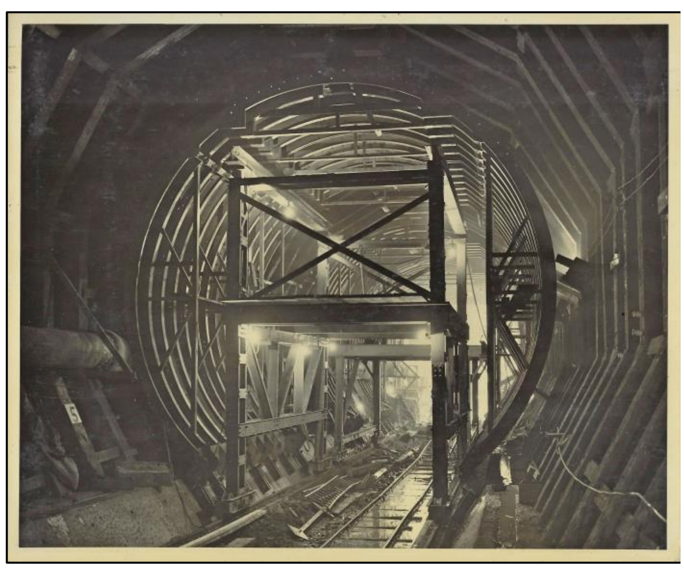
After 45 years with the firm, I'd finally get to work on a dam project. In addition, I'd learn about the complex geology in the MMD area, something I had puzzled over since 2017 when I developed a brochure for the Ice Age Floods Institute featuring Ice Age geology in the Puget Sound basin. Local MMD geology is a mix of andesite hills and ridges (one being the base of Mud Mountain) capped with clay and glacial till, and a rerouted river. The andesite hills may be as old as Mt. Rainier at a half million years. Two of the higher hills, Mt. Baldy and Mt.

Peak (Pinnacle Peak), can be spotted easily on Google Earth about 2 miles southeast of Enumclaw.

If you go to Google Earth for an aerial view of the dam, you will see the White River on its westerly course out of the Cascades. It once flowed between Mt. Baldy and Mt. Peak, but today bends around the south side of Mt. Peak. The White River may have been diverted south by a prehistoric lahar from Mt. Rainier, or it may have been pushed south about 15,000 years ago by the Canadian ice sheet as it passed by. At Enumclaw, the ice topped out at about elevation 1,700 feet, over land of 700 to 800 feet elevation. The ice sheet left a lateral moraine in the MMD area and dammed the White River valley, creating a temporary lake in which clay sediments accumulated, some on top of Mud Mountain. Then 5,700 years ago, the White River valley and land lower than Mt. Baldy and Mt. Peak was inundated by another lahar from Mt. Rainier. This one, named the Osceola Mudflow, buried the Enumclaw area and draped Mud Mountain with more mud and fragmented andesite.

The major components of the dam are the earth fill dam itself (370 feet high, 2.3 million cubic yards); the spillway; the intake works on the upstream side of the dam; and two tunnels, 9- and 23-feet diameter, which run 2,000 feet from the intake to the outlet downstream of the dam. MMD is a flood control dam, so the reservoir normally stands empty. It holds water only during prolonged periods of heavy rain, as its purpose is to prevent flooding in Auburn, Sumner, Puyallup, and Tacoma.

Work began in 1937 with site clearing, survey, geotechnical investigation, camp construction (buildings, access roads, utilities), and creating a 3-D scale model of the canyon to aid in siting and design of the dam and spillway. An interesting feature of the geotechnical investigation was Calyx drilling of 34-inch diameter boreholes so that a geologist could be lowered into the boreholes to log the sidewalls, essential to understand the nature of the andesite formation, which was heavily faulted.



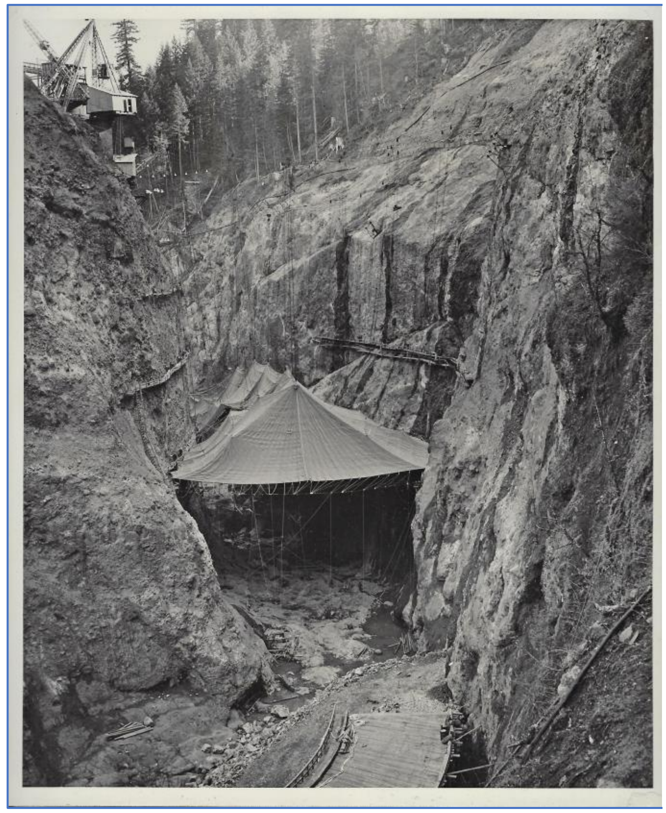
Steel forms for the concrete lining of the 23-foot tunnel.

Guy F. Atkinson was awarded the construction contract with a bid of $5.3M in August 1939. The first order of business was to construct the 23-foot tunnel to divert the river out of the canyon where the dam would be built. Access to the canyon bottom required lowering dozers and trucks down a 60-degree incline. Tunnel construction was by hard rock mining, timber shored, and lined with 2 feet of concrete. On September 1, 1940, the White River was permanently diverted into the tunnel. Construction of the 9-foot tunnel followed. Up on top, excavation of the spillway proceeded, using cable-operated shovels and steam engine-drawn side-dump rail cars.

The following photo shows most of the operation. Scaling of the canyon walls was necessary to remove all loose material and shape the walls to near vertical. The scaled material was dropped to the canyon floor where it was later trucked away. The canyon floor was cleaned of all loose material down to bedrock;

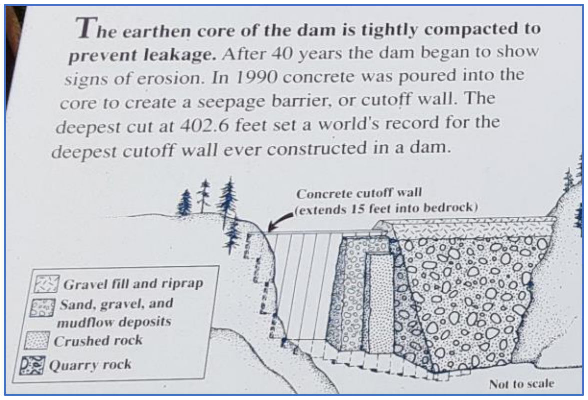
Progress view of the camp, spillway, and canyon wall.

some pockets of alluvial material were 30 feet deep. Faults and cavities were filled with concrete. Then placement of the core matrix – sand, gravel, mudflow deposits, and blue clay from the old glacial lake 2 miles distant – began. Controlling moisture content was critical. The core matrix was first dried in a 3-burner, rotating drum drying plant. A huge tent was erected over the core area to prevent rain from wetting the core as it was placed and compacted.


A huge tent shielded the core placement from rain.

On the top of the photo is the construction camp. Below that is the nearly completed spillway. The core matrix was delivered to the site by rail, then dried at the drying plant in mid-photo. Two stiff-leg derricks perched at the edge of the canyon raised and lowered construction materials and small equipment. The dried core matrix was delivered to the canyon floor, spread by a dozer, and compacted by sheepsfoot rollers. Pneumatic "pogo sticks" were used to compact tight spaces. Simultaneous with placing core material, the crushed rock filter and quarry rock shell were placed, trucked to the site by a fleet of 10- to 16-CY trucks. As the photo shows, the infrastructure to deliver materials to the dam was very complex, involving more effort than building the dam itself. Construction of the dam was interrupted by WW II with a 5-year shutdown beginning in July 1942, after which work was completed by late 1948.

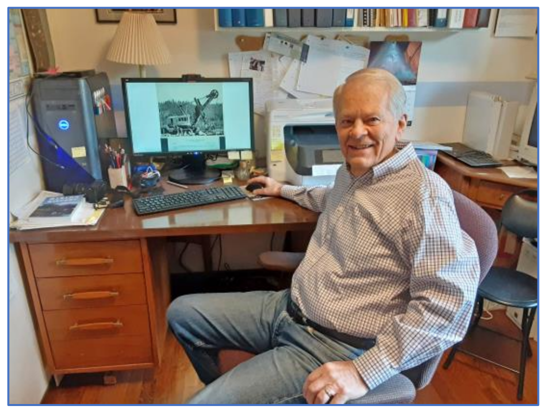
After the 1937-1948 construction, other improvements have been done at the dam. The tunnels have been relined with concrete, steel, and granite blocks, as the glacial flour-laden White River with rolling gravel and boulders is very abrasive. A new and larger intake works was constructed, as the original proved too small when floating debris (logs and stumps) blocked its limited openings. The outlet works were also modified, removing the three 84-inch Howell-Bunger (cone) valves for downstream flow control and replacing them with Tainter (radial-arm) gates for upstream flow control.



Cutaway of dam showing the core and cutoff wall.

In the 1990s, the dam core was reinforced with a 10-foot thick concrete curtain wall that extends into the canyon sidewalls. The dam spillway has never been used, as reservoir volume has been sufficient to contain the worst floods of the river.

My digitizing work is being done with home computer equipment using an HP OfficeJet Pro 8730 printer/scanner/copier and a standard Office software package that includes 'Paint,' which provides the ability to rotate and merge photos. My scanner platen dimensions are 8-1/2x14 inches. The photos are accompanied by a 2x8-inch typewritten caption below the photo, consecutively numbered, and dated. I have to make two scans, one of the photo and one of the caption, carefully trim them to align with one another, then merge them into one with a corresponding file number. The included caption also shows ownership of the photo, facilitating proper source citation. For each volume,



DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS

MUD MOUNTAIN DAM VOLUME_11_

PHOTO	DESCRIPTION	PHOTO DATE
2001	Progress view showing the grouting pipes and the concrete forms in place for the	5-Mar-41
2002	View from N1006+75, E5004+50, looking downstream showing nature of floor and fault:	7-Mar-41
2003	Progress view of the river bed rock looking downstream from N1005+75, E5001+71, ...	7-Mar-41
2004 A,B	Panorama from N1003+25, E5004+00, elevation 960, showing major fault on right	7-Mar-41
2005	View frm N1001+15, E5005+00, looking at lower end of fault on right abutment.	7-Mar-41
2006 A,B	Panorama from N1002+50, E5002+00, elevation 980, showing faults and fractures on	7-Mar-41
2007	Panorama view showing the concrete forms in the "glory hole" at the axis of the dam. .	7-Mar-41
2008	Progress view showing the last load of rock being dumped on the ramp that leads to	7-Mar-41

I create an Excel-based photo list with a brief description, making it easy for users to find any photo desired. Given these photos' unique value, I must sign a chain-of-custody form for each volume temporarily in my possession.

It takes me about 40 hours to digitize one volume of 200 photos, create the photo list, check all work, and back up files in two separate locations: an external hard drive and a portable thumb drive. A commercial digitizing process would be able to do the work faster but would be less precise. Most photos with caption are 2 to 2.5 MB apiece, so a folder of 200 totals more than 400 MB. The

Corps has no budget for archiving and digitizing; hence, their search for a volunteer. I am required to turn in a monthly timesheet.

As of mid-December 2021, I am just over half done with the project, having digitized 2,400 photos. In digital format, these photos will be available to not only the Corps and the Museum, but also to students, geologists, engineers, researchers, and the general public through the Museum.

I expect to complete the work by May 2022. And later in 2022, I plan to create a photo exhibit of MMD construction for the Museum. Hundreds of people from the Enumclaw area worked at the dam, so this will be a useful museum asset. Altogether, this has been a very interesting project to round out my engineering career.

Art Storbo