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III. **Project to be discussed at this site:**

We will be presenting information on the Calaveras Dam Replacement Project (CDRP). The Calaveras Reservoir is the SFPUC's largest local reservoir and it allows for storage of 96,850 acre feet, providing 40 percent of local water storage and 66 percent of local water yield. In 2001, the SFPUC lowered water levels due to seismic safety and a mandate from the Division on Safety of Dams and the Reservoir is currently operating at approximately 40 percent of historic capacity.

The primary objective is to build a replacement dam and new appurtenant works that meets current seismic safety standards and could accommodate a potential future dam enlargement. The new compacted earth and rock fill Dam is being constructed immediately downstream of the existing dam. The projected substantial completion date is October 2018 for this $718M project.

The project is part of the San Francisco Public Utilities Commission (SFPUC) $4.8B Water System Improvement Program (WSIP) to repair, replace, and seismically upgrade our facilities from the risk of earthquake damage. There are 83 projects including: pipelines, tunnels, dams, reservoirs, pump stations, storage tanks, and treatment facilities. Over 85 percent of the WSIP projects are completed.
IV. **Purpose of the project in relation to system performance objectives:**

The project consists of building a new zoned earth and rock fill dam immediately downstream of the existing dam. This work will restore the Calaveras Reservoir to its historic capacity. The reservoir provides approximately half of the Hetch Hetchy Regional Water System’s local Bay Area water storage. This storage is crucial to provide adequate water to our customers in times of drought and when Sierra Nevada resources are not available.

The completion of the replacement dam and appurtenant works will:
- Improve seismic reliability
- Restore reservoir capacity to pre-2001 level of 96,850 acre-feet
- Re-establish water delivery reliability
- Accommodate potential future enlargement
- Maintain high water quality

V. **Description of what was built, or is being built:**

Construction began in 2011 to build a new earth and rock fill dam adjacent to the existing dam. To date, the Contractor has moved over six million cubic yards of earth and rock materials and started to construct the new dam. Crews have constructed a new shaft and five adits (tunnels) which connect the outlet pipelines to the reservoir. We have completed grouting operations on the right abutment and started grouting work on the left abutment. Over 200,000 pounds of cement grout has been injected into the left abutment. Major work on the new concrete spillway has begun. Over 22,000 cubic yards of concrete has been placed in the new spillway structure. As of March 2015, the project is approximately 68 percent complete.

- The new dam will have a structural height of 220 feet, a crest length of 1,210 feet, and a width of 80 feet at the crest and 1,180 feet at the base
- More than 10 million cubic yards of excavation is required to construct the new dam - This is equivalent to more than 1,550 football fields buried one yard deep. Approximately 3.5 million cubic yards will go into the construction of the new dam, including a buttress fill to stabilize an existing landslide
- The new spillway will be 1,550 feet long utilizing 40,000 cubic yards of concrete
- Upon completion the Calaveras Reservoir will be restored to its historic nominal storage capacity of 96,850 acre feet (31 billion gallons)
- The new dam will allow us to release water into Alameda Creek in a manner that controls water temperatures and flow rates depending
upon the life cycle needs of the fish. We will also install fish screens and a fish ladder at the Alameda Creek Diversion Dam to support the restoration of Steelhead Trout to the Alameda Creek Watershed

- A new intake/outlet shaft tower will be constructed, consisting of a 20-foot diameter by 163-foot deep vertical shaft and three new adit tunnels. This inlet/outlet structure will convey water to and from the reservoir through a 72-inch diameter steel lined tunnel and a 78 inch diameter pipeline downstream

- 90 percent of the materials for the new dam will come from on-site borrow areas, and approximately 300,000 cubic yards of sands and gravels will need to be imported to the site for construction of the internal filters and drains within the zoned embankment dam.

VI. Engineering/Project Management/Environmental Challenges in Design, Construction, Testing, and Implementation:

In June 2012, we discovered some unexpected geologic features during excavation of the left abutment area. These uncovered geologic features were not visible at the ground surface during the extensive geotechnical investigation work performed during the planning and design phases of the project. The findings resulted in over three million cubic yards of additional material that had to be moved to ensure the long-term stability of the slope during the performance life of the dam. More than 10 million cubic yards of excavation and earthwork placement is required to construct the new dam. As of March 2015, over six million cubic yards of material has been moved.

Besides challenging geologic conditions, control of the Natural Occurring Asbestos (NOA) on site is another big environmental challenge. Due to the existence of NOA in some of the rocks on site, a Comprehensive Air Monitoring Program was developed at the beginning of the project to ensure proper protocol is in place to protect both workers and public health. While the protocol has been implemented successfully since the start of the project there are challenges in meeting the requirements without affecting project productivity.

VII. Lessons Learned from an Engineering/Project Management Perspective:

- Adverse Weather Days: Specifications include only 14 working days of adverse weather day allowance for each year. For a Heavy Civil Project like CDRP, this is not enough because it is not just the number of rain events to be considered, there is also the subsequent
consequential impact of the rain event, i.e. extremely difficult access translating to work safety hazards, etc. Although we have been in drought for the past several years, all the allowed adverse weather days in the contract have been exhausted. We learned that we should increase the Contract Adverse Weather Day Allowance to at least 30 working days per year with stipulation that any un-used weather days be rolled over from one year to the next, not just from any month with in the same year where it expires at year’s end. The idea is to convert any un-used weather days in any given year to a float that belongs to the whole project.

• Preconstruction Work: Prior to start of construction and before the contractor came on board, SFPUC worked with PG&E to upgrade the site power to prepare for the contractor’s work. This would help to alleviate schedule impacts. Due to the delays in environmental permitting and later impacts by PG&E scheduling, power upgrades were not completed at construction NTP, which impacted both the construction schedule and budget. We learned that we should clearly outline a plan for early completion of this work and develop adequate contingency measures in the event of delays.

• Construction Schedule: An aggressive construction schedule was developed in the design phase. While this led to a good bid price, the risks of the planned construction sequence were not well understood at the time of bid. For example, finding differing site conditions at the left abutment changed the construction sequencing and extended the project schedule by more than three years. Originally, the left abutment was planned to be temporarily excavated with a false cut, but due to the unexpected geologic features found at the left abutment the temporary cut slope was found to be unstable, resulting in a further layback of the slope and significant additional excavation. It also required temporary storage and stockpile of over one million cubic yards of material. Better understanding of risks and risk ownership of aggressive construction sequences should be considered when they become part of the construction documents.
VIII. CDRP Materials Attached for Use in Workshop Participant Binders and Posting to BAYWORK Website:

- Calaveras Dam Replacement Project Fact Sheet
- Dam and Spillway Excavation
- Dam Construction
- Project Footprint
- Cross Section of Replacement Dam
- Aerial Photo (Labeled)
- Environmental Awareness Training Sheet
- Naturally Occurring Asbestos Visitors Site Training