

Lake Oroville Spillways Emergency Recovery

Board of Consultants Memorandum No. 5 – April 25, 2017

Prepared by the California Department of Water Resources

Summary & Response

Question 1

Self-Explanatory

Question 2

Question 2 relates to the steep rock slopes that resulted adjacent to the main spillway chute and were a result of the scour from flows through the damaged spillway chute. The BOC is describing and in agreement of the approach to flatten the slopes.

Question 3

Question 3 relates to design details associated with the new design of the conventional and roller compacted concrete spillway chute of the main spillway gated structure. Much of the discussion revolves around construction methodology and sequencing. The BOC also has comments associated with the design details of the new drainage system.

Question 4

Question 4 mainly relates to the earthquake parameters and resulting loading criteria which will be used for designing the structures. The BOC agrees with the approach presented by DWR.

Question 5

Question 5 relates to the construction sequencing associated with the upper spillway chute. The BOC also recommends criteria for strengthening the upper chute that not be repaired this construction season.

Question 6

Questions 6 relates to the details associated with the emergency spillway. Specifically the BOC is recommending the DWR pay special attention to ensure the new secant wall is embedded in good rock that is not erodible.



OROVILLE EMERGENCY RECOVERY – SPILLWAYS

Board of Consultants Memorandum

DATE: April 25, 2017

TO: Mr. Ted Craddock, Project Manager
Oroville Emergency Recovery – Spillways
California Department of Water Resources

FROM: Independent Board of Consultants for
Oroville Emergency Recovery – Spillways

SUBJECT: Memorandum No. 5

INTRODUCTION

On April 24 and 25, 2017, the Independent Board of Consultants (BOC) met at offices of the California State Department of Water Resources (DWR) for a presentation of design criteria, further development of design concepts by DWR, the status of Construction Contracts No.1 and No. 2, and concepts regarding sequencing of construction on the Upper Chute replacement. The meeting ended on April 25 with a reading of the BOC's draft report at 3:20 pm. An agenda for the meeting is attached. All active BOC members were present; we note that BOC member Jack Cassidy resigned this week due to health issues. The BOC met with representatives of DWR Engineering Division, DSOD, FERC, and industry consultants that are working on the Oroville Spillway Recovery project; the attendees at the meeting are shown on the attached Attendance List.

The BOC has reviewed the status of past comments and recommendations in the log and this is included in the attachments. The BOC will provide comments on the status of the project Design Team responses to its recommendations, and closure, where appropriate, in a future submittal.

QUESTIONS FOR THE BOC

1. Does the BOC have any recommendations or comments on Construction Contract No. 2?

Response

The BOC is pleased to learn that Contract 2 has been awarded and that the Contractor is ready to quickly start. The fact that the Contractor has just come off

a similar spillway construction job is a favorable factor, and that his lead staff recognize the importance of the design details and specifications in the restoration of this vital facility. The suggested modifications that the Contractor has proposed during post-bid meetings with the Design Team are generally considered improvements that can speed up construction and, for the most part, appear acceptable. Specific discussion of design details for the spillway construction under Contract 2 are found in the response to Question 3.

2. Does the BOC have any recommendations or comments on Construction Contract No. 1?

Response

The BOC received an update regarding Contractor activities on Construction Contract 1. The plan for stabilizing the steep slopes above the scour hole (Stations 29+00 to 33+00) has been formalized into a combination of partial slope layback and partial fill-in with concrete. Drilling and blasting have been added to Contract 1 to expedite the slope stabilization activities. The drilling and blasting plan for excavating and laying back the upper slopes to a stable inclination was described as a two-phase sequence. In this approach, the Contractor will first proceed to excavate the inboard Zone 1 using vertical blast holes drilled to a pre-determined grade. The BOC observed videos of a test blast of an initial portion of Zone 1, which showed that minimal blast material debris fell off the slope and into the scour hole. Once Zone 1 is removed, then angled borings will be used for the blasting of Zone 2 along the top of the slope. The BOC endorses this excavation concept.

As the Contractor for Construction Contract 2 has just been selected and the lower scour hole slope will be stabilized in Contract 2, no details were presented on the cleanup and backfill of the large scour hole and stabilization of the base of the steep slopes.

3. Does the BOC have any recommendations or comments on Spillway Design Details?

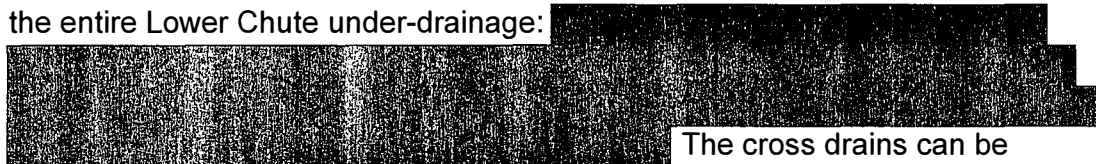
Response

The BOC believes the Design Team's decision to delete the Type 4 training wall design, which was to be used within the RCC "bathtub" or "shoulders" of the RCC Lower Chute section, is a very beneficial modification. The deletion of this wall type will make for more uniformity in the wall design and facilitate the Contractor's operations. It also eliminates the bottleneck the Contractor will have in his placing operation on these small upper portions of the RCC cross-section.

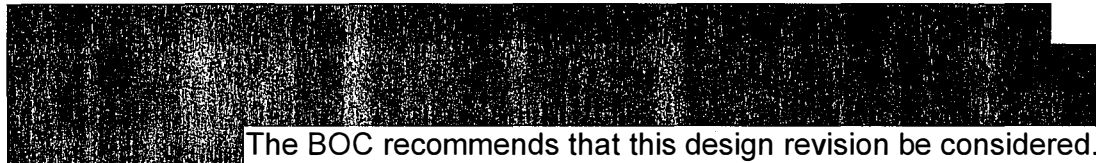
This is particularly true on the right side where rock is the abutment contact. Although the RCC infill section might be made smaller with the elimination of the shoulders, the BOC recommends that the width of the RCC foundation remain as wide as currently shown. The extra space will prove useful.

The Design Team has chosen to include the cross drain chute under-drainage in the RCC foundation portion. The BOC does not consider drainage of this interface necessary but has no objection to including the standard chute drain detail throughout this chute section founded on RCC.

Including drains in the RCC section presents a problem with routing the collector drain pipe, which will require a support system on the exposed outside wall on the left side training wall. The BOC offers a suggested solution that could simplify the entire Lower Chute under-drainage:

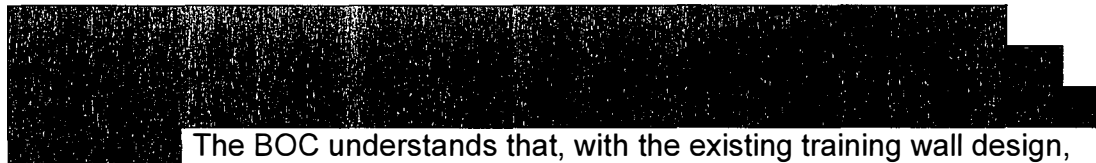


The cross drains can be installed with a slight gradient toward the ditch exit, although it is doubtful this would be needed for them to function.



The BOC recommends that this design revision be considered.

This drain modification is worth consideration as a measure for improvement of the existing Upper Chute section during the interim period until its replacement.



The BOC understands that, with the existing training wall design, backfill is needed for wall stability for the design load case of full PMF flow in the chute.



The new training walls for the restored chute are designed to be adequate without backfill.

The Contractor's preference for a straight back slope on the training walls makes sense. The change in chute panel dimensions also should be acceptable as it eliminates a longitudinal joint along the entire length. The BOC accepts the panel size increase to 30-foot by 37-foot-6-inches, as suggested by the Contractor.

A new conceptual detail for the transverse contraction joints in the slab was presented using a slanted joint with the upstream slab serving to lock the downstream panel from uplifting. The BOC has no objection to this modification if it is adopted.

[REDACTED]

[REDACTED] Other design changes, including greater thickness for the slabs of the Upper Chute, and specifying larger bar sizes for slab reinforcement and anchors, will provide greater conservatism of the design and are examples of these defensive means.

It was mentioned during the meeting that the dentate blocks on the energy dissipation structure will need repair but no design details were given. Concrete in the damaged areas will be hydro-blasted to expose reinforcement, and new concrete added to restore the original design lines. Enough concrete needs to be removed to create a large enough volume of repair concrete that has adequate reinforcement and dowels to properly adhere to the mass block.

The BOC has a number of concerns regarding details of the RCC chute foundation reconstruction in the scour hole locations. The Contractor has stated their intent to place RCC starting at the bottom of the erosion holes. The BOC is of the opinion that it will be necessary to first build up a suitably level and wide enough RCC working surface with conventional backfill concrete in order to effectively compact the RCC with equipment. Certainly, the large blocks of rock seen in the bottom of the upper erosion hole will need to be removed and the bottom effectively cleaned up in order to place RCC at such depth. However, some of this rock debris could be left in place and incorporated into a conventional concrete backfill.

The drawings show that an application of cement grout is to be used at the contact of RCC lifts with the foundation rock when the contact is at a shallow angle. The BOC does not consider this necessary for the purpose of placing RCC to rebuild the chute foundation.

The Contractor is required to demonstrate compaction of RCC on a 25% slope with a heavy vibratory roller during the construction of the RCC test pad. The BOC understands that the lifts of RCC are placed horizontal and the ends of the lifts form the 25% slope on which the compactor needs to roll for final compaction. This operation will require several lifts to be placed and then

trimmed to the proper slope and compacted before the RCC is allowed to set. The BOC foresees some difficulties with this operation particularly when the depth of the RCC to be placed is only 3 or 4 lifts in height above the rock. The Contractor should be allowed the option to use conventional concrete to achieve the final slope ready for the structural concrete slab.

4. Does the BOC have any recommendations or comments on Technical Memoranda?

Response

The BOC was informed that a number of Technical Memoranda in “Draft or Draft Final” versions were placed in the BOC’s folder for its review. A number of the documents included Design Criteria Memos that are intended to guide the design of the various features and components of the repair project. Other documents provided the basis for design and supporting material for the design of the various structures. The BOC was requested to provide its input on the drafts of design criteria memoranda; other documents were provided for the BOC’s review and comment where appropriate.

Two design criteria memoranda were provided in draft versions: Structural Design Criteria (SRT-ORO-ST-01), and Geologic/Geotechnical Design Criteria (SRT-ORO-GE-01) Memos. The BOC had reviewed earlier drafts of the Design Criteria Memos and provided its comments and recommendations in its reports of earlier meetings.

In addition, three reports providing estimates of ground motions and acceleration time histories were prepared to provide input to seismic analyses of the retrofit designs. These included: Recommended Earthquake Ground Motion Estimates for Design (SRT-ORO-ST-03) dated March 16, 2017; Revised Earthquake Ground Motion Estimates (SRT-ORO-ST-12), dated April 4, 2017; and Acceleration Time Histories for Oroville Dam Flood Control Outlet Structure Non-Linear Stability Analysis (SRT-ORO-ST-12) dated April 10, 2017.

The March 16, 2017 report provided an update of the ground motions (reported in the 2012 STID), using the 2014 Next Generation Attenuation (NGA-West 2) relationships. The updated ground motions indicate a reduction in the estimated median peak ground accelerations at the site from 0.57g (in 2012) to 0.38g. It is the BOC’s understanding that the Design Team has opted to use the originally estimated PGA value for the long-term seismic design of the repairs. The BOC considers such an approach conservative. However, the report describing the

selection of time histories for use in the non-linear dynamic analysis provides three sets of three-component time histories that were spectrally matched to the updated median response spectra with a PGA of 0.38g, This approach is considered reasonable and appropriate, considering that the return period for the median PGA is about 6,000 years (based on the results of the USGS probabilistic seismic hazard analyses).

The BOC did not have time to review the documents provided for review during this meeting; additional comments may be forthcoming.

5. Does the BOC have any recommendations or comments on the Upper Chute Construction Sequencing?

Response

In technical memorandum "SRT-FCO-DOC-06 FCO Upper Chute Construction Sequence and Phasing," the Design Team has documented the thinking behind their recommendation for the sequence of construction of the replacement FCO Upper Chute section and how it fits with the completion of the Lower Chute restoration. Essentially this calls for completion of the RCC foundation restoration and reinforced concrete chute with training walls for the full length of the Lower Chute section by November 2017. Construction of the replacement Upper Chute section would proceed from the downstream end as time allows during 2017 with the goal of completion in 2018. The BOC concurs with the adoption of this construction approach and urges that this sequence of construction be agreed to with the Contractor. It is understood that the existing Upper Chute and training walls will require further investigation as to the character of the foundation rock and measures to strengthen and repair the concrete chute slab to safely serve in the interim until its replacement.

The current plan is to use the remaining, undamaged portion of the of the Upper Chute spillway for 1 or 2 seasons until it can be demolished and replaced. The BOC recognizes that evaluation criteria for the remaining components are still being evaluated and some general concepts were discussed. [REDACTED]

[REDACTED]

[REDACTED]

The scope of work required and the design details to be used for strengthening the existing Upper Chute have not been fully delineated.

6. Does the BOC have any other recommendations or comments for the Design Team?

Response

The potential for erosion to occur on the northern-most Emergency Spillway slope should be addressed in the design. The secant wall columns will each be founded on slightly weathered rock with the final depth to be determined by actual conditions encountered during installation. However, deep weathered zones in bedrock, that have shown to be erodible, appear to cross the area downstream of the Emergency Spillway. Any such weathered zones on the unprotected rock slopes that will receive Emergency Spillway flow should be: 1) located as part of the geologic exploration; and 2) their erodibility and effect on secant wall stability should be addressed in the design.

BOC RECOMMENDATIONS SUMMARY

M5-1 The BOC concurs with the elimination of training wall Type 4 and the supporting RCC shoulders in the downstream chute section. All training walls will have the same general configuration.

M5-2 [REDACTED]

[REDACTED] The BOC considers this drainage concept a simpler design to construct, easier to inspect and maintain and fully functional.

M5-3

[REDACTED]

M5-4

The BOC concurs with the chute slab design changes which include a greater slab thickness throughout the length of the chute, heavier reinforcement and anchor bar sizes, and accepts the somewhat larger panel dimensions.

M5-5

The use of cement mortar at the foundation rock RCC contact is unnecessary where RCC is placed for the FCO chute support.

M5-6

The BOC has concerns that placing RCC and compacting on a 25% slope will be a difficult construction operation especially where the thickness of RCC over rock foundation is small. It is recommended that conventional concrete be allowed as a leveling bed on the RCC surface where needed.

M5-7

The BOC suggests continued analysis of erosion potential, and considers that assessment of conditions of the unprotected rock slopes downstream of the Emergency Spillway cutoff walls is warranted.

Respectfully submitted,

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