

OROVILLE COMPREHENSIVE NEEDS ASSESSMENT

Independent Review Board Memorandum

DATE: December 14, 2018

TO: Mr. Sergio Escobar, Project Manager
Oroville Comprehensive Needs Assessment
California Department of Water Resources

FROM: Independent Review Board for
Oroville Comprehensive Needs Assessment

SUBJECT: Report No. 3

On Thursday December 13, 2018, the Independent Review Board (IRB) met at the Office of HDR in Sacramento at 9:00 am for briefings regarding progress on the Comprehensive Needs Assessment (CNA). The IRB met with representatives from the DWR Division of Engineering (DOE), DWR Division of Operations and Maintenance (DOM), Division of Safety of Dams (DSOD) the Federal Energy Regulatory Commission (FERC), and industry consultants working on the CNA to discuss:

- Progress on developing evaluation criteria,
- Progress on Tasks 1, 2, 4 and 6,
- The upcoming FERC Part 12 Level 2 Risk Assessment,
- Update on the outline for the Final Report,
- The IRB Comment Log and status of the IRB recommendations, and
- Open discussion of the status of the CNA study.

During the morning of Friday December 14, 2018, the IRB deliberated and prepared a draft of this report. Comments made on the individual presentations and the IRB's responses to DWR questions for the IRB are included in this report. A reading of the IRB's draft report was made to representatives from DWR, DOE, DSOD, FERC, DWR DOM, and industry consultants working on the project at 12:00 pm. The meeting was adjourned following the reading of the report.

All IRB members were present on both days including (Elizabeth) Betty Andrews, Lelio Mejia, Bruce Muller, Dan Wade and Paul Schweiger. A list of meeting participants for both days is attached.

QUESTIONS FOR THE IRB

1. Does the IRB have any recommendations or comments on the evaluation criteria/progress?

Response

The IRB applauds the Project Team's thoughtful and deliberate process to identify an appropriate evaluation framework for the CNA, including the process to develop the measures and formulate the plans that will form the portfolio of alternatives for consideration by DWR leadership. The presentations identified requirements for the evaluation process that the IRB believes are appropriate and necessary.

The IRB is pleased that the Team has turned to DWR's Asset Management framework for purposes of assessing risk. Adapting this approach will be readily understood within DWR and has already had the benefit of considerable thinking and vetting through application, in addition to the other supporting reasons cited by the Team. The IRB also believes that this framework is particularly appropriate for evaluating consequences that are subject to uncertainty, whether evaluated quantitatively or semi-quantitatively. The IRB recommends further development of the evaluation framework in the near term to include additional consequences or outcome categories, including beneficial project outcomes. The Team's development of descriptive definitions of scales for each outcome category will be important to fully laying out the evaluation framework.

In adapting the Asset Management framework to the purposes of the CNA, the IRB suggests that the CNA Team consider revising the language used to represent likelihood to express it more clearly, perhaps turning to the language of probability.

2. Does the IRB have any recommendations or comments on the Task briefings?

Response

The IRB appreciates the opportunity to receive updates on many of the CNA Tasks and recognizes the considerable effort that has already gone into defining

and refining the issues, objectives, and constraints for each task. Based on these presentations, the IRB recommends that the integration team develop a common and consistently applied terminology and approach to defining and articulating issues (aka problems or needs), objectives, and constraints across the project. The IRB suggests that the CNA Project Team consider using readily-understood terms to describe constraints, such as “hard constraints” for “non-violable constraints” and “soft constraints” for “violable constraints.”

The IRB suggests that issues be expressed clearly, consistently and in a manner that is focused on what the CNA measures will address. The IRB believes that objectives should focus on outcomes rather than process.

The IRB recommends that a minimum set of hard constraints be identified as an essential first step to establishing absolute requirements for measure and plan viability. One or more tiers of soft constraints may also be identified. These soft constraints may represent different levels of importance (e.g., conditions to be met if possible versus conditions that are desirable to meet) or have varying importance over time (e.g., in the near term, the requirements of the Water Control Manual must be met, but they may change in the future). The IRB recognizes that the Project Team’s initial identification of constraints as soft and hard may change as the study proceeds. Where regulatory requirements are uncertain, the IRB recommends that a well-informed assumption and justification for those requirements be articulated and reviewed with the responsible agency(ies) for their comment and concurrence, prior to engaging in measure development.

The IRB recognizes the significant challenge posed by the need to rapidly advance each Task in parallel and yet foster a degree of consistency between them in terms of terminology and approach. To this end, the IRB recommends that the Integration Team develop a standard format for the tables of issues, objectives, and constraints that each Task Team can populate using a common terminology and formulation approach.

On a similar note, the IRB recommends that all task names and other task-level references be revised to replace “Alternatives” with “Measures.” It is confusing to use these terms differently than they have been defined elsewhere in the project documentation.

Task-specific comments follow.

Task 1 – Alternatives Evaluation to Restore Spillway Design Capacity to Pass the Probable Maximum Flood (PMF).

In IRB Report No. 1, the IRB recommended that the title of Task 1 be revised from “*Alternatives Evaluation to Restore Spillway Design Capacity to Pass the Probable Maximum Flood*” to: “*Alternatives Evaluation to Ensure Spillway Integrity to Safely Pass the PMF*”. Based on the Task 1 presentation and upon further consideration, the IRB recommends that the title to Task 1 be revised to “*Evaluating Measures to Enhance Spillway Reliability and Resiliency*”. As currently stated, the title implies that spillway discharge capacity has been lost and needs to be restored and that the current spillway configuration is unable to pass the PMF. The latest PMF hydraulic analysis appears to indicate that the combined discharge capacity of the FCO and the Emergency Spillway have adequate capacity to pass the PMF with freeboard and that overtopping of the embankment during the PMF is not a concern, although other reliability issues still need to be evaluated. The title may also imply that a determination has been made that the spillways do not meet current industry design standards and may not fully reflect the substantial structural improvements that have recently been made to both spillways. The current spillway system may, in fact, meet or exceed accepted industry standards. As stated in the most recent *Federal Guidelines for Selecting and Accommodating Inflow Design Floods for Dams (FEMA 94 /August 2013)*;

“Service spillways should be designed for frequent use and should safely convey releases from a reservoir to the natural watercourse downstream of the dam. A service spillway should exhibit excellent performance characteristics for frequent and sustained flows, such as up to the 100-year flood event. In general, service spillways should pass design flows without sustaining any damage.

Auxiliary spillways are usually designed for infrequent use. It is acceptable for an auxiliary spillway to sustain limited damage during passage of the IDF provided it does not jeopardize the structural integrity of the dam or the function of the spillway. Reference to these spillways as “emergency spillways” should be discontinued. Media references to flow through “emergency spillways” often leads to a misconception by the public that an emergency condition exists at a dam when the dam is safely functioning as designed.”

The IRB agrees with the concerns noted in the Task 1 presentation related to the spillways and that these concerns need to be investigated and potentially addressed as part of the CNA including:

- When activated, is the erosion of the Emergency (Auxiliary) Spillway channel downstream of the newly-constructed secant pile cutoff wall acceptable, or do the environmental impacts and impacts to other project features such as the tailwater depths at the Hyatt Powerplant need to be addressed?
- When activated, how much damage to the Emergency (Auxiliary) Spillway structures is acceptable and does the Emergency (Auxiliary) Spillway have adequate integrity to prevent breaching of the control section(s) for flows up to the PMF?
- Is there a need for additional cavitation damage defense measures in the FCO spillway chute for flows exceeding approximately 160,000 cfs such as providing an aeration ramp?
- Is the discharge capacity of the FCO adequate to meet future operational and regulatory requirements?

To evaluate and address these concerns, and other concerns that may emerge from the upcoming Level 2 Risk Analysis, the IRB encourages the Task Team to develop performance standards that are required for the FCO and Emergency (Auxiliary) spillways (hard constraints) along with performance enhancements that are desired or important, but not essential (soft constraints). Obtaining early consensus on the non-violable constraints is important and will enable the Task Team to focus their study effort and limited resources on developing the most appropriate enhancements to the spillways.

In the current list of problems and needs that form the basis for Task 1 measures it is noted that the FCO spillway alone does not have the capacity to pass the PMF, that flows are uncontrolled over the Emergency (Auxiliary) spillway, and that the existing capacity of downstream flood control channels is limited. The IRB does not perceive these facts by themselves as being issues (problems or needs) and suggests that they be restated or elaborated to define the underlying issue.

The IRB was pleased that the Project Team will be quantifying the extent of erosion damage that can be expected downstream of the Emergency (Auxiliary) Spillway secant pile wall should the spillway be activated. The IRB believes that it is important to understand the geology downstream of the secant pile wall to effectively complete this study. The IRB recommends that the Project Team identify and assess data gaps related to the geology of the affected overflow area between the secant pile wall and the river, and collect any additional data needed to support the recommendation of measures.

Task 2 – Operational Needs Assessment to Support Development of Alternative Reservoir Outflow Enhancements.

Although the IRB anticipates that the five issues and corresponding objectives presented for Task 2 will be reformulated according to the common strategy as noted above, the IRB recognizes that operational issues would seem to intersect with all other tasks. A complete assessment of the issues is needed before developing measures under this task. Furthermore, the IRB encourages refinement /sorting of the constraints into soft and hard as stated above.

In the presentation it was noted that “relevant” physical changes to the dam and reservoir system since 1970 should be identified and then it should be determined which of those changes should be incorporated into flood operations procedures. If there have been physical changes to the dam and reservoir system since 1970, it would seem reasonable to incorporate them into updated flood operations procedures and eventually into the USACE Water Control Manual (WCM). The IRB suggests adding the WCM to the glossary to explain what it is and to also recognize it a reference.

The IRB understands from the presentation that a strategy to incorporate climate change considerations is currently being developed and is pleased to learn that a study commissioned by DWR for the Central Valley Flood Protection Plan Update 2017 may assist in evaluation of climate change considerations while acknowledging the considerable uncertainty associated with potential climate change impacts.

Task 3 – Flood Control Outlet (FCO) Enhanced Reliability.

While not on the agenda, the IRB was pleased to hear an update indicating that a contract and work plan to perform stress analysis of the FCO as part of the FERC Part 12D effort was nearing completion. The scope of work includes on-

site performance-based testing to establish key characteristics of the FCO that can be used to validate the formulation of the analysis model.

Task 4 – Alternatives Evaluation for Low-Level Outlet.

The Task 4 presentation was very informative and well-received by the IRB. The graphic presenting the issue statement, objectives and constraints as well as the example tabulation of objectives and constraints is well-formulated and helpful. The IRB suggests that consideration be given to revising the issue statement to specifically address redundancy versus reliability for various measures to be considered. That is, when measures are evaluated, it will be important to determine which measures provide redundant drawdown capability as a strategy to achieve reliability, versus which measures are necessary to assure reliability of the FCO for evacuation of the upper reservoir without relying on redundancy.

The identification of constraints listed in the presentation graphic demonstrates a good understanding of what the IRB considers to be true “constraints” as compared to “considerations”. Some of the “constraints” listed subsequently in the presentation are really “considerations” or “issues” that need to be addressed during the evaluation process. The IRB encourages further refinement /sorting of constraints into “considerations” and soft and hard “constraints” as stated above. The IRB suggests de-emphasizing the focus on regulatory requirements as these requirements are in place to ensure good engineering practice (focus on the appropriate engineering considerations).

The IRB suggests editing objective T4-3 to focus on both capacity and “flexibility” for routine reservoir operations.

The reservoir drawdown calculations that were presented include a number of important assumptions that need further evaluation to establish their validity. Assumptions regarding outflow capacity could be influenced by tailwater elevation. The IRB recommends that the interaction of the FCO, River Valve Outlet System (RVOS) and Hyatt Powerplant (Hyatt PP) be fully defined to determine whether there is an FCO release level that could potentially incapacitate the Hyatt PP and/or RVOS due to excessive tailwater elevation. A graphic that provides RVOS and Hyatt PP elevations and key tailwater elevations would help in the evaluation.

The IRB recommends consideration be given to basing Hyatt PP capacity on seasonally adjusted historical generating unit availability data, and that inflows be seasonally adjusted based on historical monthly inflows.

The presentation listed different combinations of gates as “full open” for preliminary evacuation calculations. The IRB suggests presenting this information as selected flow rates that are significant to either downstream channel capacity or key tailwater elevations. Full open flows of differing number of gates would be highly unlikely due to the potential hydraulic and structural concerns it would create. The IRB recommends that structural considerations be explicitly addressed with respect to allowance for unbalanced operations of the gates.

As some low-level outlet measures would introduce some very challenging construction methods, the degree of construction risk should be considered in the evaluation of feasible measures. Introduction of measures should be evaluated for potential unintended consequences, for example whether rapid reservoir drawdown would introduce upstream embankment stability issues.

Task 6 – Instrumentation and Monitoring for the Oroville Dam Complex.

The Task 6 briefing provided an informative overview of the task objectives and progress to date. The work has included a review of information on the instrumentation installed at the dam, the FCO structure, other facilities, and a review of the historical monitoring data. The assessment of instrumentation needs included examining the relation between instrumentation monitoring and Potential Failure Modes identified as part of the 2014 FERC Part 12D safety inspection of the dam. The IRB was pleased with the thorough briefing and offers the following comments for consideration by the Project Team.

The IRB notes that the document review to date has focused primarily on information related to the instrumentation and monitoring of the civil works and understands that efforts are proceeding with review of instrumentation and monitoring for electrical and mechanical systems. The IRB encourages the team to focus on those systems that are critical to the safety of the facilities, including systems necessary for the safe operation of the FCO, the Hyatt PP, and the RVOS. The IRB believes that periodic testing of the FCO gate trunnion anchors is critical to the safety monitoring of the facility and suggests that it be reviewed and documented as part of the task scope.

The document also tends to focus on physical instruments. The IRB recommends that the scope of Task #6 be expanded to include visual monitoring of the performance of the dam.

The need for instrumentation of reservoir inflows was discussed during the meeting. Inflows are inferred from water balance calculations and inflow forecasts draw from an extensive networked system of weather stations and streamflow gages within the watershed. The IRB suggests that the accuracy of these forecasts be examined based on performance during past storms, and that protocols for dealing with loss of communications and data feed from the network be examined.

The IRB is pleased to know that the team is considering the use of new technologies for instrumentation, monitoring and data management, and suggests that such considerations extend to data interpretation.

3. Does the IRB have any recommendations or comments on the Part 12D Level 2 briefing?

Response:

The effort to conduct the Level 2 Risk Analysis (separate effort as part of the FERC Part 12D process) will benefit the CNA Study by providing baseline risk information and an established framework for development of risk reduction measures. The IRB was provided the proposed plan for the Level 2 Risk Analysis. The complexity of the Oroville facilities and the limited availability of trained personnel to conduct complex risk analyses for dams require careful consideration of the process and staffing of the effort. The proposed process has been modeled upon a well-established process that has been used and refined in the federal sector for nearly 20 years. The US Society on Dams has presented a course on best practices for risk analysis of dams which forms the basis for the Oroville Dam risk analysis.

Staffing of the risk analysis effort is critical to ensure both independence and credibility. Facilitators, subject matter experts, recorders, and reviewers with substantial experience in both dam engineering and risk analysis of dams have been assembled. The proposed risk analysis has been partitioned in a way that will ensure that participants in each segment will have the specialized subject matter expertise to develop credible semi-quantitative estimates of risk.

The IRB will be represented during the risk analysis workshops. Several members may observe as a means of gaining a better understanding of the results of the process. The IRB looks forward to reviewing the results of the risk analysis workshops and the potential risk reduction measures developed by the various task teams.

4. Does the IRB have any recommendations or comments on the final report outline?

Response:

The IRB is pleased that the Project Team has adopted the principle of “begin with the end in mind” and has begun outlining the final report. The draft final report outline is taking shape nicely and defines the content of the key deliverables and will benefit the project by identifying many of the subtasks that are necessary to complete the deliverables. The IRB understands that the report outline provided for review is a work in progress and that the content will be expanded as the project progresses. Below are some comments to help develop this document.

1. Priority should be given to developing similar outlines for the individual Task Reports (6 Task Reports) that will be presented in Appendices D through I.
2. The IRB appreciates that a section describing the 50-year operational history will be included in the report. Consider adding a subsection within Section 2.1 of the report documenting the history of significant modifications made to the project from its original construction to the present along with a brief description why each modification was made.
3. Consider also making additions to Section 2 – Introduction and Project Motivation to discuss at a high level the overall CNA project approach (add Section 2.3) and report organization (add Section 2.4).
4. Include a brief description of why the six tasks were selected as the focus of the study.
5. References are made to “restoring” the project and “to bring Oroville Dam to its original design level of safety”. Many features of the project, such as the FCO spillway chute and the Emergency (Auxiliary) Spillway have been significantly improved to meet or exceed current design standards and now surpass the original design level of safety. Since the focus of the CNA is to identify areas of residual risk and evaluate potential enhancements to further reduce risk and improve

reliability and resilience, consider describing how and why the design practice and standards have evolved since 1969 for key project features, and emphasize that the goal of the CNA is to ensure Oroville Dam meets or exceeds current design standards.

5. Does the IRB have any recommendations or comments on the IRB Comments Log?

Response:

The IRB proposes to expand the status categories to better describe the status of recommendations and to allow DWR to show progress. The IRB plans to use the following status indicators:

Under Consideration – The Project Team is considering the IRB recommendation.

Planned – The IRB has accepted the Project Team’s response to the recommendation and an action to address the recommendation is planned by the Project Team.

In Progress – The Project Team’s planned action is in progress.

Closed – The IRB has reviewed and confirmed that the Project Team’s planned action has been completed and the recommendation has been adequately addressed.

Not Adopted – The Project Team did not adopt the IRB recommendation. An explanation for not adopting the recommendation has been or will be provided.

Superseded – The recommendation was superseded by the IRB and therefore not adopted by the Project Team. An explanation for any recommendations that are superseded will be provided and referenced to the revised recommendation.

The IRB reviewed the Comment Log and entered the status of each recommendation based upon the information provided in presentations to date.

6. Does the IRB have any other recommendations or comments?

Response:

The IRB looks forward to hearing about the following topics at the next IRB meeting:

- Schedule progress
- Initial results from Level 2 Risk Assessment
- Definition of issues/objectives/constraints/ tables
- Final draft of Evaluation Framework
- Outlines of the task reports contained in the appendices

Concluding Remark:

The IRB appreciates the quality presentations and effort that has gone into the study to date and looks forward to further developments.

IRB RECOMMENDATIONS SUMMARY

- M3-1 The IRB recommends further development of the evaluation framework in the near term to include additional consequences or outcome categories, including beneficial project outcomes.
- M3-2 The IRB recommends that the integration team develop a common and consistently applied terminology and approach to defining and articulating issues (aka problems or needs), objectives, and constraints across the project.
- M3-3 The IRB recommends that a minimum set of hard constraints be identified as an essential first step to establishing absolute requirements for measuring plan viability.
- M3-4 Where regulatory requirements are uncertain, the IRB recommends that a well-informed assumption and justification for those requirements be articulated and reviewed with the responsible agency(ies) for their comment and concurrence, prior to engaging in measure development.
- M3-5 IRB recommends that the Integration Team develop a standard format for the tables of issues, objectives, and constraints that each Task Team can populate using a common terminology and formulation approach.
- M3-6 The IRB recommends that all task names be revised to replace “Alternatives” with “Measures.”

- M3-7 The IRB recommends that the title to Task 1 be revised to “Evaluating Measures to Enhance Spillway Reliability and Resiliency”.
- M3-8 The IRB recommends that the Project Team identify and assess data gaps related to the geology of the affected overflow area from between the secant pile wall and the river, and collect any additional data needed to support the recommendation of measures.
- M3-9 The IRB recommends that the interaction of the FCO, River Valve Outlet System and Hyatt Powerplant be fully defined to determine whether there is an FCO release level that could potentially incapacitate the Hyatt PP and/or River Valve Outlet System (RVOS) due to excessive tailwater elevation.
- M3-10 The IRB recommends consideration be given to basing Hyatt Powerplant capacity on seasonally adjusted historical generating unit availability data, and that inflows be seasonally adjusted based on historical monthly inflows.
- M3-11 The IRB recommends that structural considerations be explicitly addressed with respect to allowance for unbalanced operations of the gates.
- M3-12 The IRB recommends that the scope of Task #6 be expanded to include visual monitoring of the performance of the dam.

Respectfully submitted,



Betty Andrews



Lelio Mejia



Bruce Muller



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Dan Wade