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CENWO-PMA 08 December 2020

MEMORANDUM THRU Director, U.S. Army Corps of Engineers Risk Management Center (CEIWR-RMC-DIR), 12596 West Bayaud Avenue, Suite 400, Lakewood, CO 80228

FOR Dam Safety Officer, U.S. Army Corps of Engineers Northwestern Division (CENWD-RBT), 1201 Northeast Lloyd Boulevard, Suite 400, Portland, OR 97232

SUBJECT: Bear Creek Dam Periodic Assessment 01 Update

1. Purpose: The purpose of this memorandum is to present the results of an update to Bear Creek Dam Periodic Assessment 01 (PA 01), including a one-day abbreviated Semi-Quantitative Risk Assessment (SQRA), conducted in order to determine the viability, from a dam safety risk perspective, of proceeding with a Water Supply Reallocation General Investigations (GI) Study of the dam. The abbreviated SQRA was conducted on 30 September 2020, with members of the USACE, Omaha District (NWO) and Risk Management Center (RMC) as participants, and with representatives from the State of Colorado Engineer's Office, Dam Safety Division and the Colorado Water Conservation Board (CWCB) present as observers.

2. Background:

a. As water resources in the arid Colorado Front Range region become increasingly scarce, the State of Colorado is seeking additional surface water storage capacity to meet the water needs of the region's growing population. To help meet these needs, the CWCB signed a Feasibility Cost Sharing Agreement (FCSA) with NWO on 30 August 2019 to be the non-Federal sponsor for the Bear Creek Reallocation GI Study. The intent of the Reallocation Study is to evaluate adding water supply storage as an authorized purpose for the USACE owned and operated Bear Creek Dam project and reallocating some of the existing reservoir storage to water supply.

b. The Bear Creek Dam main embankment is currently categorized as Dam Safety Action Classification (DSAC) 3, based on the results of PA 01, completed in July 2016. Per Engineer Regulation (ER) 1110-2-1156, Safety of Dams, dams classified as DSAC 1, 2, or 3 may not be considered for reallocation without a specific policy exception. Therefore, prior to signing the FCSA, NWO requested a policy exception to study pool reallocation alternatives for water supply storage at the Bear Creek Project. The policy exception request was approved by the USACE Dam Safety Officer on 23 May 2018.

c. During initial scoping of the Reallocation Study, the Project Delivery Team (PDT) identified the need to perform a Dam Safety Issue Evaluation Study (IES) in parallel with the Reallocation Study to identify dam safety issues that must be addressed as part of any reallocation plan. CWCB raised concerns about performing the IES in parallel with the Reallocation Study because they did not want to expend state resources on the Reallocation Study without reasonable assurance that reallocation would not be precluded by dam safety issues. CWCB further requested that the Reallocation Study be suspended until USACE could provide such reasonable assurance.

d. Due to the schedule constraints placed on GI studies, completing a full IES for Bear Creek Dam prior to commencing the Reallocation Study was not possible. NWO coordinated with the RMC

and CWCB to identify a plan for making a preliminary determination as to what the effects would be on the safety of the dam if storage in Bear Creek Reservoir was reallocated for water supply.

3. Procedures:

a. The dam safety risk for Bear Creek Dam was updated for both existing conditions and two simplified potential water supply reallocation alternatives (10,000 ac-ft and 20,000 ac-ft water supply storage alternatives). The two reallocation alternatives were approximated by assuming a reservoir starting pool elevation corresponding to 10,000 and 20,000 ac-ft of additional storage compared to the existing conditions normal operating pool. The additional storage was assumed to be reallocated from the surcharge pool to the multipurpose pool. The three primary tasks included in the update were:

(1) Loading Conditions Update: NWO updated the hydrologic analysis to follow current guidelines in RMC-TR-2018-03 by extending the period of record, including historical and paleoflood data on extreme floods, and using the RMC-Reservoir Frequency Analysis (RFA) software. Additionally, NWO updated the seismic loading using the most current U.S. Geological Survey data. See Enclosure 1 for additional details of the loading conditions update and Enclosure 2 for additional details of the hydrologic loading update.

(2) Consequences Update: NWO updated the consequences (life loss) estimates by using Hydrologic Engineering Center-LifeSim software and Version 2.0 of the National Structure Inventory. See Enclosure 3 for additional details of the consequences update.

(3) SQRA Update: Updated the SQRA from PA 01 to evaluate the impacts of the updated loading conditions and consequences, and the two potential reallocation alternatives. Due to the one-day time constraint, the risk assessment update focused only on the Potential Failure Modes (PFMs) most likely to be impacted by the updated loading and consequences, and the reallocated pool alternatives. It did not necessarily consider all previously identified risk driving or non-risk driving PFM's. Non-breach conditions were also reassessed to determine if the reallocated pool alternatives would increase downstream flood risk. See Enclosure 4 for additional details of the SQRA update.

4. Limitations and Assumptions:

a. Given the preliminary nature of the SQRA update, the Potential Failure Modes Analysis process was abbreviated, and the assessment did not include a site visit or a brainstorming session.

b. Loading curve analysis assumed a critical duration of one day, indicative of rainfall events expected to cause infrequent loadings. Additional assessment, including assessment of longer snowmelt influenced durations, would be needed to better capture loading through more frequent return periods.

c. Reallocation alternatives assessed for this SQRA were simplified as no period of record reallocation study has been conducted yet to inform expected pool behavior, a parameter that influences the starting pool stage duration in production of the loading curve. Simplifying assumptions were implemented, representing a constant starting pool corresponding to 10,000 and 20,000 ac-ft of additional storage compared to the existing conditions base of flood control pool.

5. Results and Findings:

a. Based on the results of the updated SQRA, the risk to the main embankment is not significantly affected by the two reallocation alternatives considered. Compared to PA 01, the consequences have increased significantly, but there has been a corresponding decrease in the hydrologic loading probability. The risk for PFM 1R (Spillway Erosion, 20,000 ac-ft reallocation pool) would increase slightly by one-half Order of Magnitude (OOM) but still plots well below the tolerable risk limits.

b. Non-breach risk increased approximately one-fourth OOM from existing conditions for the 10,000 ac-ft reallocation pool and by approximately three-fourths OOM from existing conditions for the 20,000 ac-ft reallocation pool, although the non-breach risk still plots within the same OOM box as the existing conditions non-breach risk for both reallocation pools. The non-breach life loss threshold was estimated at 1/180,000 years for existing conditions, 1/105,000 years for the 10,000 ac-ft reallocation pool, and 1/55,000 years for the 20,000 ac-ft reallocation pool. Further quantitative analysis of non-breach risk will likely show at least a one-half OOM increase in non-breach risk for the 20,000 ac-ft reallocation pool, indicating a potential for higher frequency of downstream flooding due to reallocation.

c. The hydrologic loading update reduced the loading frequency by up to an OOM from PA 01.

d. The consequences update increased the incremental life loss by one-half OOM for critical loading conditions, and up to three OOM for more frequent loadings (Normal High Pool and Security Storage Pool).

e. The risk from the PFMs identified in PA 01, other than overtopping, would not be expected to increase substantially due to the reallocation alternatives that were considered.

f. This assessment was intended to refine the risk assessment for PA 01 using current best practices for SQRAs. The two hypothetical reallocation alternatives used in this analysis are not risk-neutral and result in increased risk to the dam and increased flood risk. The assessment did not consider potential project modifications that could mitigate the increased risk, and risk neutral alternatives likely exist that could be considered as part of the reallocation project. Such modifications would likely need to include, but not be limited to, modifications to the intake tower, spillway, and upstream slope protection.

g. The updated hydrologic loading curve is shown on page 5 of Enclosure 2.

h. The updated societal risk chart is shown on page 21 of Enclosure 4.

6. RMC Vertical Team Briefing and Response:

a. The results and findings of the PA 01 update were briefed to the RMC vertical team on 14 October 2020. The briefing included summaries of the loading conditions and consequences updates, as well as a summary of the SQRA update.

b. The RMC Director indicated that the Reallocation Study may continue based on dam safety risk considerations but cautioned that the study sponsor should understand that significant infrastructure investments may be required in order to implement water supply reallocation.

c. The RMC Director expressed concern about the risk of undertaking a reallocation study that may recommend trading flood risk management benefits for water supply benefits. The Assistant Secretary of the Army for Civil Works [ASA(CW)] has indicated an unwillingness to trade flood risk management benefits for water supply benefits as evidenced by the ASA(CW) memorandum dated 07 April 2020 (SUBJECT: Delegation of Approval And Execution Authority for Water Supply Reallocation Reports and Agreements) and the ASA(CW) memorandum dated 08 March 2019 (SUBJECT: Middle Brazos Systems Assessment, Phase II: Aquilla Lake, Texas Reallocation Report and Environmental Assessment), disapproving the subject report. The RMC Director urged NWO to ensure that CWCB fully understands and is willing to accept this risk prior to proceeding with the Reallocation Study.

d. The RMC Director suggested that it would be prudent to pre-brief the ASA(CW) on the Reallocation Study and the potential that it will recommend a project that would trade flood risk management benefits for water supply benefits. The purpose of this pre-brief would be to seek feedback on whether such a trade-off would be acceptable prior to expending additional Federal and non-Federal resources on the Study.

7. Recommended Path Forward:

a. NWO and CWCB will consider the risk highlighted by the RMC Director, as well as other risks of continuing the Reallocation Study, and in coordination with Northwestern Division (NWD) and the Headquarters USACE NWD Regional Integration Team, will make a risk-informed decision whether to proceed with the Study.

b. If the Reallocation Study proceeds, NWO will continue coordination with RMC on the dam safety risk aspects of the Study, such as the IES.

4 Encls
1. Loading Conditions Update
2. Hydraulic Loading Update
3. Consequences Update
4. SQRA Update

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