DEPARTMENT OF THE ARMY
CHIEF OF ENGINEERS
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DAEN

12 MAR 2014

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS)
108 ARMY PENTAGON, WASHINGTON, DC 20310-0108

SUBJECT: Sutter Basin Pilot Feasibility Study, Sutter and Butte Counties, California – Final USACE Response to Independent External Peer Review

1. Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Section 2034 of the Water Resources Development Act of 2007, EC 1165-2-214, and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review (2004).

2. The IEPR was conducted by Battelle Memorial Institute. The IEPR panel consisted of four members with technical expertise in Civil Works planning/economics, biology/ecology, geotechnical engineering, and hydrologic and hydraulic engineering.

3. The final written responses to the IEPR are hereby approved. The enclosed document contains the final written responses of the Chief of Engineers to the issues raised and the recommendations contained in the IEPR report. The IEPR Report and the USACE responses have been coordinated with the vertical team and will be posted on the Internet, as required in EC 1165-2-214.

4. If you have any questions on this matter, please contact me or have a member of your staff contact Mr. Bradd Schwichtenberg, Deputy Chief, South Pacific Division Regional Integration Team, at 202-761-1367.

Encl

THOMAS P. BOSTICK
Lieutenant General, USA
Chief of Engineers

Sutter Basin, California
Sutter Basin Pilot Feasibility Report-
Final Environmental Impact Report/
Supplemental Environmental Impact Statement

U.S. Army Corps of Engineers Response to
Independent External Peer Review
September 2013

Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Section 2034 of the Water Resources Development Act of 2007, EC 1165-2-214, and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review (2004)*. The goal of the U.S. Army Corps of Engineers (USACE) Civil Works program is to always provide the most scientifically sound, sustainable water resource solutions for the nation. The USACE review processes are essential to ensuring project safety and quality of products USACE provides to the American people.

Battelle Memorial Institute (Battelle), a non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to conduct the IEPR for the Sutter Basin Pilot Feasibility Report and Final Environmental Impact Report/Supplemental Environmental Impact Statement. The Battelle IEPR panel reviewed the Draft Sutter Basin Pilot Feasibility Report – Final Environmental Impact Report/Supplemental Environmental Impact, as well as the supporting documentation. The Final IEPR Battelle Report was issued on 18 September 2013.

Overall, nineteen comments were identified and documented. One comment was identified as having high significance, fifteen comments had medium significance, and three comments had low significance.

- 'High': Describes a fundamental problem with the project that could affect the recommendation, success, or justification of the project.
- 'Medium': Affects the completeness of the report in describing the project, but will not affect the recommendation or justification of the project.
- 'Low': Affects the understanding or accuracy of the project as described in the report, but will not affect the recommendation or justification of the project.

The following discussions present the USACE Final Response to the Comments.

1. **IEPR Comment – *High Significance* – The feasibility study planning objectives to reduce flood risk utilizing a federal 1% (100-year) annual chance exceedance (ACE) event appears to conflict with a 2007 California law that requires flood protection to the 0.5% (200-year) ACE event in urban areas.**

   There are four recommendations as part of this comment, all of which were adopted, as discussed below.

   Recommendation 1: Confirm and clarify the applicability of state and federal design flood standards governing U.S. Army Corps of Engineers projects having federal and non-federal sponsors.

   USACE Response: Adopted.

   Action taken: Discussion of the study planning objectives can be found in in Chapter 2, Section 2.2.1 of the Final Feasibility Report. The Federal objective is to maximize sustainable economic development and is not based upon providing flood risk reduction for a "design flood event". The non-Federal, or local objectives are discussed in Section 2.2.2 and do deal with achieving a 200-year protection as established in California law. While these state and Federal objectives are not the same, it is a normal part of feasibility studies for local sponsors to have some different objectives than those of USACE, which could lead to a Locally Preferred Plan (LPP).

   Recommendation 2: Clarify the applicability of California SB5 to the Sutter Basin project.

   USACE Response: Adopted.

   Action taken: California SB5 establishes the non-Federal planning objectives discussed in Chapter 2, Section 2.2.1 of the Final Feasibility Report. Although, by policy, not a factor in the identification of the NED plan, the non-Federal planning objectives are relevant in the identification of the Locally Preferred Plan (LPP). For the Sutter Basin project, the Assistant Secretary of the Army, for Civil Works, did approve a policy exemption to allow recommendation of the LPP as the tentatively selected plan (now Recommended Plan) with non-Federal interests being responsible for 100% of the additional cost of the LPP over the NED plan.

   Recommendation 3: Edit the EIR/SEIS and Appendix C accordingly to clarify the issues presented in this Final Panel Comment.

   USACE Response: Adopted.

   Action taken: The planning objectives are described in the Final Feasibility Report, sections 2.2.1-2.2.3. Additional explanation about the 0.2% (200-year) ACE project performance related to the local sponsor objectives has also been added to Chapter 7 of the Final Feasibility Report and to Appendix C1b.

Recommendation 4: Provide results in the main body of the EIR/SEIS, through the use of text and figures, to demonstrate the ability of the LPP (Alternative SB-8) to achieve flood risk planning objectives for the 0.5% (200-year) ACE.

USACE Response: Adopted.

Action taken: A section has been added to the Final Hydraulic Design Appendix and Chapter 7 of the FS/EIS that describes the performance of the project relative to the States SB-5 0.5% (200-year) ACE design criteria.

2. **IEPR Comment – *Medium Significance* – Residual risks associated with the 1% annual chance exceedance (ACE) event are not fully evaluated and may not be accounted for in the project costs.**

There are six recommendations as part of this comment, all of which were adopted as described below.

Recommendation 1: Clarify whether stop-logs or sand bags are planned to address the low levee elevation at the railroad crossing.

USACE Response: Adopted.

Action taken: During evaluation of the final array, a gate type closure structure was selected rather than a sandbag closure structure to increase the robustness and resiliency of alternatives SB-7 and SB-8. Section 5.5b of the Hydraulic Design Appendix has been revised to describe the gate type closure structure as it relates to the Recommended Plan.

Recommendation 2: Describe and, if necessary, assess the contribution of slope instability to geotechnical fragility to post-repair conditions.

USACE Response: Adopted.

Action taken: USACE performed a sensitivity analysis by developing a with-project fragility curve, including slope instability, for the highest consequence index point adjacent to Yuba City. The analysis showed assurance statistics for both 2% and 0.4% ACE events show very little change. Equivalent Annual Benefits show a reduction of less than 4% using with project fragility curves. In terms of risk and uncertainty used for this study, these changes are well within the probabilistic ranges and would not result in a change in NED identification, the Recommended Plan or economic justification. A more detailed summary of the sensitivity analysis has been added to section 7.1.1 of the Final Feasibility Report.

Recommendation 3: Assess the effect of "judgment" contribution on post-repair conditions, including the potential for defects in the slurry walls.

USACE Response: Adopted.

Action taken: The total judgment portion of the existing conditions varies between 0.0870 and 0.2098. A with-project fragility curve was developed for one index point in order to perform a sensitivity analysis. The analysis showed assurance statistics for both 2% and 0.4% ACE events show very little change. Equivalent Annual Benefits show a reduction of less than 4% using with project fragility curves. In terms of risk and uncertainty used for this study, these changes are well within the probabilistic ranges and would not result in a change in NED identification, the Recommended Plan or economic justification. A more detailed summary of the sensitivity analysis has been added to section 7.1.1 of the Final Feasibility Report.

Action to be taken: For the cutoff walls, quality control testing in the construction specifications will be performed in the Pre-construction, Engineering and Design (PED) phase and will minimize the possibility of defects, and soil-bentonite (SB) cutoff walls tend to be "self-healing" because they are flexible and not stiff like soil-cement-bentonite (SCB) walls. The main negative impact on permeability of SB walls are likely to be "windows" in the wall, usually caused by trapped pockets of slurry during the backfilling operation. There are no adequate published studies documenting "typical" rate of defects in SB cutoff walls.

Recommendation 4: Evaluate the probability that human error or failure of the stop-log/sand bag structure could lead to overtopping at the train track, and include the probability in the assessment of residual risk.

USACE Response: Adopted.

Action to be taken: The operation of the closure will be be defined in the operations manual during the Pre-construction, Engineering and Design (PED) phase of the project. River flows are forecasted near the location based on upstream flood control releases. The gate could be closed well in advance of a forecasted overtopping stage. A discussion of the residual risk associated with improper operation of the railroad closure gate has been added to the residual risk discussion in the Final Feasibility Report.

Recommendation 5: Develop fragility curves for post-repair conditions if the assessed risk due to slope instability or judgment is considered significant.

USACE Response: Adopted.

Action taken: A sensitivity analysis was performed incorporating with project fragility curves at the index point showing the highest damages for Yuba City. The analysis showed assurance statistics for both 2% and 0.4% ACE events show very little change. Equivalent Annual Benefits show a reduction of less than 4% using with project fragility curves. In terms of risk and uncertainty used for this study, these changes are well within the probabilistic ranges and would not result in a change in NED identification, the Recommended Plan or economic justification. A more detailed summary of the sensitivity analysis has been added to section 7.1.1 of the Final Feasibility Report.

Additional discussions have been added to the Final Hydraulic Design Appendix and the Final Economics Appendix indicating that with-project fragility curves were not used in this analysis as they were found to have an insignificant impact on the results.

Recommendation 6: Calculate the equivalent annual cost associated with residual risk of failure after levee repair.

USACE Response: Adopted.

Action taken: A sensitivity analysis was conducted evaluating the effects of using with project fragility curves for Yuba City (the highest damage impact area) The equivalent annual cost associated with residual risk of failure for Yuba City (using a with project was approximately $1.8m, while overtopping accounts for $8.2m in residual risk. $1.8m represents less than 4% of the total benefits of $48m (structures, contents and autos only) and is found to be insignificant. Because the incorporation of residual damages due to levee failure would not change the NED identification, Recommended Plan selection or economic justification it was not incorporated into the final analysis.

3. **IEPR Comment – *Medium Significance* – The consequences of residual risk from events larger than the 1% annual chance exceedance (ACE) event are not adequately presented, and associated mitigation measures are not fully described.**

There are five recommendations as part of this comment, all of which were adopted, as described below.

Recommendation 1: Define "residual risk", "potentially developable floodplains", and other terms used in conjunction with residual risk in the Sutter Basin EIR/SEIS.

USACE Response: Adopted.

Action taken: Residual Risk refers to the flood risk that remains (in terms of probability of flooding, population within the floodplain, critical infrastructure, etc.) in the study area after the Recommended Plan is built. This study has defined "potentially developable floodplains" as land within the 1% (1/100) ACE floodplain that would flood to a depth of less than 3 feet. Three foot depth was selected because it would be feasible for new construction to be elevated such that first floor elevations would comply with FEMA requirements (see section ES.8.4 and 3.4.2 of the Final Feasibility Report). section 7.1.11 was also added to the Final Feasibility Report to further discuss residual risk.

Recommendation 2: Revise the discussion on all measures capable of reducing initial risk to a residual risk level (see Figure 6-1 of NRC, 2013).

USACE Response: Adopted.

Action taken: A comparison of the initial risk (No action) to the residual risk (Recommended Plan) has been added to section 7.1.11 of the Final Feasibility Report.

Residual risk is compared in terms of floodplains, project performance, population within the floodplain, life safety and critical infrastructure.

Recommendation 3: Revise the discussion on how residual risk will be addressed for events greater than the 1% ACE standard.

USACE Response: Adopted.

Action taken: Section 7.1.11 has been revised in the Final Feasibility Report and residual risk is now compared in terms of floodplains, project performance, population within the floodplain, life safety and critical infrastructure at varying frequencies, including those less frequent than the 1% ACE.

Recommendation 4: Consider the use of numerical hydraulic model capabilities to guide evacuation planning, such as the ability of the FLO-2D model to estimate times to reach specified flood depths.

USACE Response: Adopted.

Action to be taken: USACE considered the use of LIFESim or HEC-FIA modeling using the 2-dimensional inundation mapping results. However the USACE Risk Management Center (RMC) was already scoped to conduct a Baseline Conditional Risk Assessment (BCRA) analysis using this approach. The BCRA study is ongoing and results are not available for the feasibility study. Findings of the BCRA will be further evaluated in the Pre-construction, Engineering and Design (PED) phase and any potential effects on evacuation planning will be considered at that time.

Recommendation 5: Clarify whether the potential for increased development in residual risk locations within the study area has been considered.

USACE Response: Adopted.

Action taken: Discussion of increased development and population growth within the study area was added in Section 7.1.9 of the Final Feasibility Report. Even with a full growth assumption, there is adequate developable land under the existing conditions to satisfy demand. The Recommended Plan will not increase the potentially developable land compared to the without project condition.

4. **IEPR Comment – *Medium Significance* – The hydrologic and hydraulic analyses may have mischaracterized the 1% annual chance exceedance (ACE) event and resulting floodplains because "best available" data were not used.**

There are two recommendations as part of this comment, both of which were adopted, as described below.

Recommendation 1: Provide the rationale for using the data presented in the EIR/SEIS and supporting technical documentation, and acknowledge the existence of other data that may be considered "best available" data.

USACE Response: Adopted.

Action taken: At the time of the study, the published 2002 "Sacramento-San Joaquin Comprehensive Study" (Comp Study) was the best available data for the rain flood frequency curves. The Comp Study curves reflect the last significant event on record (1997). USACE assessed the value of updating the flow frequency curves with the added 13 years of data and concluded it would not yield a significant change to the statistics of the flow frequency curves.

Recommendation 2: Provide examples of sensitivity testing to demonstrate the relative changes anticipated in using different datasets.

USACE Response: Adopted.

Action taken: Comparisons in hydrology were made between the 2002 Comp Study and the preliminary Central Valley Hydrology Study (CVHS) results and there is general agreement. The definition of 'best available,' for the hydrology in this study includes readily accessible and, to the extent possible, already published and reviewed and any additional effort to what has already been done must be able to answer in the affirmative that it would ultimately have an effect on the final recommendation of the alternative. In this case, updating the flow frequency curves with the added 13 years of data would not change the plan recommendation.

5. **IEPR Comment – *Medium Significance* – The validity of some aspects of the hydraulic and hydrologic analyses cannot be confirmed because several assumptions are unclear or are not provided.**

There are twelve recommendations as part of this comment, all of which were adopted, as discussed below

Recommendation 1: Clarify why the current USGS rating curve was not used in the HEC-RAS modeling.

USACE Response: Adopted.

Action taken: The USGS rating curve was adjusted to reflect long term averages. The current rating curve represents a snap shot in time (current conditions). However, under risk and uncertainty based methods the stage should reflect mean conditions and associated uncertainty. Regardless, stages within the study area are unaffected because the curve is located far enough downstream (and below the Fremont weir) to have no impact on the study area. Further discussion can be found in section 3.3.a (9) of the Final Hydraulic Design Appendix.

Recommendation 2: Explain why the more recent CVFED HEC-RAS cross-section data were not used.

USACE Response: Adopted.

Action taken: The CVFED bathymetric cross sections were not available when the modeling was conducted for this study. In addition, the bathymetric data are located at different river stations and this would require revising the entire model geometry. Comparisons were made to CVFED Lidar along study reaches and found to agree. The stage-uncertainty estimates reflect the accuracy of the model used for the study. This has been described in section 3.3 of the Final Hydraulic Design Appendix .

Recommendation 3: Discuss whether ground elevation data in the HEC-RAS model properly represent the sloped river side of the levee up to the elevation of the levee crest, where the blocked obstruction apparently begins (obstructions can only provide a vertical face), and explain why the levee option in HEC-RAS was not used to represent levees.

USACE Response: Adopted.

Action taken: The hydraulic model includes the sloped levee face except at star bend and Three River Levee Improvement Authority (TRLIA) setbacks on the Feather River. This is an appropriate assumption because the sloped portion of the levee is an extremely small fraction of the overall cross sectional area. This information was added to Section 3.3 of the Final Hydraulic Design Appendix.

Blocked obstructions were used throughout the model to eliminate the cross section area on the landward side of the levee. The landward areas are modeled as storage areas and lateral weirs along the crest of the levee control the flow over and into and out of the storage areas. The blocked obstructions are needed because the cross sections extend approximately 100 feet landward of the levee and this is not a conveyance area under this approach. The levee option is not suitable in this case because the conveyance area on the landward side of the cross section would become conveyance area once overtopped. In other words, the levee option is not appropriate if levees are modeled as lateral weirs. This information was also added to Section 3.3 of the Final Hydraulic Design Appendix.

Recommendation 4: Explain why wave runup and setup estimates were made but not included in the assurance calculations.

USACE Response: Adopted.

Action taken: The wind wave run-up calculations were used to assess the probability of wind wave overtopping. This discussion has been added to section 3.6 of the Final Hydraulic Design Appendix.

Recommendation 5: Provide the assumptions or design calculations estimating the hydraulic conditions (overtopping discharges, velocities, shear stresses, durations, etc.) used in the design of the erosion protection matting.

USACE Response: Adopted.

Action taken: The purpose of the matting is to address levee superiority by providing additional resilience to the locations likely to be overtopped first. USACE has no design guidance for this purpose. Therefore, the method was based on the approach used for the Napa Flood Risk Management Project. This has been described in section 4.5c and 5.5c of the Final Hydraulic Design Appendix.

Recommendation 6: Present the basis for the assumed 1,500-foot-wide breach width and 1-hour breach formation time.

USACE Response: Adopted.

Action taken: The 1,500-foot wide width used in the analysis is based on historical breaches within the central valley and achieving a headwater depth to tailwater depth ratio of 0.90. The breach width for Cherokee canal was based on observed breach sizes.

For the Sutter Bypass and Feather River's the breach was assumed to exist at the start of the model simulation. This was done to reflect the hydrologic floodwave assumptions. The 2002 "Sacramento-San Joaquin Comprehensive Study" hydrographs assume a series of six 5-day floodwaves make up the 30-day hydrograph. They put the largest 5-day wave in the middle of the series. However, the sequence of these 5-day events is uncertain and the largest could be the first. A breach at the initiation of the 30-day wave would reflect the true 30-day flow duration.

Levee breaches are used to define the inundation if a breach were to occur. The probability of the breach is computed by the FDA model using the discharge-frequency, stage-discharge, failure probability (fragility curve), and their associated uncertainties.

This information was added to section 3.4 of the Hydraulic Design Appendix.

Recommendation 7: Describe the basis for the assumption that initiates levee breaching prior to the peak flood stage.

USACE Response: Adopted.

Action taken: The USACE has no guidance on the selection of breach width, formation time, and time of breach for levee breaches. A literary search also found no appropriate guidance. Assumptions were based on historical breaches within the central valley and the general study area.

For the Sutter Bypass and Feather River's the breach was assumed to exist at the start of the model simulation. This was done to reflect the hydrologic floodwave assumptions. The 2002 "Sacramento-San Joaquin Comprehensive Study" hydrographs assume a series of six 5-day floodwaves make up the 30-day hydrograph. They put the largest 5-day wave in the middle of the series. However, the sequence of these 5-day events is uncertain and the largest could be the first. A breach at the initiation of the 30-day wave would reflect the true 30-day flow duration.

For Cherokee Canal, the width and time to formation were based on anecdotal accounts of a past levee breach. The initiation time was selected by setting a stage trigger 1 foot below the peak stage. This reflects the breach occurring at the peak of the event and would result in the fastest inundation. These assumptions were clarified in section 3.4 of the Final Hydraulic Design Appendix.

Recommendation 8: Explain why the FLO-2D model was not used to estimate flood velocities and velocity x depth relationships.

USACE Response: Adopted.

Action taken: The FLO-2D models did generate velocities and depths. However, these were not post processed as velocity x depth. Only depth is used in the FDA model. For the life safety evaluation a simple depth metric was used and is sufficient to select the Recommended Plan. This explanation was added to section 3.4 of the Final Hydraulic Design Appendix.

Recommendation 9: Clarify the assumptions made to estimate populations from census block data and explain whether any portion of the population was assumed to be capable of evacuating.

USACE Response: Adopted.

Action taken: Essentially the population was assigned to single family residences within the census block. The population of the residences within a grid element were then added to determine its population. The population within a floodplain was a simple addition of all grid elements with depths greater than a specified depth. These values were generated for depths greater than 0, 2, and 15. These depths are associated with inflection points in mortality vs. depth curves and the analysis is documented in a technical memorandum. This information is summarized in section 7.1.11.1 and 7.1.11.2 of the Final Feasibility Report and in section 3.8 of the Final Hydraulic Design Appendix.

Recommendation 10: Correct the apparent discrepancy in the definition of "shallow" flooding.

USACE Response: Adopted.

Action taken: Report text has been revised in section 3.4.4.1.2 of the Final Feasibility Report in order to be consistent with the FEMA definition. Shallow flooding is defined by FEMA as average depths ranging from 1 to 3 feet. This comment has no impact on plan recommendation.

Recommendation 11: Explain why the velocity of floodwaters is not considered together with the depth of flooding when assessing "developable" floodplain land areas.

USACE Response: Adopted.

Action taken: Within the study area, velocity of floodwaters is not used as a floodplain regulation. Therefore, structures associated with new development only need to be elevated above the FEMA base flood elevation.

Recommendation 12: Describe the specific activities that would occur in "developable" floodplains, and clarify whether zoning and building code provisions would be changed to accommodate or restrict construction in floodplains.

USACE Response: Adopted.

Action taken: Section 7.1.9 has been added to the Final Feasibility Report The section discussion addresses developable floodplains, population and growth projections.

6. **IEPR Comment – *Medium Significance* – The 1957 design water profiles appear to be a key hydraulic design assumption, even though more recent data are available.**

There are two recommendations as part of this comment, both of which were adopted, as discussed below

Recommendation 1: Review all references to the 1957 design criteria and clarify how those criteria are used (or not used) in relationship to the design 1% ACE.

USACE Response: Adopted.

Action taken: The 1957 profiles describe only the currently authorized design. Flood risk within the study area is based on this design height and the sponsors are required to maintain the 1957 profile height and follow the operations and maintenance requirements. Therefore, this profile is considered a future without project condition. A new levee design height was considered during plan formulation. However, a change to the design height would involve extremely costly transfer of hydrologic and hydraulic related flood risk within the study area or adjacent areas. This analysis uses more recent H&H data, primarily from the 2002 "Sacramento-San Joaquin Comprehensive Study" in their analysis and to assess the performance of the 1957 design profile over a full range of flood frequencies (see section 3.3 of the Final Hydraulic Design Appendix).

The 1% flood is not a required USACE design criteria. An evaluation of the Recommended Plan was conducted and the assurance of passing the 1% flood was evaluated at multiple index points throughout the area, but the project is not "designed" to this height.

Recommendation 2: Clearly state early in the design documentation the implications of using the 1957 design profiles versus other hydraulic data.

USACE Response: Adopted.

Action taken: There are no implications because Hydraulic Design used more recent H&H data, primarily from the 2002 "Sacramento-San Joaquin Comprehensive Study" in their analysis and to assess the performance of the 1957 design profile over a full range of flood frequencies (see section 3.3 of the Final Hydraulic Design Appendix).

7. **IEPR Comment – *Medium Significance* – Methods used to develop geotechnical fragility curves have not been sufficiently calibrated by using observed frequency of actual failures.**

There are five recommendations as part of this comment, all of which were adopted, as discussed below:

Recommendation 1: Assess whether the fragility curves and failure probabilities are statistically consistent with observed behavior of the Feather River Levees and have been appropriately extrapolated to relatively rare events such as the design flood.

USACE Response: Adopted.

Action taken: Calibration was assessed and the curves are in qualitative agreement with the actual levee performance. There has been one breach on the FRWL since 1955. There have been two breaches on the Feather River east levee (i.e. across the river) since 1955. Other potential breaches were prevented by heroic floodfighting. The characteristics of the individual performance mode fragility curves (i.e. underseepage, stability, and judgment) agree very well with the historical performance of the levees within the Feasibility Study. The documented levee performance history since 1955 is heavily skewed towards underseepage distress as are the fragility curves. Due to the observed qualitative agreement between the fragility curves and the actual levee performance, USACE believes performance of a robust statistical analysis between the two will not change the overall study conclusions or the Recommended Plan.

Recommendation 2: Determine and discuss whether more advanced methods have been developed since ETL556 was issued that might improve confidence in the development of fragility curves.

USACE Response: Adopted.

Action taken: While ETL 556 is the governing document for preparation of fragility curves, other methods have been developed since the ETL was issued. The Risk Management Center (RMC) performed a Baseline Condition Risk Assessment (BCRA) concurrent to the Feasibility Study. The BCRA report was reviewed by several Feasibility Study PDT members. This comprehensive risk assessment uses the geotechnical fragility curves as a step on the event tree that leads to levee failure. The BCRA report has not been publically released, but it reached the same conclusions as the Feasibility Study in regards to the existing condition of the levees and the need for remediation measures to improve levee performance.

Recommendation 3: Assess whether it is possible to evaluate and report the likely range in the reported failure probability and resulting project benefits in addition to the mean values.

USACE Response: Adopted

Action Taken: Levee performance and estimated annual damages were computed using current USACE state of practice risk and uncertainty methods following ER 1105-2-101 and the approved HEC-FDA model. The HEC-FDA model incorporates uncertainty in geotechnical performance using fragility curves, however the model does not incorporate uncertainty in the fragility curves. Uncertainty in both the hydrology and hydraulics within the FDA model cause a significant and appropriate level uncertainty in the frequency stage relationship as it relates to fragility curves. HEC-FDA computes the expected annual damage estimates and their expected range using these uncertainty values. These values and their ranges are reported in Tables 9a and 10 of the Final Economics Appendix and Table 3-13 of the Final Feasibility Report.

Recommendation 4: Evaluate the probability of failure given that the probability of poor performance has been accurately extrapolated by expert elicitation to relatively rare events such as the design flood so that the probability of failure is consistent with geotechnical theory and observed performance.

USACE Response: Adopted

Action taken: The fragility curves shown in the analyses were evaluated and did consider probability of failure from a water surface about 3 feet above the levee toe to the top of the levee, which is higher than the design water elevation. Therefore, the probability of failure is accurately extrapolated by the analyses to high rare flood events. Also, the fragility curves developed are consistent with the past historical performances of the levee embankment. The major floods for which accurate records are available (1955, 1986, and 1997) had an Annual Chance Exceedance (ACE) of around 0.01 (1/100 year). Those events resulted in breaches and near breaches that were prevented by heroic floodfighting. The design water surface for the study levees is about 2.5 feet higher than the 0.01 ACE event. The probability of failure at the design water surface is high since there have been failures and near failures at lower events.

Recommendation 5: Conduct sensitivity studies to determine the effect of reducing levee failure probability by one and two orders of magnitude.

USACE Response: Adopted

Action Taken: Sensitivity analysis was performed and it shows that decreasing levee fragility by an order of magnitude (10-fold) results in an approximate 6-fold decrease in annual damages. Decreasing by 2 orders of magnitude (100-fold) essentially eliminates all levee fragility and you are arrive at with-project conditions with very little residual flooding. This is to be expected in a study area where brittle levee failures and not levee stage/overtopping is the key risk factor causing historical flooding. Fragility curves were developed following the current USACE state of practice as defined in ER 11105-2-101

and ETL 1110-2-556. Empirical evidence and multiple historical breaches well below top of levee (along with heroic flood fighting efforts and near breaches) also show us that the order of magnitude decreases in fragility are not reasonable to use in this particular analysis.

8. **IEPR Comment – *Medium Significance* – The statistical parameters and methods used for seepage analyses result in excessive uncertainty in calculations of geotechnical reliability that may overestimate the project's net benefits.**

There are three recommendations as part of this comment, all of which were adopted, as discussed below.

Recommendation 1: Assess whether uncertainty could be reduced by calculating statistical moments for engineering parameters using only samples from a similar depositional environment.

USACE Response: Adopted.

Action taken: An assessment found that the Excel workbooks used to develop the fragility curves do not use every soil boring within a particular reach. Once the index point location is selected, only the representative borings only within 2500 on either side of the selected index point were used for the statistical analysis. The soil borings used are listed on the first page of the workbook of the R&U analyses. Restricting the soil borings used to a limited geographic area results in data from a similar depositional environment being used for each curve.

Recommendation 2: Assess whether using methods for estimating variance presented by Duncan (2000) would reduce uncertainty.

USACE Response: Adopted.

Action taken: The methods of estimating variance presented by Duncan (2000) have been used on many other studies within the Sacramento District and have been compared with the variances used for Sutter. Using different methods of estimating variance did not change the conclusions and recommendations of those other studies. Therefore, using different methods of estimating variance would not reduce uncertainty or change the conclusions and recommendations of this study.

Recommendation 3: Consider using lognormal random variables where appropriate.

USACE Response: Adopted.

Action taken: Lognormal random variables were considered for this study, but it was determined based on extensive knowledge and experience that normal random variables (layer thickness and permeability ratio for underseepage, unit weight and soil strength for slope stability) are appropriate.

9. **IEPR Comment – *Medium Significance* – Methods used to divide the levees into reaches may result in inaccurate calculations of geotechnical reliability that may impact the estimated net benefit of the project.**

There is one recommendation as part of this comment, which was adopted as discussed below.

Recommendation 1: Conduct a detailed technical review to estimate whether significant errors may have been introduced by the method used to divide the levee into reaches.

USACE Response: Adopted.

Action taken: A technical review was conducted and it was determined that this analysis used an appropriate number of levee reaches to represent the relative flood risk within the study area. There are 6 index points on the FRWL for the 29.3 miles of the FRWL levee between Shanghai Bend and the Thermalito Afterbay, compared to 5 index points for the 43.1 miles of levee for the Wadsworth Canal left levee, Sutter Bypass left (east) levee, and FRWL downstream of Shanghai Bend. Given the topography and the location of the population concentrations within the Sutter Basin levee system, USACE believes it is appropriate to have more index points along the FRWL upstream of Shanghai Bend then on the remaining levees within the system. USACE also believes that 6 index points on the FRWL between Shanghai Bend and the Thermalito Afterbay (approximately one index point for every 5 levee miles) adequately balances the need to calculate accurate damages/benefits at different breach locations along the levee with the need to complete the study in a reasonable amount of time for a reasonable cost.

Because without project damages are governed by the index point associated with the highest risk (probability and consequences), identifying additional reaches with higher project performance will not change without project damages or with project benefits. Conceptual sensitivity analysis shows that identifying additional levee reaches with lower project performance would actually increase without project damages and increase project benefits. Therefore, the benefits and net benefits found in the Final Feasibility Report represent a conservative estimate compared to the potential result of separating into smaller levee increments.

10. **IEPR Comment – *Medium Significance* – The rationale for eliminating the setback levee alternative is not provided in sufficient detail, indicating that it may have been prematurely eliminated from the plan formulation objectives.**

There are two recommendations as part of this comment, both of which were adopted as discussed below.

Recommendation 1: Provide a detailed rationale for eliminating Alternative 4.1.

USACE Response: Adopted.

Action taken: Additional narrative detail and rationale for the screening out of the ecosystem and recreational opportunities from the original study objectives and associated conceptual alternatives (4.1 Setbacks) was expanded in the Final Feasibility Report: section 3.2.2.

In summary, as part of this evaluation, the construction of setback levees to reduce flood risk was determined to be not as cost effective or as efficient, in terms of higher construction, environmental, and real estate costs, for addressing the existing levee geotechnical issues as compared to the fix-in place measures. Setback levees address FRM issues and also provide opportunities at the newly created waterside areas for ecosystem restoration and recreation. Fix-in-place measures do not have associated or conjunctive ecosystem or recreation opportunities. The Feather River levees differ from other California levees such as the Sacramento River in that in the majority of reaches the levees are already setback hundreds of feet from the river channel with this connected floodplain area consisting of remnant riparian, fallow, and agriculture areas. During the analysis, it was determined that these existing remnant riparian and fallow areas provide better and less costly opportunities for ecosystem restoration and recreation than can be pursued independently from the study.

Recommendation 2: Calculate the cost differential between fix-in-place and setback levee measures and compare the additional cost to the value of the ecosystem restoration benefits forgone.

USACE Response: Adopted.

Action taken: A cost comparison between fix and place and setback levee measures was performed as part of the study at four locations identified as having the most potential to provide both FRM and ER benefits. The amount of restored floodplain created at each of the four setback locations ranged from as little as 45 acres to as much as 1,760 acres. For this cost comparison exercise it was assumed that environmental benefits are directly correlated to the amount of new floodplain restored to the river system. The cost comparison found that setback levees were significantly more costly than fix in place levee measures and that the restored acreage of floodplain did not justify the added costs. All setback levee options exceeded a cost per acre of $100,000, ranging from about $116,000 to $547,000 per acre. Further refinement of costs could improve the cost-benefit value of setbacks, however, habitat development costs (site preparation, planting, irrigation, and monitoring) yet to be included would have added additional costs.

11. IEPR Comment – *Medium Significance* – The sensitivity of the alternative selection process to the issue of climate change is unclear because the methodology has not been fully articulated.

There are two recommendations as part of this comment, both of which were adopted, as discussed below.

Recommendation 1: Revise, as necessary, the methodology used to assess the sensitivity of alternative selection to climate change.

USACE Response: Adopted.

Action taken: Section 1.1 summarizing the results of a climate change sensitivity analysis has been added to Final Feasibility Report. This senstivity analysis achieves the desired end – to assess whether the affect of climate change would change the recommended alternative. The results indicate that the identification of the NED Alternative (SB-7) is not sensitive to the climate change scenarios. Further, the rationale for selection of the LPP (SB-8) would not be affected by climate change scenarios. A more detailed description about the sensitivity analysis can also be found in the Final Hydrology Appendix.

Recommendation 2: Coordinate discussion and conclusions of climate change between the EIR/SEIS and supporting documentation.

USACE Response: Adopted.

Action taken: The Final Feasibility Report has been revised to be consistent with final supporting documentation.

12. IEPR Comment – *Medium Significance* – The process for prioritizing project goals is not supported because the evaluation criteria used in the screening process were not quantified

There was one recommendation as part of this comment which was not adopted, as discussed below.

Recommendation 1: Incorporate the specific evaluation criteria and the processes by which they were quantified in the Sutter Basin EIR/SEIS.

USACE Response: Not adopted.

This comment was considered, however this section of the report was eliminated from the Final Feasibility Report because it was not used in the decision process.

13. IEPR Comment – *Medium Significance* – Economic risk and uncertainty associated with future without-project conditions were not considered when identifying the Tentatively Selected Plan

There is one recommendation as part of this comment which was adopted, as discussed below.

Recommendation 1: Develop a future without-project condition that accurately describes expected future conditions in the study area without the project.

USACE Response: Adopted.

Action taken: A discussion regarding future population growth and floodplain management (EO 11988) has been added to both the Final Economics Appendix (Chapter 4, Pgs 17-19 and Attachment 4) and the Final Feasibility Report (Section 7.1.9). Future without project population growth and development were considered in terms of residual risk and EO 11988, but were not included in the economic damage analysis, as it would have little impact on project benefits and would not change NED identification, the recommended plan or economic feasibility.

Factors that led to the future without project condition assumptions used for this study from a planning and economic standpoint were:

1) Sec 308 of WRDA 1990 (33 USC 2318) precludes USACE from justifying projects based on future development. Residual risk associated with a potential full growth scenario is presented in the Final Feasibility Report (Section 7.1.9).

2) CA Senate Bill 5 will limit future development in the study area under future without project conditions given that the study area would not have 0.5% ACE ("200yr") level of flood protection. According to current USACE floodplain modeling, this area would be within the 0.5% ACE ("200yr") without project floodplain.

3) Given #2 above, any development that did take place would likely occur outside or with foundation heights above the mean 0.5% ACE "200yr" WSEL, meaning very infrequent damaging flooding which would be discounted to present values. The result is low equivalent annual damages which would not significantly impact plan selection or project benefits.

14. IEPR Comment – *Medium Significance* – The spatial effect of removing vegetation from the levees, which could result in long-term habitat fragmentation, is not discussed, although the total acreage loss is mitigated.

There are three recommendations as part of this comment, all of which were adopted, as discussed below.

Recommendation 1: Discuss how vegetation removal in compliance with the Vegetation ETL would affect the spatial distribution of woodland habitat within the study area.

USACE Response: Adopted.

Action taken: Additional information on vegetation removal in compliance with the Vegetation ETL has been added to section 4.7 (Vegetation and Wetlands) and section 4.8 (Wildlife) of the Final Feasibility Report to address effects on the spatial distribution of woodland habitat. Historic losses of riparian forest in conjunction with project

implementation could cause further fragmentation of floodplain forest leading to constrictions in habitat core areas and increases in overall habitat edges, which, in turn, would affect patch sizes, and distances between patches, and impervious surfaces.

Recommendation 2: Include in Effect WILD-11 a conclusion about whether the vegetation removal would result in wildlife habitat fragmentation and whether the potential habitat fragmentation would interfere with wildlife movement in the project area.

USACE Response: Adopted.

Action taken: A conclusion has been added in Effect WILD-11, section 4.8, of the Final Feasibility Report about vegetation removal and its effect on wildlife habitat fragmentation and the potential to interfere with wildlife movement within the project area. Upon completion of levee improvements, the affected area would have a different footprint but generally would be available as a movement corridor. Mitigation Measure VEG-MM-1 would compensate for the "narrowing" of riparian stands and habitat fragmentation by improving connectivity along the riparian corridor. No permanent barriers would be installed as part of the proposed project. This effect is considered less than significant, and no mitigation is required.

Recommendation 3: Discuss how the mitigation plantings provided in Mitigation Measure VEG-MM-1 would compensate for habitat fragmentation if the spatial loss of woodland is determined to result in significant wildlife habitat fragmentation.

USACE Response: Adopted.

Action taken: A discussion on how mitigation plantings (Mitigation Measure VEG-MM-1) will compensate for habitat fragmentation and spatial loss of woodland has been added to section 4.7 (Vegetation and Wetlands) and section 4.8 (Wildlife) of the Final Feasibility Report. Information has been added regarding the extent to which the proposed Three Rivers and Star Bend riparian restoration mitigation sites will in fact "bridge" adjacent habitat areas and create larger habitat nodes.

15. IEPR Comment – *Medium Significance* – The impacts to environmental resources from operation and maintenance activities are not analyzed in accordance with relevant federal and state legislation.

There are four recommendations as part of this comment, all of which were adopted, as discussed below.

Recommendation 1: Provide more detail in the EIR/SEIS about the OMRR&R activities and how they may change under the alternatives. Clearly state what the changed OMRR&R activities would include.

USACE Response: Adopted.

Action taken: A more detailed description has been included in section 4.1.4 of the Final Feasibility Report to explain to what extent OMRR&R activities will change under the alternatives. While disturbance from OMRR&R activities would occur under the No-Action Alternative, OMRR&R activities have been described in greater detail to provide clarity and disclosure.

Recommendation 2: Clearly state in the EIR/SEIS whether any of the OMRR&R activities are likely to adversely affect environmental resources.

USACE Response: Adopted.

Action taken: An analysis discussing OMRR&R activities that are likely to adversely affect environmental resources has been added to section 4.8 (Wildlife) of the Final Feasibility Report. The effects on wildlife from O&M activities would not be appreciably different from existing or future without project conditions.

Recommendation 3: Analyze and describe in Sections 4.7 and 4.8 of the EIR/SEIS whether impacts to the biological resources described in those sections would occur.

USACE Response: Adopted.

Action taken: Additional analysis has been added on the impact of OMRR&R activities on biological resources to sections 4.7 (Vegetation and Wetlands) and 4.8 (Wildlife) of the Final Feasibility Report. Because no additional vegetation removal would occur beyond the vegetation removed by construction, O&M activities per se would not result in additional impact on vegetation, therefore vegetation effects from O&M would be less than significant. The effects on wildlife from O&M activities would not be appreciably different from existing or future without project conditions.

Recommendation 4: Determine whether OMRR&R activities should be considered within the cumulative context to evaluate potential cumulative impacts to biological resources (or other environmental resources) as appropriate.

USACE Response: Adopted.

Action taken: In response, the cumulative effects of OMRR&R activities were considered and are addressed in Section 4.13.3 (Cumulative Effects) of the Final Feasibility Report.

16. IEPR Comment – *Medium Significance* – The project's impact on the temporal loss of nesting habitat for Swainson's hawk is not evaluated.

There are three recommendations as part of this comment, all of which were adopted, as discussed below.

Recommendation 1: Include in Effect WILD-5 the number of potential Swainson's hawk nesting pairs that could be affected by the vegetation removal based on available survey data or as reported to the California Natural Diversity Database (CNDDB 2013).

USACE Response: Adopted.

Action taken: As recommended, pertinent Swainson's hawk nesting information from the CNDDB 2013 and other survey info has been added to Effect WILD-5, section 4.8, of the Final Feasibility Report to address effects for document completeness and disclosure.

Recommendation 2: Discuss whether alternate nesting habitat is available to support potentially displaced nesting pairs.

USACE Response: Adopted.

Action taken: A discussion in Effect WILD-6, section 4.8, (Potential Mortality or Disturbance of Nesting Special-Status and Non Special Status Birds and Removal of Suitable Breeding Habitat) has been included in the Final Feasibility Report to address potentially displaced nesting pairs. Seven recorded locations in and immediately adjacent to the affected area were found as suitable nesting and foraging habitat for the Swainson's hawk.

Recommendation 3: Analyze whether the loss of riparian woodland would result in a regional loss of productivity for Swainson's hawk.

USACE Response: Adopted.

Action taken: A discussion in Effect WILD-5, section 4.8, has been added to the Final Feasibility Report on the project's effect on regional productivity of Swainson's hawks. The removal of vegetation is not anticipated to have a significant effect on the regional productivity of Swainson's hawks.

17. IEPR Comment – *Low Significance* – The assumption that through-seepage does not contribute to geotechnical fragility is inconsistent with the description of the risk of through-seepage elsewhere in the report.

There are two recommendations as part of this comment, both of which were adopted, as discussed below.

Recommendation 1: Develop a consensus regarding the risk level associated with through-seepage, conduct analyses as appropriate, and revise the text of the Sutter Basin Environmental Impact Report/Supplemental Environmental Impact Statement appropriately.

USACE Response: Adopted.

Action taken: The Executive Summary and some text in chapters within the Final Feasibility Report have been changed to remove through-levee seepage as a concern. As stated in the Final Geotechnical Design Appendix, the only documented case of through-levee seepage causing a problem for the FRWL was during the 1986 flood, when the landside levee slope became saturated and bulged outward in downtown Yuba City. A stability berm was constructed at that location after the 1986 flood, and a cutoff wall was constructed through the levee crest at that location after the 1997 flood.

Recommendation 2: Include risks in the development of geotechnical fragility curves. If the risks are not considered significant, revise the text of the executive summary. Alternatively, if the risks are as described in the Geotechnical Analyses for Pre-Design Formulation, explain why the through-seepage problems are not significant enough to include in the determination of geotechnical fragility curves.

USACE Response: Adopted.

Action taken: The Executive Summary (and some text in chapters within the Final Feasibility Report) have been changed to remove through-levee seepage as a concern.

18. **IEPR Comment – *Low Significance* Evidence is not provided to support using slurry cutoff walls for levee underseepage instead of other repair options such as seepage berms and relief wells; therefore, it cannot be determined whether the optimum solution to seepage management was selected.**

There is one recommendation as part of this comment which was adopted, as discussed below.

Recommendation 1: Conduct a value engineering analysis that examines alternative repair options for levee underseepage.

USACE Response: Adopted.

Action taken: USACE reviewed and concurred with an analysis done by the Sutter Butte Flood Control Agecny (SBFCA) 408 design team on a reach-by-reach cost comparison of two repair methods as part of their plan formulation process. This is documented in Chapter 9 of the Pre-Design Formulation Report (PFR) (the main report, not the Geotechnical Appendix to the PFR). In general, the two measures compared were a fully-penetrating cutoff wall and a seepage berm; in some reaches, a shallow cutoff wall was combined with the seepage berm. For most reaches, the fully-penetrating cutoff wall was the lowest cost of the two measures. USACE, as part of the Lower San Joaquin River Feasibility Study, did a cost comparison between seepage berms (Fix 3) and cutoff walls (Fix 6) of various depths. The Lower San Joaquin study showed that cutoff walls, unless they are very shallow, have a lower cost per foot than seepage berms. These results are highly representative of similar study areas (such as Sutter) within the California Central Valley. Real Estate and Environmental mitigation costs are very high

in California. Relief wells have a relatively low initial cost to install, but they are very expensive for sponsors to maintain over the long term. Many of the LMAs do not maintain relief wells properly, resulting in a reduction of their effectiveness over the long term. For this reason, USACE only recommends relief wells at locations where no other remediation method is possible.

19. IEPR Comment – *Low Significance* –. With regard to the future with-project conditions, the 50-year period of analysis extends over different years for different analyses, and some conditions are not evaluated.

There are two recommendations as part of this comment, all of which were adopted, as discussed below.

Recommendation 1: Review and confirm that the specific dates of the 50-year planning period for this project are coordinated between design, economics, climate change, and other pertinent analyses, or at least explain the differences.

USACE Response: Adopted.

Action taken: All evaluations were performed considering a 50 year period of analysis. Population projections to 2070 have been included in the Final Economics Appendix, and summarized in Section 7.1.9 of the Final Feasibility Report. The analysis shows that the anticipated population growth and associated development can be accommodated within the acreage available for development under the without project; therefore, the TSP will not result in induced development. Climate change was evaluated, as documented in the Final Hydrology Appendix, and summarized in Chapter 7, Section 7.1.1 of the Final Feasibility Report. The identification of the NED Plan and the Recommended Plan is not sensitive to the likely climate change scenarios.

Recommendation 2: Review Section 2.3 of the EIR/SEIS (Critical Assumptions Affecting Development of Future Without-Project Conditions) and confirm that all reasonable assumptions are addressed. For example, consider identifying the physical and anthropogenic changes that may occur over this 50-year period, such as sedimentation rates and population growth/decline, and assess the implications of these changes on design assumptions and alternative selection.

USACE Response: Adopted.

Action taken: Section 2.3 of the Final Feasibility Report was reviewed and the assumptions that affect the plan formulation were still deemed reasonable. Section 2.3 recognizes that if no action is taken, the geotechnical condition of the levees within the study area will slowly deteriorate in the future. Every major flood event causes internal erosion of foundation soils, which weakens the levee foundation if it is not remediated after the flood. Drainage and utility lines crossing the levee will corrode, eventually resulting in failure if the lines are not replaced or rehabilitated. This slow deterioration is not quantifiable under existing guidance for the production of geotechnical levee fragility

curves, so the existing geotechnical levee conditions, as given by the existing condition levee fragility curves, is assumed to continue into the future. Further, the existing levees are part of the authorized Sacramento River Flood Control Project. Local non-Federal levee maintenance organizations are obligated to operate and maintain the levee system in accordance with the Operation and Maintenance manuals prescribed by the government.