Post Authorization Change Report and Interim General Reevaluation Report
American River Watershed Common Features Project
Natomas Basin

USACE Response to Independent External Peer Review
September 2010

Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Department of the Army, USACE, guidance *Peer Review of Decision Documents* (EC 1105-2-410) dated August 22, 2008, CECW-CP Memorandum dated March 30, 2007, and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* released December 16, 2004.

The purpose of the report is to evaluate and recommend flood risk management measures to further reduce flood risk for the Natomas Basin, which includes the urbanized Natomas basin portion of the City of Sacramento. Natomas Basin is home to approximately 80,000 residents and has one of the highest flood risks in the nation. A catastrophic failure of the levee system around the Natomas Basin would cause an estimated loss of over $7 billion in residential, commercial and industrial property damage, imperil the health and safety of approximately 80,000 residents, and result in the closure of the Sacramento International Airport and two strategically important interstate freeways, Interstates 80 and 5. The final Post Authorization Change Report and Interim General Reevaluation Report contains final recommendations for flood risk management measures for the Natomas Basin. The report consists of a Main Report, an Environmental Impact Statement, and supporting technical appendices for each of those documents.

Battelle Memorial Institute, a non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to coordinate the IEPR of the Natomas Post Authorization Change Report and Interim General Reevaluation Report. The IEPR consisted of six individuals selected by Battelle with technical expertise in hydrology and hydraulics, geotechnical engineering, economics, and environmental science.

The Final Report from the IEPR was issued by Battelle on September 7, 2010. Overall, the report contained 35 comments. The report presented the 35 comments in categories with 6 identified as having high significance, 15 having medium significance, and 14 having low significance. Further details on each comment, such as the basis for the comment and comments cross-reference were also included.

The following discussions present the USACE Final Response to the 35 IEPR comments.

> **Comment A01 - The sequence of the plan formulation process appears to be incomplete and is hard to follow; therefore, it is difficult to determine whether the National Economic Development (NED) Plan has been correctly identified.**

USACE Response: Recommendations 1, 2, 3, and 5 were adopted. Recommendation 4 was not adopted. Additional information on the step-by-step process has been added. Each step in the incremental analysis is now shown. The tables have been extensively revised, and a column for incremental benefits has been added. The discussion has been revised to clarify that Reach D was chosen as an anchor point because the risk was highest there; namely, that the combination of probability of failure and economic consequences was the worst, not merely the worst probability of failure. The discussion has been

revised to correct the inconsistencies. The recommended plan has changed since the draft report. The recommended plan now consists of nine increments. Even though the ninth increment does not produce any net benefits, it reduces risk in an area of the basin where population is concentrated, loss of life and property damage are likely to be high, and warning time in the event of a levee failure is the least. Additionally, from a system perspective a "Last Added" analysis was not completed because this is an interim document in which levee raises were not considered for recommendation. The follow-on Common Features GRR will address optimizing the plan, including levee raises. A Last Added analysis will be performed then.

Comment A02 – The discussion of induced development as it relates to Executive Order 11988 requires clarification.

USACE Response: Adopted
While there is a development moratorium at the present time, recertification of the levees will remove it. This will allow development to continue as before. Since this project does not recommend levee raises, the levee will not be certified. Therefore, for the purposes of this interim report, there will be no induced development. However, if one considers that there will be a follow-on Common Features GRR, and in all likelihood levee raises will be recommended and the levee may be able to be recertified, development will resume. Still, there are mechanisms in place which will limit development to planned areas and planned scope. These mechanisms include the Development Impact Fee, which will generate funding for flood risk management, and the Natomas Basin Habitat Conservation Plan, which is managing large areas of the Basin for wildlife conservation. Additionally, even in the absence of this project, development could continue, if the developer is willing to build flood risk management features into the development. These could include ring levees around subdivisions or raising the sites to above anticipated flood elevations. Therefore, the conclusion is that the project, in and of itself, is not growth inducing. Recommendations partly adopted. Additional information will be added about induced development. The text will be revised to avoid the conflict regarding Step 5.

Comment A03 - The assumptions that underlie the economic analysis need to address the discrepancy in the Without-Project Conditions that might affect plan formulation.

USACE Response: Adopted
The inclusion of the remainder of the Common Features project has little to no effect on the formulation of alternatives for the Natomas Basin. The American River does not affect the Natomas Basin to the degree that it affects other areas of Sacramento. Additionally, none of the Common Features elements for the Natomas Basin have been constructed. Therefore, when considering the Natomas Basin as a stand-alone system, it is not necessary to consider the inclusion of constructed Common Features elements as part of the Without-Project Condition. A detailed narrative that clearly outlines the Without-Project Conditions will be added. This will include a narrative discussing the American River Common Features and whether or not they are included. A detailed narrative that clearly discusses the probability or likelihood of the Common Features being implemented and when the features will be completed will be added.

Comment A04 - The Post-Authorization Change Report (PACR) does not explain the alternative for the closing of the Sankey Road Gap.

USACE Response: Adopted
The Sankey Gap will be left as is because the consequences of flow from the outside of the Natomas perimeter to the inside at Sankey Gap are very small. Recommendation partly adopted. The text will describe the Sankey Gap alternative and why it was eliminated from consideration. The contradicting statements in the document will be reconciled.

Comment A05 - The most recent version of the report should reference the Environmental Impact Statement (EIS) as a report Appendix for the overall project.

USACE Response: Not adopted
It is against Corps Policy to include this as an appendix to the Planning document. It must be a stand-alone document. The Main Report will be revised to reference the EIS as a separate document. Any references to Appendix A will be removed.

Comment A06 - A conclusion or analysis on how past and current related studies or projects affect the Natomas Basin or how the proposed plan affects the overall flood risk management system needs to be included.

USACE Response: Adopted
The report has been revised to include a description of how the Natomas Basin is by and large hydraulically separate from the rest of the overall flood management system. The report explains why a solution to the problems in Natomas can be considered outside of the context of a system solution.

Comment A07 - The technical considerations contained in the rationale for eliminating certain alternatives should be further developed and results of evaluations documented.

USACE Response: Adopted
Yolo Bypass improvement were eliminated primarily because widening the bypass does not produce water surface reductions great enough to have any appreciable effect on the seepage problems in Natomas. The analyses supporting this conclusion are not included because of the volume of the document as is. The Main Report will reference these analyses and discuss the conclusions drawn from them.

Comment A08 - The non-structural measure of buyouts/permanent relocations needs to be addressed in the main report.

USACE Response: Adopted
A discussion of buyouts and relocations was added to the Main Report.

Comment A09 - Public comments on the Natomas PACR need to be addressed in the report.

USACE Response: Adopted
An appendix entitled "Public Involvement" has been added to the report. This appendix addresses every comment received on the Post-Authorization Change Report. Every comment was addressed, with a

response in the appendix and revisions to the PACR where appropriate. Additionally, the EIS contains an appendix summarizing public comments and responses.

Comment A10 - The Post-Authorization Change Report (PACR)/Interim General Reevaluation Report (IGRR) could be improved by referencing the report appendices, thereby directing the reader to more in-depth discussion of the technical details which form the basis of the conclusions.

USACE Response: Adopted
The technical appendices are referenced in the Main Report.

Comment A11 - Minor suggested changes to the document are recommended to improve the readability and understanding of the report.

USACE Response: Recommendations 1, 2, and 3 are adopted. Recommendation 4 not adopted. Grammar and reference errors have been corrected. The discrepancies in the damage amounts between Page 2-5 and Table 2-10 have been corrected. Sankey Road will be marked on the appropriate plate(s). The plates will not be inserted into the body of the report. The two history sections are required; therefore, they cannot be combined.

Comment B01 - Prehistoric Native American residents of the project area are not covered by Executive Order 12898 (Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations) and should be discussed separately.

USACE Response: Not adopted.
We agree that the inclusion of Indian Tribes under Environmental Justice should only apply when Native American residents are present within the project area and have been determined to be of minority or low-income status. That does not appear to be the case in the current project area. The repatriation of artifacts and remains is a separate issue and is guided by other regulations dependent on the land holding status. As the evidence of prehistoric occupation is sufficiently covered by in "Cultural Resources" (Section 3.8 and 4.8), the following paragraph from page 3-137 will be removed: "While not currently residing in the Natomas Basin, including the Phase 4b Project area, as a distinct population group, Native American tribes are known to have lived in the Natomas Basin in the past. Evidence of their occupation of the Natomas Basin includes known villages, midden sites, burial sites, and other artifacts as described in Section 3.8, "Cultural Resources," above. The sites of occupation by Native American tribes are considered culturally significant." And replaced by: "No Native American tribes currently reside within the project area as a distinct population group and so would not invoke Environmental Justice." Similarly the paragraph under Section 6.13, will be deleted:
"While not currently residing in the NLIP area, including the Phase 4b Project, Native American tribes are known to have lived in the Natomas Basin in the past and there is evidence of their occupation of the Natomas Basin. The sites of occupation by Native American tribes are considered culturally significant and, therefore, are addressed in this EIS/EIR." As this material is covered in the "Cultural Resources" section of the reports there should be no reason to introduce a new section of the report, and NAGPRA would not apply in this situation as no federal land exists within the project area.

Comment B02 - Construction timing related to the presence of Swainson's Hawk and the anadromous fish species should be clarified as to the potential for impacts to those species.

USACE Response: Not adopted.
Details of the periods of residence for migratory birds are located on page 3-67 of the EIS/EIR.

Comment B03 - The likelihood of Native American remains in the project area is not well documented and the interpretation of such remains as a significant effect warrants further justification.

USACE Response: Not adopted
A number of highly significant prehistoric resources have been determined eligible in project Phases 1-4a. A number of eligible resources are likely to occur in Phase 4b, as it occurs within similar environmental regimes. Prehistoric sites were often located near the river and when levees were constructed these sites were often covered by levees and in some cases materials from sites may have been incorporated into the levee. As many prehistoric mound sites have historically been leveled throughout the Sacramento River system this cultural resource has become scarce and the cumulative effect of this project on any mound sites within the project area would have a significant negative impact on the archaeological record. In addition to prehistoric sites in the project area, there were also a number of historic buildings and structures (pre-1960), many part of the Reclamation District 1000, which are likely to be impacted by this project. Most of these structures have either been mitigated for in previous projects or are not eligible for the National Register of Historic Places. The comparison of the Paleontological Record in section 5.1.5.10 is unwarranted as archaeological and paleontological sites are formed under different processes and one would not determine the presence or absence of the other. Section 5.1.5.9 was edited to reflect the significant prehistoric and historic resources that would be impacted or likely impacted by the project.

Comment B04 - The overall readability of the document could be improved by incorporating additional details and some reorganization to the plate illustrations.

USACE Response: Not adopted.
Chapter 2 plates all appear at the end of Chapter 2 (in the plates section). All other plates appear in-text. The reason is that there are so many plates in Chapter 2 that the text would be constantly interrupted by plates. Plus, there are many cross-references to the Chapter 2 plates and it is more convenient to have them in one location. In comparison, there are not many plates outside of Chapter 2.

Comment B05 - The final use for topsoil that has been stripped from farmable land areas should be reconsidered for locations where the borrow area will be transformed as detention ponds or managed wetlands.

USACE Response: Not adopted
Soil testing at borrow locations needs to be done in order to determine if the best use would be to replace the soil onto the site after borrow excavation. Farmland in the Natomas basin is plentiful, and therefore, topsoil is of little value. If it is determined that topsoil (strippings) should be used elsewhere, this would be an insignificant change to the project and would not require additional NEPA documentation.

Comment B06 - The discussion of Impacts to Fish and Aquatic Habitats is not well constructed and not thoroughly supported.

USACE Response: Not adopted
The EIS states on page 4.7-44 (top of page) that it has been determined that the outfall structures would not have a significant impact on fish migration. It is important to discuss the pumps as potential impact so the readers understand that an evaluation of this was conducted.

Comment C01 - The assumption of "no hydraulic impacts" is unclear and may not be appropriate under the "with-project" condition.

USACE Response: Recommendation 1 is not adopted. Recommendation 2 is adopted.
A discussion on the differences between the without and with project conditions is contained in Section 2.5 of the Hydraulic Appendix. Table 2-1 also summarizes the various conditions. The following italicized portion was taken from the report:
For the PAC document there is only a single without project condition that was analyzed. This condition was known as the NA3 condition in the CF GRR F3 documentation. Because previous nomenclature used was confusing, a new naming system was developed. The NA3 condition is now known as the Authorized Common Features + Joint-Federal-Plan + Dam Mini-Raise (ACF + JFP + Dam Mini-Raise). This plan includes all previously authorized work constructed and unconstructed on the American River, the new spillway being constructed at Folsom Dam and the future planned raise of Folsom Dam. All this is considered the without project condition. Any work beyond the without project condition, being proposed under the PAC, is the with-project condition. The with-project condition can be divided up into 2 increments – 1. Fix levee to the existing top of levee and 2. Fix levee to the existing top of levee including levee raise. Levee raise cannot be recommended (due to issues previously discussed) but was analyzed as part of the PAC. The only hydrologic/hydraulic difference between the without project condition and the with-project condition (without levee raise) is the peak flow on the American River is higher due to routing changes (for the 200-yr event, without project it is 145k and for with-project it is 160k). For the with project condition, where levee raise is considered, the levees were raised to not allow any overtopping under any condition for all levees within the project area including American North and South areas. All other levees within the system remained the same and were not raised. This plan is known as the selected levee raise plan (SLR). In summary the 3 conditions analyzed as part of the PAC include (See also Table 2-1):

1. Without Project = ACF+JFP+RAISE = NA3

2. With-Project = Fix to existing top of levee

3. With-Project with SLR = Fix to existing top of levee + levee raise.

Further clarification will be provided in Section 2.5 and 4.3.5. The Natomas work primarily calls for landside fixes of levees that do not change in channel geometry or characteristics, so the hydraulics do not change. The only major change, from a hydrologic perspective, for the with-project condition (fix levee to top of levee increment), are the flood hydrographs on the American River from Folsom Dam. This results in some increase to the water surface elevation for the 200-yr event for reaches in the lower part of the Natomas Basin, with a maximum change of 0.52 ft for Reach I (there are no increases in water surface elevation for any other event or location). However, this change in flow from Folsom was made to reflect an expected future change outside the levee work being proposed as part of the PAC,

and cannot be construed as an impact resulting from work in Natomas. Future studies under Common Features will consider overall hydraulic impact that include all increments under Common Features as well as the potential hydraulic impact of raising levees surrounding the Natomas Basin.

Comment C02 – The assumption of stage-frequency relationships for reaches F, G, and H as described in the first paragraph of Section 4.1 in Appendix D is not well supported by Figure 2-14.

USACE Response: Adopted.
Additional clarification was provided in Section 4.1 to explain how stage values were derived. To further clarify: Peak stage data for all index points was derived in the same manner - they for most frequency events were taken directly from the HEC-RAS model results (1-yr and 2-yr event stage data was derived in a different process discussed below). The documentation was attempting to distinguish between index points that used flow-frequency and stage-discharge relationships or simply stage-frequency relationships. The use of flow-frequency and stage-discharge relationships in FDA are preferable, however, currently FDA requires an increasing flow value for an increasing stage value. Model results show that this is not achieved for reaches A, D, E, F, G H due to backwater effects. Downstream conditions also seem to impact Reach H such that flow values are less for larger events and thus a stage-frequency relationship was used.
Additional discussion is provided in the report about generating stage values for the 1-yr and 2-yr events. This discussion applies to all index points (however, Reaches F, G, and H were not adjusted for the 2-yr event because no reliable gage data was available). It was generally known that 2-yr stages over-predicted stage values using the current hydrology in the model and that more realistic values for the 2-yr event could be derived from gage data. 1-yr event stage data was also derived using the gage data.

Comment C03 – The approach for generating peak flow frequency curves for Dry and Arcade Creeks should be clarified by providing the relationship for the development of peak flows, and a statement discussing the amount of floodplain storage being utilized in the routing of flood flows.

USACE Response: Not adopted
Basis for Comment: Paragraph 1 – "In the last paragraph on Page B3-2 and again in the last paragraph on Page B3-5, statements are made regarding developments/adjustments of peak flows based on drainage area relationships. However, no description of these relationships is provided."

Response: Peak and 1-day flows were estimated for Dry Creek near Roseville gage (drainage area = 78.2 sq.mi., state gage A00040, period of record 1951-1966) based on flow records for Dry Creek at Royer Park gage (drainage area = 57.9 sq.mi., state gage A00037, period of record 1967-1982). Peak and 1-day flow frequency curves for Dry Creek near Roseville, using a record of 1951 to 1982, was included in the Dry Creek Hydrology Office Report Supplement No. 1, Dry Creek Basin, Placer and Sacramento Counties, CA, March 1985, revised July 1986. The hydrologist who developed the relationship between the "near Roseville" gage and the Royer Park gage has been retired for over 15 years and is no longer in contact. The following relationship has been found in the backup data for the 1985 Dry Creek Hydrology Report and may be the relationship used to estimate the peak flows for the "near Roseville" gage.
Peak for Roseville gage (in csm) = 1.29 * (one-day flow at Royer Park gage, in csm) + 2.39

Reference 3 ("Statement of Findings"… "Peer Review," dated 6 November 1996) in Appendix B3, accepted the estimated peak flows for Dry Creek near Roseville, based on the Dry Creek at Royer Park gage, for water years 1968, 1970-1975, 1978-1981. The "near Roseville" gage peak flow frequency curve developed during the "Peer Review" is included on Plate 4 in Appendix B3.

Basis for Comment: Paragraph 2 – "Also, in Table 1 (Page B3-3), the flows for the HEC-1 calibration are lower at NEMDC than at Vernon Street. At first glance, this would seem unlikely since one-third of the watershed contributes between these two locations. However, it is recognized that there may be a significant amount of floodplain storage being utilized which exists between these nodes. The follow-up discussion in Section 7.6 (Pages B3-32 to B3-22) is good, but information may be needed earlier in the report to avoid confusion.

Hydrology Response: Appendix B1, Plate 4 shows the Average Annual Precipitation map for Dry and Arcade creeks. While this report does not include a topographic map, the increase in rainfall from west to east is due to the orographic effect from the orographic effect of the watersheds' extension into the Sierra foothills. The increasing rainfall pattern from west to east is also evident in the isohyetal maps for 6 historical storms over Dry and Arcade creeks (Plates 5 – 10). The elevation of the Dry Creek near Roseville gage is about 100 feet. The Dry Creek headwaters extend up to 1200 feet. While Dry Creek downstream of the Roseville gage is about one-third of the drainage area, a lot more than two-thirds of the rainfall occurs to the east and northeast of Roseville, due to the orographic effect. Dry Creek from the Roseville gage down to Steelhead Creek is mostly below 100 feet. The rainfall and contributing runoff is a lot smaller. The routing parameters in the Dry Creek computer model between the Roseville streamgage and Steelhead Creek downstream can have the effect of attenuating the peak flow more than local downstream flow may be able to replenish it. So the peak flow for Dry Creek at Steelhead Creek can be lower than the peak flow at the Roseville gage, especially for the 10% chance and rarer flood events.

Also, the upper watershed of Dry Creek consists of four streams (Secret Ravine, Miners Ravine, Antelope Creek, and Clover Creek) flowing in parallel channels southwest toward Roseville. The flows in those channels combine less than three miles upstream of the Roseville streamgage. This stream distribution pattern tends to concentrate higher peak flows downstream at the Roseville streamgage. Downstream of Roseville the flow pattern is different, with inflow from small tributary watersheds combining singly with Dry Creek.

The most recent previous hydrology report, the Dry Creek Hydrology Office Report, revised April 1988, showed a similar decrease in Dry Creek peak flow between Roseville and Steelhead Creek for the 10% through 1.0% chance floods.

Comment C04 – A clarification of the higher FLO-2D water surface elevation relative to the HEC-RAS water surface at the upstream end of Figure 1-8 needs to be provided.

USACE Response: Recommendation 1 is adopted. Recommendation 2 is not adopted.

Additional clarification will be provided in the report. Figure 1-8 is a remnant of previous documentation for the North Area FLO-2D hydraulic model. The model was expanded to include the Natomas Basin. The differences in the water surface elevations are attributable to the modeling differences between HEC-RAS and FLO-2D. HEC-RAS models the floodplain area using storage areas. The tailwater in HEC-RAS storage areas first fill low spots in the floodplain as opposed to the area

directly next to the landside of the levee. Also, the levee breach width in HEC-RAS does not equate to the FLO-2D grid element width and can artificially "stack" up water. The elevations in Figure 1-8 were adjusted so they are on the same datum.

Comment C05 –The location of the storage areas in relation to cross section locations in the HEC-RAS model is unclear.

USACE Response: Not adopted
Figure 2-1 shows locations of the storage areas in the model. The cross sections deleted were at the upper end of the Natomas Cross Canal (as it curves from a northeast direction to a southeast direction) and the entire Pleasant Grove Creek Canal.

Comment C06 – Method 2 of the procedure for the downstream boundary condition requires some additional clarification to be differentiated from Method 1.

USACE Response: Not adopted
The downstream boundary does not impact the Natomas PACR and is being further considered in the Common Features General Reevaluation Report that includes areas that may be impacted by the downstream boundary condition used.

Comment C07 – The effect of the datum differences on frequency-damage curves for the Natomas Basin needs additional clarification.

USACE Response: Adopted
Further clarification was provided in the report in Section 3. A breach hydrograph generated from HEC-RAS is developed and explicitly input into FLO-2D. The breach hydrograph most likely is the same regardless if the modeling in HEC-RAS was done in NGVD'29 or NAVD'88 (the floodplain and channel information in HEC-RAS was on the same vertical datum). This hydrograph was then input into FLO-2D. The FDA analysis uses the depth-damage information from FLO-2D and the in channel stage information from HEC-RAS. The HEC-RAS information is adjusted to NAVD'88 from NGVD'29 for use in the FDA model using the best available information.

Comment C08 – The discussion of hydraulic uncertainty in Section 4.2.1 requires clarification.

USACE Response: Not adopted
Calculations to determine the natural uncertainty were done using metric units. The resulting answer was then converted to English units. This will be noted in the report.

Comment C09 – Figures 2-14, 2-17, and 2-20 should label the pump station location along the profile to avoid confusion.

USACE Response: Adopted
The pump station has been labeled on the NEMDC profiles.

Comment C10 – The adjustment to the 2-year stages provided in Section 4.1 need additional details.

USACE Response: Recommendations 1&2 are adopted. Recommendation 3 is not adopted.
Further clarification will be provided in the documentation in Section 4.1. There was one index point for each reach. The index points also represented levee breach locations. 1-yr and 2-yr stages were derived using nearby gages. Four different gages were used in making translations and a gage was only used for a particular reach if it was expected to respond similarly to the gage location. For example the Verona gage was used to translate data for index points on reaches B and C on the upper Sacramento River and reach D on the Natomas Cross Canal. All were in relative close proximity and were expected to respond similarly in a flood event. No adjustment was made for the 2-yr event for the Upper NEMDC because no reliable gage data was available. It is recognized that various means could be employed to translate data from the gage to the index point, however, the values for the 1-yr and 2-yr stages are generally not critical to the analysis, and are used as placeholders for the FDA analysis.

> **Comment C11 – It is unclear whether the discussion of the backwater effects on levee breaches in the HEC-RAS model pertains to tailwater on the other side of the breach, or backwater from another flooding source.**

USACE Response: Not adopted
Further clarification will be provided in Section 1.12. "Backwater" does refer to tailwater in this instance. The HEC-RAS model storage areas are based upon the same terrain data from which the FLO-2D model is made up. The HEC-RAS storage areas were adjusted from NAVD'88 to NGVD'29 so that the storage areas in the HEC-RAS model are on the same datum as the channel geometric features. Eventually the entire model will be adjusted to NAVD'88 for future study efforts. Reference to Figures 1-12 and 1-13 will be corrected. Figure 1-12 should refer to Figure 1-8. The reference to Figure 1-13 will be deleted. A previous version of the FLO-2D documentation referred to the North and South model. For the Natomas PAC, only the North model is needed and all reference to the south model was to be deleted.

> **Comment D01 - Document readability and clarity of Appendix F would be improved by including an additional figure at the beginning of the document labeling levee miles within each reach**

USACE Response: Adopted
Agree that readability and clarity of Appendix F would be improved by providing levee miles within each reach on a figure. Recommendation was adopted to update Figure 5-1 to include labels of levee miles with the planning reaches.

> **Comment D02 - Document readability and clarity could be improved by showing without project and with project combined fragility curves.**

USACE Response: Adopted.
Agree that the readability and clarity could be improved by showing the without and with project combined fragility curves in one figure. Recommendations 1 and 2 were incorporated into the document by including an additional figure for each reach that shows the combined without and with project fragility curves. Additional text for each reach was added to discuss how the project changes the corresponding fragility curve.

Comment D03 - A validation of historical experience of flood height and levee performance should be provided to support the fragility curve for levee failure which seems high for some reaches.

USACE Response: Not adopted.
The probabilistic geotechnical analysis and the levee fragility curves were prepared in accordance with USACE policy. Observed past performance was accounted for in the judgment portion of the fragility curves and no further analysis or figures accounting for historic past performance will be included in the report.

Comment E01 – The incremental analysis floodplain assignments (i.e., water surface profiles) used to perform the increments, or order of fixes, is unclear.

USACE Response: Not adopted

Revisions to Chapters 5, 6, 7a, and 7b have been made in order to more clearly explain the incremental analysis approach, including the method used to assign floodplains for each incremental fix. A revised explanation of the incremental analysis approach is provided below.

Nine suites of without-project floodplains (one for each reach) were developed through Hydraulic modeling by the Hydraulic Design Section; a total of 63 without-project floodplains, therefore, were developed. In performing the incremental analysis, once a levee reach was fixed the floodplains associated with events unlikely (as determined using annual exceedance probability and geotechnical fragility curves as gages) to cause a levee breach (post-fix) in that reach were effectively removed from the "mix."

The order of increments described in Chapter 6 of the Economic Appendix and used to perform the incremental analysis was based on reach-specific expected annual damage (EAD) results and reach-specific annual exceedance probability (AEP) results obtained from the base HEC-FDA modeling and reported in Chapter 5; these results informed/guided the order of increments outlined in Tables 6-7 and 6-8. The order was based on a combination of AEP and EAD values for each reach. Generally, a reach with a high AEP also had high expected damages (e.g., NAT D); the reach with the highest AEP would be fixed first. After this fix, the reach with the next highest AEP was considered the "weakest link" in terms of performance in the Basin and so would be fixed next. The "floodplain assignments" (which are really flood depths taken from the floodplain of the reach listed in the tables) displayed in Tables 6-7 and 6-8 show the progression (i.e., reduction in the number of floodplains from the total mix of floodplains) as each reach is fixed. Based on AEP base modeling results, the reaches in the Major area would be ordered as follows: D (AEP = .21), A (AEP = .20), E (AEP = .18), B (AEP = .12), C (AEP = .04), H (AEP = .04), and I (AEP = .015). In the case of reaches C and H, where AEP is the same, EAD was used to determine which reach would be fixed first. Here, reach C had a much greater EAD value than reach H ($215 million for C versus $76 million for H), so C was selected to be fixed before H. For increment 2, NAT E was selected as the next "weakest link" in the Basin, since NAT D was already fixed in the prior increment and NAT A is being fixed in this increment; floodplain assignments for each frequency event were selected based on the remaining floodplains in the "mix" after taking into consideration 1) those reaches that have already been fixed 2) those that still need to be fixed and 3) the floodplains still in the mix that result in the most severe consequences (damages) for each frequency event. So, for increment 2, since NAT D and NAT A have already been fixed, some of their event floodplains can be removed from the mix, but some of their event floodplains still remain (e.g., NAT D's 100-yr through 500-yr, since even

with the fix NAT D has an AEP of .015). Once a floodplain is removed from the mix, the floodplain with the greatest consequences still remaining takes its place, per frequency event. For increment 2, NAT B's 2-yr and 10-yr event floodplains were assigned since these produced the most consequences (as shown in Tables 5-23 to 5-33), higher than any other remaining event floodplains, including reach E's.

The Natomas Basin is surrounded by levees, which have been evaluated to be in poor condition due to seepage and stability issues. The Basin can be characterized as a "bathtub", and any flooding from a levee breach under either without-project conditions (before a fix) or under with-project conditions (after a fix or multiple fixes), would result in similar types of flooding (floodplains), per reach. The differentiating factor, then, between the without-project condition and with-project condition is the chance of a breach occurring, which is represented in HEC-FDA by without-project and with-project geotechnical fragility curves. In the base HEC-FDA modeling completed for each reach, the same floodplains were used to evaluate the without-project and with-project conditions as well as the modeling completed to perform the incremental analysis, in which without-project floodplains were assigned after each incremental fix. Within HEC-FDA, the primary factor used to differentiate between the without-project and with-project conditions were the geotechnical fragility curves, which determine at which point (stage) the levee is likely to breach.

It is believed that the nature of flooding in the Natomas Basin does not warrant additional hydraulic modeling to develop with-project floodplains. The incremental analysis was based on suites of without-project floodplains developed through hydraulic modeling for each of the nine index points. Additional details regarding the incremental analysis approach has been incorporated into the Economic Appendix.

> **Comment E02 – The technical soundness and clarity of the incremental benefit analysis could be improved by performing a "last added" increment as a separate action.**

USACE Response: Not adopted

In the Natomas Basin, levee reach NAT D was determined to be the starting point for the incremental analysis. Flooding associated with a breach in this reach was characterized by an annual exceedance probability (AEP) of .21 and expected annual damages (EAD) of $462 million – the worst of any of the reaches. Incremental fixes were ordered based on first fixing the reach in the Basin considered the "weakest link" (in terms of the chance of flooding and the consequences of flooding), and then moving on to the next "weakest link" until all levee reaches around the entire Basin were fixed. In effect, this incremental approach accomplishes the same optimization objective as a "last added" analysis would, since increments were ordered 1) based on overall risk of flooding in the Natomas Basin and 2) with the objective of reducing flood risk on a Basin-wide basis. With this objective in mind, specific fixes around the Basin can be thought of as being synergistic with other fixes – one incremental fix relies on another incremental fix in order to reduce the flood risk on Basin-wide basis. Eliminating increments as they have been presented in the Economic Appendix, therefore, would result in little to no additional benefits (since there would be little to no reduction in risk both in terms of the chance of flooding and the consequences of flooding, on a basin-wide basis) but would result in additional costs associated with the last reach added. In other words, from a risk reduction perspective, it would not be cost-effective to fix lower-risk reaches before fixing any higher-risk reaches.

The order of increments presented in the documentation is the result of an iterative analytical process that considered both the chance of flooding and the consequences of flooding in order to reasonably represent the overall risk of flooding in the Natomas Basin as a whole. A "last added" analysis is

inherently captured in the incremental analysis as a result of the approach used to evaluate fixes around the Basin; this approach (incremental fixes around the basin, assigning flood depth data for each increment) was used to address the multiple-source flooding/single target situation posed by the Natomas Basin study area.

The explanation of the incremental analysis as presented in the previously-submitted Economic Appendix was unclear. Additional information regarding the approach used to perform the incremental analysis has been incorporated into the Appendix.

> **Comment E03 – A detailed narrative on the major economic assumptions is provided, but does not address the likelihood that the proposed modifications assumed for the NA3 condition will occur.**

USACE Response: Adopted.
The description of the without-project condition in the Economic Appendix is unclear. In the Appendix, the terms "no action condition" and "without-project condition" were discussed. The "no action condition" assumes that no additional features would be implemented by the Federal Government or by local interests to achieve the planning objectives, over and above those elements of the Common Features project that will have been implemented prior to reauthorization of the project. The "without-project condition" assumes that none of the features of the American River Common Features Project have been implemented. While this distinction is important when applied to the American River South and American River North Basins (both of which will be evaluated in the GRR), it does not apply to the Natomas Basin (which is the focus of this PAC). For the Natomas Basin, the "without-project condition" is the same as the "no action condition" since none of the features of the Authorized Common Features Project has been built or will be built prior to any reauthorization. The term "without-project condition," the basis for which all alternatives are measured, will be used in Economic Appendix.

The Economic Appendix has been revised to more clearly state the without-project condition and any assumptions attached to this condition used in the economic analysis. The Economic Appendix for the GRR, where proposed modifications (components of Authorized Common Features, Joint Federal Project, and mini dam raise) do affect the American River South and North Basins, will address the likelihood and timing of implementation of these proposed modifications.

> **Comment E04 – The sensitivity analysis on net benefits considering rebuild period and decreasing inventory is well supported and documented but needs to be clarified.**

USACE Response: Adopted
Revisions have been made to Chapter 7b to more clearly explain the @Risk model, the assumptions captured in the model, the data inputs required to run the model, the incremental analysis performed in the model, the results (damages and benefits) obtained from the model, and the revised net benefit and benefit-to-cost analyses.

Following agency technical review (ATR), it was determined that the economic assumptions (post-flood rebuild period, decreasing inventory, and the cap to the number of flood events allowed to occur over the 50-year period of analysis) accounted for in the @Risk analysis more accurately represented the "real world" if flooding should occur in the Natomas Basin. Therefore, the expected annual damages and benefits results obtained from the incremental analysis performed in the @Risk model, instead of the damages and benefits derived from using the HEC-FDA model, were used as the basis for plan

formulation. Consequently, plan formulation was based on a revised without-project expected annual damage (EAD) value of $462 million, which is about a 67% reduction from the HEC-FDA EAD of approximately $1.4 billion.

The incremental analysis results performed using the @Risk model follows closely those results obtained using HEC-FDA on a relative basis. The major differences lie in the magnitude of without-project damages (starting point for the incremental analysis) and the benefits derived after each incremental fix – in absolute terms. This difference in magnitude of damages and benefits stem from the additional assumptions considered in the @Risk model – the rebuild period, the decreasing inventory, and a cap to the number of flood events/rebuilding cycles realized over the 50-year period of analysis, which are assumptions that cannot be incorporated into the HEC-FDA model.