Fargo-Moorhead Metropolitan
Flood Risk Management Feasibility Study
North Dakota and Minnesota
Feasibility Report and Environmental Impact Statement

USACE Response to Independent External Peer Review
November 2011

Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Department of the Army, USACE, guidance *Civil Works Review Policy* (EC 1165-2-209) dated January 31, 2010; 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.

This flood risk management feasibility study was authorized by a Resolution of the Senate Committee on Public Works adopted on 30 September 1974. The Fargo-Moorhead metropolitan area was included in the Red River Reconnaissance Study approved in 2002. However, that study was not in sufficient detail to recommend a feasibility study specifically for the Fargo-Moorhead metropolitan area. A supplemental reconnaissance report recommending this feasibility study was approved by the Mississippi Valley Division on April 8, 2008. Based on the supplemental reconnaissance study findings, the cities of Fargo and Moorhead and the Federal Government entered into a Feasibility Cost Share Agreement on September 22, 2008 with the cities of Fargo, North Dakota, and Moorhead, Minnesota, as non-Federal sponsors. The study cost share was 50/50 between the Federal Government and the two non-Federal sponsors. The Corps of Engineers issued a notice of intent to prepare an environmental impact statement in the Federal Register on May 5, 2009.

IEPR for the feasibility study was completed in two separate but coordinated reviews; the responses presented here reflect the actions taken to address the comments from both IEPR reviews. The U.S. Army Corps of Engineers (USACE) St. Paul District completed a draft feasibility report recommending a project to address flood risk management and recreation needs of the study area in February 2010. An IEPR of the draft feasibility report, draft environmental impact statement, and technical appendixes (DFR/EIS) was initiated in February 2010, and the documents to be reviewed were provided to the IEPR panel in March 2010. The first Final IEPR Report was completed in May 2010, and the USACE/IEPR panel comment and response process was completed in July 2010.

Subsequent plan formulation resulted in substantive revisions to the documents that had undergone IEPR. These revisions were sufficient to warrant the development of a supplemental draft feasibility report and an IEPR of the changes. A second IEPR of the supplemental draft feasibility report, environmental impact statement, and technical appendixes (SDFR/EIS) was initiated in April 2011. The final IEPR report was completed in July 2011, and the USACE/IEPR panel comment and response process was completed in August 2011.

Battelle Memorial Institute, a nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to coordinate the IEPR of the Fargo-Moorhead Metropolitan Flood Risk Management Draft Feasibility Report and Environmental Impact Statement. The IEPR panel consisted of five individuals selected by Battelle with technical expertise in biology/National Environmental Policy Act compliance, hydrology/hydraulic engineering, geotechnical engineering, civil design/construction cost engineering, and economics. The same panel members reviewed both the DFR/EIS and SDFR/EIS.

After the Feasibility phase, a project with a signed Design Agreement, moves into Pre-Construction, Engineering, and Design phase (PED) to continue to refine and develop plans and specifications for the project. During PED, the USACE team will be better able to answer specific questions regarding certain project elements at that time.

IEPR on DFR/EIS

Battelle issued the final report from the first IEPR on May 17, 2010. The final IEPR report contains a total of 23 comments categorized by level of significance: 7 comments are identified as having high significance, 13 are identified as having medium significance, and 3 are identified as having low significance.

> 'High': Describes a fundamental problem with the project that could affect the recommendation or justification of the project.
> 'Medium': Affects the completeness or understanding of the reports/project
> 'Low': Affects the technical quality of the reports but will not affect the recommendation of the project."

USACE commends the IEPR Panel for their grasp and understanding of this important project; their prompt comments were instrumental in maintaining the project schedule. The following outline summarizes USACE actions which addressed each recommendation for each of the comments provided.

The following discussions present the USACE Final Response to the 23 IEPR comments.

1. IEPR Comment – High Significance: There are insufficient geotechnical analyses to justify the proposed channel slopes, channel depth, spoil pile configuration, cost estimates, and real estate requirements for the North Dakota Diversion Alternative.

USACE Response: Adopted

Action Taken: The final feasibility report, Section 3.14.2, presents revised comparative costs for both the North Dakota Diversion and Minnesota Diversion Alternatives at equivalent levels of detail. More detailed analyses, including analysis of spoil pile configuration and real estate requirements, will be conducted during final project design to insure the most economical design providing an acceptable factor of safety.

The final feasibility report, Appendix I – Geotechnical Engineering, provides revised descriptions reflecting the subsequent geotechnical analyses that uniformly evaluates and

describes the two diversion alternatives with adequate factors of safety. The diversion channels and associated hydraulic structures have been re-analyzed from a hydraulic engineering perspective, taking into account the more detailed geotechnical engineering analyses of the diversion channels. The excavation quantities are based upon the geotechnical/hydraulic analyses and the cost estimate has been revised accordingly. This additional geotechnical analysis, that includes slope stability, has resulted in significant design changes to incorporate an adequate factor of safety. These design changes include changes in channel invert elevation, channel bottom width, and the need to incorporate benches in the side slope design. These descriptions will continue to be refined as more detailed analyses are conducted during final project design.

In the final feasibility report, Appendix J – Structural Engineering and Appendix B – Hydraulics, hydraulic structures associated with the two diversion channels have been included as integral components of the two alternatives. Future final project design studies will include more detailed geotechnical and hydraulic analyses of hydraulic structures.

2. IEPR Comment – High Significance: The stability of the channel slopes, foundation deposits, and related spoil piles should be evaluated using ultimate or near ultimate soil strength values for the End of Construction (EOC) condition.

USACE Response: Adopted

Action Taken: The draft feasibility report uses long-term stability analyses as the controlling factor in determining slope configuration for the diversion channels and spoil piles, while the panel felt that short-term or "end of construction" (EOC) conditions may be a more important consideration. Based on the IEPR comment, the undrained shear strength tests were reviewed and ultimate shear strength parameters were selected. The EOC conditions were checked using the ultimate shear strength parameters for a uniform spoil pile setback of 50 feet. In those instances where the factor of safety fell below the minimum requirement, the spoil pile height was lowered to meet the minimum factor of safety requirement.

The approach addressed the concerns raised in the panel's comment, albeit though a different method of analysis. The USACE recognizes that a coupled Sigma/W and Slope/W analysis recommended by the IEPR panel would be another means of evaluating the stability of the excavated channel, like used in the evaluation of the I-94 abutment failure in Fargo. The Sigma/W analysis would estimate pore pressures during excavation of the channel and placement of the spoil material and then an effective stress limit equilibrium slope stability analysis could be completed using Slope/W and effective stress parameters. Due to the lack of actual field data the Sigma/W and Slope/W models cannot be calibrated as in the instance of the I-94 Interchange embankment. A number of assumptions would be required for these analyses and could lead to more uncertainty in the results. It is felt that using ultimate undrained shear strength parameters to evaluate the EOC condition is adequate for the feasibility stage of the project. In addition, the feasibility report analyses for slope stability are considered sufficiently detailed and uniform to make comparisons between alternatives for planning purposes. More detailed slope stability analyses during final project design will include both long-term and EOC conditions.

3. IEPR Comment – High Significance: An explanation should be provided for the difference in channel bottom width dimensions between the Red and Wild Rice Rivers and the downstream end of the diversion for the North Dakota East Diversion Alternative.

USACE Response: Adopted

Action Taken: Detailed hydraulic modeling was completed on the North Dakota Diversion channel which verified that the conveyance was adequate with the varying bottom widths. This is because conveyance is a function of channel bottom width, channel depth, side slopes, manning's n values and wetted perimeter. The slope, cross section, and other details of the channel were continually refined and adjusted throughout the study, as additional information became available. The design was constrained by different factors at different locations, including geotechnical and cost considerations that limited channel depths, widths and slope. The final feasibility design balances these concerns to provide the necessary conveyance at each location. An explanation was provided in the final feasibility report, Attachment 5, to better explain the hydraulic conveyance capacity. Paragraphs discussing the hydraulic design for the North Dakota Diversion and plots showing water surface profiles, invert elevations and conveyance were added to Attachment 5.

4. IEPR Comment – High Significance: Physical hydraulic modeling and computational fluid dynamics (CFD) modeling studies should be conducted on the project hydraulic structures and flow conditions described in Figures 17, 18, 19, 20, 21, and 22.

USACE Response: Adopted

Action to Be Taken: During the design phase, both physical and additional numerical modeling of the main hydraulic structures will be completed. The actual definition of the scope of this work will follow after completion of the final feasibility report. Calibrated numeric models will be used to optimize the design of the hydraulic structures and their interaction with the North Dakota Diversion channel.

5. IEPR Comment – High Significance: A three-dimensional (3D) hydrodynamic model, rather than a two-dimensional (2D) hydrodynamic model should be used to compute the flow velocity field and flow depths at the Red River Control Structure.

USACE Response: Adopted

Action to Be Taken: The suggested modeling will be completed during the design phase. The analysis completed to date, as described in the following paragraph, is adequate for feasibility level investigation. During the design phases both physical and (additional) numerical modeling of the main hydraulic structures will be completed. The actual definition of the scope of this work will follow after completion of the final feasibility report, and during the design phase it will be determined if a 3D hydrodynamic model is warranted.

The depth-averaged model (RMA2) used for modeling the flow at the Red River Control Structure served a primary purpose: compare the flow velocity distributions (across the channel

or control structure) with-project and without when the gates are fully open. The total width of the control structure is similar and even wider than the width of the natural cross section for the flows modeled with RMA2. Therefore, we consider it valid to assume hydrostatic water pressure distributions. The other issue to clarify is that the footprint area of the Red River Control Structure will consist of a 36 inch-thick concrete pile cap, combined with scour protection upstream and downstream of the crossing. Therefore, we believe considerations about scour and erosion have been properly addressed in the feasibility designs.

6. IEPR Comment – High Significance: The plan acceptability discussion should be expanded to include the impacts and risks associated with each alignment alternative such as flood plain impacts, upstream and downstream effects, and tolerable risks.

USACE Response: Adopted

Action Taken: Additional analysis was conducted on the flood plain impacts, upstream and downstream effects and tolerable risks for each of the plans in the final array. The discussion of acceptability, Section 3.8.3.4, was expanded to present the additional information.

7. IEPR Comment – High Significance: The No-Action Alternative should be clarified by incorporating a discussion of flood fighting in the cost-benefit calculations.

USACE Response: Adopted

Action Taken: Section 2.3.3 of the feasibility report was expanded to discuss assumptions about flood fight success, and a sensitivity analysis was added to the Economics appendix. The sensitivity analysis showed that the selected plan would be economically justified even if full consideration was given to emergency measures. USACE chose not to consider emergency actions in the No-Action alternative, even though they have historically been successful as flood fights are not fully reliable over the long term, they are reliant on predictions from the National Weather Service, and the project area is in the upper portion of the basin with short times to respond.

8. IEPR Comment – Medium Significance: The proposed re-establishment of river channel meanders along previously straightened portions of the Red River and its tributaries presents a potential high risk of streambank erosion and earth slides and should be evaluated.

USACE Response: Adopted

Action to Be Taken: The mitigation included in the final feasibility report is at the appropriate level for this feasibility study and was acceptable to resource agencies. The mitigation for this project will be further developed in the design phase in which streambank erosion and earth slides would be evaluated and closely coordinated with the environmental resource agencies.

9. IEPR Comment – Medium Significance: A more comprehensive analysis of sediment characteristics (i.e., size distribution) and sediment transport (i.e., bedload and suspended load) is needed for the Red River of the North and its tributaries.

USACE Response: Adopted

Action Taken: The United States Geological Survey (USGS) collected erosion and sedimentation data during the spring of 2010 flood event, the spring 2011 flood event, and during the summer and fall of 2011; the information from the spring of 2010 was available in December 2010. Preliminary results from the 2010 flood showed that there was very little bed material, and the amount varied throughout the event. In addition, field investigations (surveys of the physical habitat) were completed in 2011.

Watershed sediment erosion and yield analyses of the Sheyenne, Wild Rice, and Maple Rivers were performed and added to the report, Appendix B - Hydraulics. Detailed geomorphic assessments of the Red River and tributaries will be performed prior to and following construction. This will address the issues of scour, deposition and sediment transport. This has not been included in the final feasibility report but will be completed in design. Geomorphic assessments are scheduled to be completed in calendar year 2011. (Also see the response to IEPR Comment 6 from the July 2011 IEPR comments on the following pages.)

10. IEPR Comment – Medium Significance: The performance of existing and future upstream flood control measures needs to be better quantified with respect to their effect on the magnitude and frequency of floods in the defined project area.

USACE Response: Not Adopted

The future without project conditions normally considers projects that are under construction, authorized for construction and projects that are permitted for construction as the most like to happen over the period of analysis for a study, which for this study is fifty years. Although it is acknowledged that some storage may come online in the next fifty years, it would not be nearly of the magnitude necessary to change the analysis. As part of the Fargo-Moorhead Upstream Study (FMUS) it was determined that approximately 200,000-400,000 acre feet of storage could reduce the peak 1% chance stages in Fargo by up to 1.6 feet. Others have conducted additional analyses and reached similar conclusions, particularly in looking for ways to offset the potential impacts of the diversion project. The diversion channel alternatives are able to reduce the peak stages in Fargo approximately 10 feet. The Fargo-Moorhead Upstream Feasibility Study also showed that storage is far more effective for small flood events than larger ones. Since the diversion channels are being sized for the largest flood events, incremental flood storage upstream would be unlikely to affect the design.

11. IEPR Comment – Medium Significance: The assumptions about relocating the existing rail yard for the Minnesota Diversion Alternative are a concern because of the potential environmental cleanup, increased construction costs, and potential disruption to rail traffic.

USACE Response: Adopted

Action Taken: Additional investigations and discussions have been completed regarding the potential for environmental issues and impacts to rail operations at the railyard, Main Report –

section 3.5.3.11 and 3.6.1, Appendix O, section 7.1,. Burlington Northern and Santa Fe railroad company does not believe there to be a high risk of any environmental hazards because the yard is relatively new, has been used as an intermodal site, the site is not used for cleaning or fueling in the yard. If the Minnesota alignment was selected, additional environmental analysis would be completed on the project alignment during the design phase to assess the risk to the project schedule if environmental hazards were discovered. If contamination was discovered, the costs to address cleanup would not be attributable to the project per USACE policy.

Preliminary design was completed for all of the railroad bridges and the rail yard to the specifications of Burlington Northern Santa Fe; the costs for these features are included in the final feasibility report, Appendix L - Cost Engineering.

12. IEPR Comment – Medium Significance: The conclusion that the downstream adverse effects are acceptable is contrary to the latest policy in floodplain management.

USACE Response: Adopted

Action Taken: Significantly more hydraulic modeling was completed after the first IEPR was conducted to fully define the downstream impacts of the diversion alternatives. This information was included in the draft and final feasibility reports (Section 3.8.3.4.2) presented to the public and other state and federal agencies. The selected plan was formulated (subsequent to this IEPR comment) to minimize downstream impacts, but it would cause significant upstream impacts and mitigate for them as necessary. Coordination with appropriate agencies will continue into the design and implementation phases.

Although a goal of floodplain management is to cause no impacts to flood stages, that is not always practical for large flood risk management projects. Tradeoffs must be made to achieve an overall reasonable solution. Landowners would be compensated for any quantifiable economic impacts that are determined in the USACE takings analysis. The impacts of the proposed Fargo-Moorhead project, whether upstream or downstream, are considered acceptable because the project can be implemented within the stated laws and policies of the Federal government and the States of Minnesota and North Dakota. Alternatives that would not affect flood stages were not determined to be cost effective for Federal implementation.

No additional analysis downstream would be completed on the fish and wetland habitats based on the additional flows. Although there will be minor downstream stage increases, these increases are relatively minor compared to the overall flood event and it is not anticipated that there would be any adverse impacts to the natural resources.

13. IEPR Comment – Medium Significance: The cost estimate should reflect the techniques and details used to construct the earthworks excavation in similar clay deposits for the diversion on the Red River at Winnipeg, Manitoba.

USACE Response: Adopted

Action Taken: The study team consulted with the people who designed and constructed the Winnipeg floodway project, and the information they shared is included in the final feasibility report within the Consultants' Report and this information was used to produce the cost estimates. The final feasibility study cost estimate utilized a conservative approach assuming excavation operations for 8-9 months per year rather than the year-round excavation that was used for the expansion of the Winnipeg floodway. This construction method will be considered further during the design and implementation phases. The technique of allowing the material to freeze a minimum amount could potentially make the excavation of the material below the water table more successful, both in the terms of the ability to excavate the material and the utilization of year-round construction. The downside to excavating frozen material could be the placement of the material in the spoil areas. While much of the spoil areas would not act as levees, especially for the Minnesota diversion alignment, there are some areas that would act as levees, and a proper engineered compaction will be required in those areas.

14. IEPR Comment – Medium Significance: Project cost estimates associated with non-structural flood reduction techniques need to be explained and referenced.

USACE Response: Adopted

Action Taken: Sources for unit costs and the assumptions used in developing the non-structural cost estimates were added to Appendix P in the final feasibility report.

15. IEPR Comment – Medium Significance: The statement that "the probability of success with an emergency flood fight is not zero but is very low" is confusing and contradicts historical experience.

USACE Response: Adopted

Action Taken: The discussion in section 2.3.3 about the success of past flood fights and assumptions regarding the success of future flood fights was revised to clarify the issue. (Also see the response to IEPR Comment 7.)

16. IEPR Comment – Medium Significance: The lists of land and water and economic opportunities that may arise from the execution of the project should be expanded in order to support the decision making process.

USACE Response: Adopted

The final feasibility report includes the problems and opportunities that were developed as part of the project scoping process, which included a partial list of land and water and economic opportunities that would result from a project in the study area. It was not necessary to develop a comprehensive list to formulate a feasibility level recommendation. Of the items listed in the basis for comment, only "improved traffic movement" could be quantified for use in the economic analysis of NED benefits (and was included in the final economic analysis)—all of the other suggested opportunities would not qualify for inclusion in the NED analysis but were discussed in the report.

17. IEPR Comment – Medium Significance: It is unclear if growth expansion was incorporated into the HEC-FDA model and if a sensitivity analysis will be conducted.

USACE Response: Adopted

Action Taken: The models provided to the IEPR team did not include future development. Flood Risk was reevaluated in HEC-FDA to include future development, and a full range of flood events was considered (analysis does not terminate at the 500 year event). The assumptions about future growth are consistent with the Fargo Growth Plan (2007). Growth rates presented in the Regional Economic Development study relate to changes in Gross Regional Product, rather than land use. Appendix C section 4.2.4.5 was revised to clarify the assumptions regarding growth within the study area. The use of the same growth scenario for with and without project conditions is an assumption made in order to simplify the NED analysis. See IEPR on SDFR/EIS comment 14.

18. IEPR Comment – Medium Significance: The predicted impact of the project alternatives on wetland areas would benefit from a more detailed description within the Fargo-Moorhead DFR/EIS.

USACE Response: Adopted

Action Taken: The discussion of impacts to wetlands was expanded in Chapter 5 of the final feasibility report. Prior to the first IEPR, the National Wetland Inventory was overlaid onto aerial photographs, and coordination with the Natural Resource Conservation Service was used to locate existing wetlands for the draft feasibility report. Subsequent to the first IEPR, wetland delineation and a wetland function analysis was completed for existing wetlands along the proposed alignments by USACE staff. This information was shared with environmental agencies and was included in the final feasibility report along with detailed discussion of potential impacts.

19. IEPR Comment – Medium Significance: Details for fish passage and structures need to be developed beyond the broad conceptual level.

USACE Response: Adopted

Action Taken: The final feasibility report presents significantly more detailed design of fish passage features and hydraulic structures than was provided for the first IEPR. Section 5 of the report also discusses the major design parameters and expected impacts at each structure. The design was based on additional hydraulic analysis, hydrology and flow frequency analysis, and discussion with fisheries experts regarding appropriate design parameters to facilitate fish passage. Refinements will continue to be made during the design and implementation phases.

20. IEPR Comment – Medium Significance: The overall readability of the document could be improved with some reorganization, some additional discussion, and by incorporating some of the material from the appendices into the main report.

This comment includes nine recommendations for resolution, five of which have been adopted, and 4 of which have not been adopted, as discussed below.

USACE Response: Adopted

Action Taken: The discussion of the flood histories, flood fights, and future flooding was moved to section 2.0 just before the purpose and needs section. See also the response to Comment 7. Chapter 3 was reorganized to better explain the plan formulation process, and Appendix O was also updated. The acceptability table was removed from the document as it did not add value to the report, but the information under the subject of acceptability was expanded and updated to include discussion of flood stage impacts and tolerable risks. More information regarding the screening process was included in the main report from Appendix O and Appendix I.

USACE Response: Not Adopted

Four specific editorial suggestions, regarding additional information on prior reports, inclusion of flow charts, adding executive summaries to each appendix, and inclusion of all assumptions in the main report were not adopted. In general, the suggestions related to report organization and requests for additional background information. The USACE considered the recommendations and determined that the report is adequate without them, and the likely cost to adopt them would exceed their potential added value.

21. IEPR Comment – Low Significance: There are inconsistencies in the estimated costs, flood damages, and design parameters that should be cross-checked for accuracy.

USACE Response: Adopted

Action Taken: The final feasibility report was thoroughly reviewed to cross check data presented in the text and in tables. The cost estimate was reviewed and approved by The Cost Engineering Directory of Expertise (DX), at the Walla Walla District.

22. IEPR Comment – Low Significance: The potential effect of ice jams and debris loading on the performance of hydraulic structures is unclear and should be addressed.

USACE Response: Adopted

Action Taken: The design presented in the final feasibility report includes features to address ice and debris issues, Appendix B – Hydraulics, including wide gate openings and debris barriers at specific locations. The feasibility level design was coordinated with an ice expert at the USACE Cold Regions Research and Engineering Laboratory (CRREL). Coordination with

CRREL will continue throughout the design and implementation phases to ensure that ice and debris issues are properly addressed.

23. IEPR Comment – Low Significance: The study area needs to be clearly defined in text and illustrations.

USACE Response: Adopted

Action Taken: The maps and text were reviewed and updated for the final feasibility report including Figure 1.

IEPR on SDFR/EIS

An IEPR of the supplemental draft feasibility report, environmental impact statement, and technical appendixes (SDFR/EIS) was initiated in April 2011. The final IEPR report was completed in July 2011, and the USACE/IEPR panel comment and response process was completed in August 2011. The final IEPR report contains 16 comments categorized by level of significance. One comment is identified as having high significance, twelve identified as having medium significance, and three identified as having low significance. Again,

> "'High': Describes a fundamental problem with the project that could affect the recommendation or justification of the project.
> 'Medium': Affects the completeness or understanding of the reports/project
> 'Low': Affects the technical quality of the reports but will not affect the recommendation of the project."

The following discussions present the USACE Final Response to the 16 IEPR comments. The IEPR Panel concurred and closed all comments.

1. IEPR Comment – High Significance: The potential risks, both mechanical as well as hydrologic, associated with the operation of the gates at the diversion control structures do not seem to be considered in the feasibility analysis.

USACE Response: Adopted

Action Taken: The risk of project failure is discussed in general in section 3.10.4 of the final feasibility report.

Action To Be Taken: Detailed studies including physical and HEC-RAS modeling will be conducted during the design phase to determine the proper gate and loss coefficients and to develop the ultimate operation plan for all structures. Redundancy, including the number of gates that can be used to throttle the flow more effectively and that can be operated in case of emergency, will also be investigated during the design phase.

2. IEPR Comment – Medium Significance: The risks and uncertainties associated with the performance of the hydraulic structures under dynamic conditions are not fully addressed.

USACE Response: Adopted

Action To Be Taken: Physical and numerical modeling of the control structures and the diversion inlet structure is planned during the design phase of the study. The results of the physical and numerical modeling will be used to generate rating curves for the hydraulic structures and other parameters for the engineering design. This information will allow the design team to assess the risks and uncertainties of the hydraulic structures.

3. IEPR Comment – Medium Significance: The impacts of overtopping of the CR17 tieback levee under extreme flood conditions were not evaluated, and the related potential for increased damage and loss of life was not well defined.

USACE Response: Adopted

Action To Be Taken: Overtopping of the CR17 tieback levee and the potential for a breach and the associated potential loss of life will be evaluated during the design phase of the study.

4. IEPR Comment – Medium Significance: The limitation of the maximum spoil pile height to 15 feet is not discussed or justified in the report.

USACE Response: Adopted

Action Taken: Narrative discussion on selection of spoil pile height was added to Appendix I. Optimization of the spoil pile will be evaluated further during the design phase to determine if there are any cost savings that could be realized during construction by allowing higher spoil piles.

5. IEPR Comment – Medium Significance: The potential use of spoil piles for agricultural purposes, including those spoil piles that serve as levees, may impact real estate costs.

USACE Response: Adopted

Action Taken: Discussion of potential agricultural use of the spoil piles was added to the final feasibility report, sections 3.11.1.1, 3.12.2, and 3.13.1.1. In the design phase, the details will be developed and determinations will be made as to what special treatment or restrictions on levee use need to be met to ensure the project operates as designed. These details will be developed to define the areas that are available for agricultural practices. Allowing continued agricultural use of project lands after construction may reduce the real estate costs or allow the non-Federal sponsors to generate income using project lands.

6. IEPR Comment – Medium Significance: The assumption that the total sediment load will divide in proportion to the amount of water diverted may not be correct, and could have a negative impact on river morphology downstream of the diversions.

USACE Response: Adopted

Action To Be Taken: The USGS collected summer and fall (2011) sediment transport data for the Red River of the North (RRN) and tributaries in the study area. This data will provide measured sediment transport data over a wide range of flow conditions when combined with the spring 2010 and spring 2011 sediment sampling data.

A geomorphology study for the project is in progress for all tributaries in the study area and the diversion channel. As part of the geomorphology study, stability analyses, sediment impact analyses, and effects of the future conditions on long-term geomorphology and geomorphic

changes will be performed during the design phase. Sediment rating curves will be created based on the full range of sediment transport available up to the end of the fall 2011 measurement period. These sediment rating curves will be used in the sediment impact analyses. The geomorphology study will be assessing the effects of the diversion on the morphology of the tributaries in the study area besides the RRN and the diversion channel itself.

The existing Horace to West Fargo diversion channel provides a smaller scale example in the study area of the effects a diversion channel has on the sediment load of the Sheyenne River. Sediment data is being collected around this diversion channel for a wide range of flow conditions and will be used in the analysis during the design phase.

7. IEPR Comment – Medium Significance: The current design of fish passages does not consider the effects of high flow velocity on the rock size used to protect against scour and fish collisions leading to an increase in mortality.

USACE Response: Adopted

Action Taken: During operation, fishways would likely maintain flow velocities of 2-6 feet per second over riffles. These velocities are within a range typical of other fishway designs that have been built within the U.S. Fish passageways would be closed when water elevations increase to a level resulting in orifice flow. This should avoid situations where substantial velocities are present (e.g., 8 feet per second or more), thus minimizing risk of fish injury or mortality as they move upstream or downstream through the fish passage channels. Coordination with resource agencies did not identify any concerns with this specific issue, but coordination with the agencies will continue during the design phase. While we do not believe this will be a substantial issue, project designs will be further coordinated with the resource agencies to minimize impacts to fish migration, entrainment mortality, or other issues.

Action To Be Taken: Future design efforts will be based on more detailed hydraulic modeling, to potentially include 3-D and/or physical modeling, to evaluate potential hydraulic issues. To the extent practicable, this issue will be minimized. Fishway designs will be further coordinated with the resource agencies to maximize effectiveness for fish passage while minimizing risk for scour or damage to the structure.

8. IEPR Comment – Medium Significance: The risk to migrating fish due to the operating hydraulics of the proposed Red River control structure has not been fully considered.

USACE Response: Adopted

Action Taken: The draft and final feasibility reports evaluated the potential frequency and duration of project operations. The discussion in the draft report was provided for assessing impacts to upstream fish migration, Section 5.2.1, but the same frequency analysis would apply just as easily for other impact concerns, including this for injury. Future design efforts will be based on more detailed hydraulic modeling, to potentially include 3-D and/or physical modeling, to evaluate potential hydraulic issues. To the extent practicable, this issue will be minimized. An impact assessment explicit to fish injury/mortality due to entrainment through project features

was not performed. This issue was not identified as a concern through extensive coordination with the natural resource agencies. We are not aware of such issues being identified with similar projects. For example, the USACE Upper Mississippi River navigation project includes dams that would operate in a similar fashion to the control structure here for the Red and Wild Rice rivers. To date, the natural resource agencies generally believe fish can migrate downstream through the Upper Mississippi River (UMR) successfully with the dam gates in the water (and velocities above 8ft/s). While not all fish may pass through UMR gates, we aren't aware of concerns or issues with fish injury or mortality due to collision with baffle blocks or other structures. The fish assemblages on the UMR are fairly similar to those on the Red River. While we do not believe this will be a substantial issue, project designs will be further coordinated with the resource agencies to minimize impacts to fish migration, entrainment mortality, or other issues.

9. IEPR Comment – Medium Significance: The effect of water recession on fish escapement from the diversion channel has not been analyzed, which may impact fish mortality.

USACE Response: Adopted

Action Taken: Discussion of potential stranding in Section 5.2.1 of the final feasibility report was expanded. While it is possible that debris could partially block the low-flow channel, it seems unlikely that the entire low flow channel would be blocked to the extent fish could not migrate around the obstruction. Even if there was a complete blockage of the low-flow channel, this blockage would cause water upstream elevations to increase in the diversion channel, and fish could likely migrate around the obstruction. Our impact conclusion remains less than significant for fish stranding in the diversion channel. Although the impact conclusion was less than significant, to address remaining concern and risk, potential fish stranding will be observed within the diversion channel during at least the first few flood events where the project operates. These observations are now included as a part of monitoring within the Adaptive Management Plan. These observations would be made collaboratively with the natural resource agencies. Results of fish stranding observations will be coordinated with the natural resource agencies. If fish stranding appears to be a significant issue, the sponsor could work with the agency team to evaluate options to alleviate this issue through the adaptive process.

10. IEPR Comment – Medium Significance: The report does not address the impact of project construction and operation on mussel populations.

USACE Response: Adopted

Action To Be Taken: Impacts to mussels and their habitat have been evaluated and will continue to be evaluated prior to and following project construction and operation. This will be accomplished through direct mussel surveys, monitoring of impacts to fish migration, and monitoring of river habitat via geomorphic surveys. The report does discuss mussel impacts, though that is mostly relative to footprint impacts, Section 5.2.1. The report also discusses potential changes to geomorphology. Changes in geomorphic condition would be the trigger for changes to stream habitat outside of footprint areas. However, since no significant impacts are

anticipated to stream geomorphology, then significant changes to stream habitat, and the biota that use that habitat, also would not be anticipated.

To further address mussel impacts, mussel monitoring will be included at select sites as a part of the adaptive management plan, Section 5.5. So too will monitoring of geomorphic conditions. Results of surveys will be coordinated with the natural resource agencies prior to and following construction to verify if impacts due to construction warrant actions to minimize impacts. This could include pre-project mussel relocation from footprint areas if dense mussel beds are found. Post-project actions could include additional mitigation via near-by habitat restoration.

The report already discusses potential impacts to fish migration for critical fish species. The report does not specifically address individual species that may be host to individual mussels. However, the analysis does discuss frequency, duration and timing during typical seasonal periods, and references species migrational tendencies to relate potential impacts. With all avoid, minimize and mitigation measures in place, any impacts to fish migration, and any related impacts to mussels, would be expected to be less than significant. It is also not believed that any individual species would experience a significant impact to its population. As a result, significant impacts to mussels would not be anticipated as a result of reduced connectivity.

To verify this conclusion, the project includes extensive funding to monitor project impacts to fish migration following project construction. These results also will be coordinated with the agencies to verify if there are any remaining significant impacts to connectivity, and whether additional avoid, minimize or mitigation measures are warranted.

11. IEPR Comment – Medium Significance: The amphibian and reptile fauna have not been considered in the environmental impact analysis.

USACE Response: Adopted

The final feasibility report addresses impacts to herptile habitats, including surface waters, wetlands (Section 5.2.1.5), and riparian habitat (Section 5.2.1.8). Although evaluations specific to herptiles was not included, the impacts to herptiles can be inferred from the discussions of impacts to their habitat. The final feasibility report indirectly includes mitigation measures for reptiles and amphibians as the habitat types used by them were similar to those in the mitigation measures. Through mitigation of this habitat type, potential impacts to herptiles should be reduced to less-than-significant levels. Identification of the specific indigenous reptiles and amphibian species that inhabit the project were not directly incorporated into the final feasibility report.

12. IEPR Comment – Medium Significance: There appear to be inconsistencies and overstated benefits associated with the use of the steady Phase III hydraulic model to estimate expected annual damages in the metro area of the Red River.

USACE Response: Not Adopted

The use of both steady and unsteady HEC-RAS hydraulic models is discussed in Appendix C section 3.4.3. The same hydrology was used throughout the study area (split period hydrology with "wet" / "dry" analysis years) – so the flows are consistent between models. The way those flows are routed is different, depending on whether the steady or unsteady hydraulic model was used. The use of different hydraulic models is a source of uncertainty in the economic analysis. The overstated project benefits are not of the magnitude that would change the outcome of the study. The uncertainties associated with using different hydraulic models have been explained in the Risk and Uncertainty section (Appendix C section 3.10), and the USACE Vertical Team is comfortable with the uncertainties.

13. IEPR Comment – Medium Significance: Comparable hydrologic and hydraulic models and methods have not been used to develop the LPP and Federally Comparable Plan (FCP) and limit the ability to accurately differentiate the impacts of the alternatives.

USACE Response: Not Adopted

The hydrologic and hydraulic models used in plan formulation were directly comparable during each phase of the study as indicated in Appendix O – Plan Formulation. It is very unlikely that inclusion of upstream staging and storage measures as additional features of the FCP would be incrementally justified (as discussed in Appendix O section 8.4). Conceptually, the FCP is the plan that provides the same level of benefits as the LPP most efficiently. Staging and storage areas would not make the FCP more efficient, so it is unnecessary to analyze such a plan in detail.

14. IEPR Comment – Low Significance: The economic analyses of the future "with" and "without project" conditions provided in Appendix C and the Regional Economic Development (RED) section are inconsistent.

USACE Response: Not Adopted

Additional economic work was not completed, but Appendix C section 4.2.4.5 was revised to clarify the assumptions regarding growth within the study area. The use of the same growth scenario for with and without project conditions is an assumption made in order to simplify the NED analysis. Although the NED analysis assumes that the same level of development would occur with or without a project, in reality some additional demand for new commercial structures would occur. The RED analysis is sensitive to changes in business activity; however it is difficult to predict how changes in business activity will affect demand for new buildings. While additional business activity would occur if a flood risk management project were completed, that activity may or may not occur in the floodplain, and may or may not significantly impact development. Therefore, it is a critical assumption for the RED analysis that the level of

economic activity would be affected by a project; however it is not an important factor in the analysis of flood damage reduction for the NED account. It is unlikely that additional Census data from the 2010 Census would resolve the concern about inconsistency. More analysis of the relationship between increased business activity and demand for development would be required. It is unlikely that this analysis would add much valuable information to the NED analysis or change plan selection.

15. IEPR Comment – Low Significance: A sensitivity analysis has not been conducted to determine the flood fight success rate needed to make the LPP or the FCP infeasible.

USACE Response: Adopted

Action Taken: A sensitivity analysis of flood fight measures is important for decision makers. This analysis was completed for the NED, LPP, and FCP plans and included in the final feasibility report (Appendix C section 3.10.1). The analysis shows that each plan is feasible with 100% credit to emergency levees.

16. IEPR Comment – Low Significance: Costs for individual features are not provided in the Total Project Cost Summary (TPCS), which impairs the ability to define annual project improvements.

USACE Response: Not Adopted

USACE guidance contained in Engineer Regulation 1110-2-1150, Appendix C, suggests presenting costs in final feasibility reports at the subfeature level. Agency Technical Review comments from the Corps of Engineers Cost Engineering Directory of Expertise urged removal of the detailed unit costs from a public document which could potentially compromise the Government's position of cost for Government estimates and bidding. While the detailed unit costs are not shown in the public release of the feasibility report, they are part of the official MCACES cost estimate that project planners will be able to utilize to modify future construction budgets.