HYDRAULIC CONSIDERATIONS

Revised Oct. 98

1. General. Hydraulic design of a modification or new construction within the foreshore and critical area of a flood protection project must result in a safe, reliable project with appropriate consideration of environmental and social aspects.

2. Alignment and configuration of structures located in or crossing the foreshore and critical area, including rail, highway and utility crossings, buildings, boat ramps and docks.

2.1. Structures located in or crossing the foreshore and critical area have an impact on the hydraulics of a flood protection project. Railroad and highway crossings or encroachments, utility crossings, boat ramps and docks, and buildings affect a stream's flow distribution at out-of-bank (flood) discharges. Undesirable flow distributions and patterns may result in scouring at the levee, on the foreshore, or within the critical area, which in turn may result in project failure at less than design stages and discharges. Undesirable flow distributions and patterns may also fill interior ponding areas or otherwise inhibit interior drainage.

2.2. All structures or facilities located at the levee or within the critical area should be investigated for hydraulic impacts on the flood flow distributions.

2.3. All bridges and other structures or materials placed in the foreshore area should be investigated for scour and erosion effects. Bridge scour data furnished to the COE should include contraction, abutment, and pier scour calculations performed using standard FHWA methods and publications.

3. Design flood frequencies and hydrographs. Development of hydrographs and design flood frequencies will be required when that information is not furnished by the COE. Hydrographs are necessary for determining runoff timing and volumes used in routing and interior drainage calculations.

4. Interior drainage outflow alignment and configuration. Interior drainage outflow alignment and configuration has an effect on the hydraulic flow characteristics on the foreshore during flood flows. These structures should be designed and constructed so that scouring of the floodplain, foreshore area and levee is avoided.

5. Alignment, location, configuration and adequacy of temporary and/or construction-related facilities near flood control projects.

5.1. It is imperative that the alignment, location, configuration and adequacy of temporary and/or construction-related facilities not interfere with the hydraulic performance of the flood protection project.

5.2. Alignment, location, configuration, and adequacy of temporary and/or construction-related facilities should follow the same guidelines presented for permanent facilities in paragraphs 2. and 4. of this Appendix.

6. Other individual projects not specifically noted above but having an effect the flood control project. Examples of projects not specifically addressed above includes but is not limited to levee recreational trails, riverfront park areas, and land-locked river boat casino development. These facilities should be reviewed by the COE prior to construction and should follow the same guidelines presented in paragraphs 1. through 5. of this Appendix.

7. Hydraulic and hydrologic analyses will be reviewed by the COE in accordance with FEMA criteria where applicable (where Flood Insurance Studies have been performed and accepted). Calculations should be provided that detail any impacts to the 100 year frequency water surface elevations as well as impacts to any regulated floodways near the project. Additional Corps of Engineers criteria or policies may be used to assess impacts of unique or special project submittals.

8. Recommended References.

8.1. EM 1110-2-1418, CHANNEL STABILITY ASSESSMENT FOR FLOOD CONTROL PROJECTS, provides guidance on determining potential channel instability and sedimentation/degradation effects in flood control projects.

8.2. EM 1110-2-1601, HYDRAULIC DESIGN OF FLOOD CONTROL CHANNELS, provides guidance on hydraulic design analysis for modified channels that are intended to carry rapid and/or tranquil flood flows.

8.3. EM 1110-2-3102, GENERAL PRINCIPLES OF PUMPING STATION DESIGN AND LAYOUT, discusses the design of pumping stations. Provides guidance regarding location and orientation of the pumping station and the associated discharge lines.

8.4. EM 1110-2-4000, SEDIMENTATION INVESTIGATIONS OF RIVERS AND RESERVOIRS, provides guidance on sedimentation and degradation problems associated with local flood protection projects, including operational and maintenance issues, hydraulic issues, debris problems and channel modifications.

8.5. EM 1110-2-1405, FLOOD HYDROGRAPH ANALYSES AND COMPUTATIONS, provides guidance on derivation of fundamental hydrologic factors by analyzing observed hydrographs and meteorological events. Methods of utilizing these factors in development of hydrographs intended to reflect projected future conditions are presented.

8.6. EM 1110-2-1408, ROUTING OF FLOODS THROUGH RIVER CHANNELS, provides guidance on the routing of flood discharges through natural and constructed channels. Flood

routing is a method of determining the flood peak reduction on a streams' hydrograph due to channel and floodplain storage. Material presented is applicable to small streams as well as large river systems.

8.7. EM 1110-2-1409, BACKWATER CURVES IN RIVER CHANNELS, provides theory and guidance on determination of one-dimensional backwater curves in river channels using Manning's equation and the energy method. Selection of coefficients and boundary conditions, backwater computations through river confluences and several examples are presented.

8.8. EM 1110-2-1411, STANDARD PROJECT FLOOD DETERMINATIONS, provides guidance on determination of the Standard Project Flood (SPF). The SPF is defined and compared to the Design Flood. Methods for computing the SPF using rainfall and excess rainfall data are presented.

8.9. EM 1110-2-1413, HYDROLOGIC ANALYSIS OF INTERIOR AREAS, provides guidance on hydrologic analysis specific to interior areas.

8.10. EM 1110-2-1415, HYDROLOGIC FREQUENCY ANALYSIS, provides guidance in applying statistical principles to the analysis of hydrologic data for all Corps of Engineers projects. Hydrologic frequency analyses, coincident stages and frequencies, flow duration curves and effects of basin development are presented.

8.11. EM 1110-2-1416, RIVER HYDRAULICS, provides guidance on the principles and procedures for analysis of open channel flows in natural river systems. Topics covered include steady and unsteady flow analysis, movable boundary water surface profile analysis and one and two dimensional flow analysis.

8.12 EM 1110-2-1417, FLOOD-RUNOFF ANALYSIS, provides guidance on evaluation of flood-runoff characteristics of watersheds including discussions regarding the nature of a basin's hydrograph and flood frequency analyses.

8.13. FHWA-IP-90-014, STREAM STABILITY AT HIGHWAY STRUCTURES, HYDRAULIC ENGINEERING CIRCULAR NO. 20. This document was developed by the Federal Highway Administration, and provides guidelines for identifying stream instability problems at highway stream crossings. Countermeasures and design criteria are summarized.

8.14. FHWA-IP-90-017, EVALUATING SCOUR AT BRIDGES, HYDRAULIC ENGINEERING CIRCULAR NO. 18. This document was developed by the Federal Highway Administration, and provides guidelines and methods for the design, evaluation and inspection of bridges for scour.