The consideration of the potential impacts constitutes an assessment of risk for the specific site. The least total expected cost (LTEC) alternative should be developed in accordance with Federal Highway Administration (FHWA) HEC-17 only where a need for this type of analysis is indicated by the risk assessment. This analysis provides a comparison between other alternatives developed in response to considerations such as environmental, regulatory, and political.

12.3.2.3 Design Floods

Design floods for such things as the evaluation of backwater, clearance, and overtopping, unless available from FEMA or other appropriate sources, should be established predicated on local site conditions. They should reflect consideration of traffic service, environmental impact, property damage, hazard to human life and floodplain management criteria. Design floods for roadway inundation are specified in Chapter 6, Hydrology. It should be noted, in the case of bridged waterways, that the design flood is normally whichever of the customarily documented events (i.e. the 2, 5, 10, 25, 50, 100, & 500-yr. floods) that will pass under the bridge superstructure at its lowest elevation with at least one or more feet of freeboard, provided that level of protection is acceptable to the bridge designer.

12.3.2.4 Backwater/Increases Over Existing Conditions

Designers shall conform to FEMA regulations for sites covered by the National Flood Insurance Program (NFIP). It is the Department's policy not to allow any increase in the level of the 1 percent flood for delineated floodplains established under the NFIP and for the increase to not exceed one foot during the passage of the 1 percent flood for sites not covered by NFIP. Refer to section 12.6.1 for additional details.

12.3.2.5 Clearance

Where practical a minimum clearance of one foot should be provided between the design approach water surface elevation and the low chord of the bridge for the design flood. Where this is not practicable, the bridge designer should establish the clearance based on the desired level of protection.

12.3.2.6 Flow Distribution

The conveyance of the proposed stream crossing should be calculated to determine the flow distribution and to establish the location of bridge opening(s). The proposed facility should not cause any significant change in the existing flow distribution. Relief openings in the approach roadway embankment or other appropriate measures should be investigated if there is more than a 10 percent redistribution of flow.

12.3.2.7 Scour

Design for bridge foundation scour should consider the magnitude of the flood that generates the maximum scour depth. The design should use a geotechnical design practice factor of safety from 2 to 3. The resulting design should then be checked using a super-flood such as the 0.2 percent event and a geotechnical design practice safety factor of at least 1.0. A plot or sketch showing the scoured bed profile for both the design and super-flood events shall be prepared and included with documentation (LD-293) described in Section 12.6.5.2.

12.4 Design Concepts

12.4.1 Methodologies

A step-backwater computer model is usually employed to perform the hydraulic analysis in these situations due to the complexity of the hydraulic conditions and the risk involved. No single method is ideally suited for all situations. If a satisfactory computation cannot be achieved with a given method, an alternate method should be attempted. However, it has been found that, with careful attention to the setup requirements of each method, acceptable results can usually be achieved regardless of the step-backwater computer model being employed. Where the use of a one-dimensional step backwater computer model is indicated, the Department accepts any computer model currently approved by FEMA but prefers HEC-2 or HEC-RAS.

12.4.2 Bridge Scour or Aggradation

The Department employs the procedures and criteria presented in the FHWA's "Evaluating Scour at Bridges" (HEC-18) and "Stream Stability at Highway Structures" (HEC-20) to determine and counteract the impact of scour and long term aggradation/degradation on bridges. Both these publications can be accessed and/or downloaded from the publications section of the FHWA's Internet web site at http://www.fhwa.dot.gov\bridge\hydpub.htm.

12.4.3 Riprap

Riprap is not to be used for scour protection at piers for new bridges. Riprap may be used to protect exposed abutment slopes or as a scour countermeasure at existing bridge piers and abutments. Design guidelines for placement and sizing of riprap are presented in the FHWA's "Bridge Scour and Stream Instability Countermeasures" (HEC-23) publication. This publication can be accessed and/or downloaded from the publications section of the FHWA's Internet web site at http://www.fhwa.dot.gov\bridge\hydpub.htm.