REMR TECHNICAL NOTE HY-FC-1.3

STRUCTURAL MODIFICATIONS TO PREVENT EXCESSIVE SCOUR DOWNSTREAM FROM HIGH-LEVEL EMERGENCY SPILLWAYS

PURPOSE: To describe possible structural modifications for consideration by responsible personnel in developing plans to prevent excessive scour downstream from high-level emergency spillways.

DEFINITION: The term "excessive scour" refers to scour that may threaten the safety of a spillway.

STRUCTURAL MODIFICATIONS: The following modifications should be considered when the results of the spillway evaluation (see REMR Technical Note HY-FC-1.2) indicate that the structural integrity of the spillway may be threatened. The decision as to which modification(s) is appropriate should be based on the physical and topographical characteristics of the approach channel, spillway, and exit channel.

a. A subcritical reach of exit channel can be an adequate and inexpensive structural modification if the appropriate topographical conditions are present. Use of this option requires a spillway discharge channel with a mild slope immediately downstream of the spillway apron or stilling basin. The function of the mild slope reach is to maintain a subcritical (nonerosive) flow regime in the region, thus transferring the release of potential erosive energy to a point well downstream of the structure. The end of the mild slope should be sealed off using a cutoff wall or a natural hardpoint in the channel to prevent failure from headcutting. Large amounts of scour should be expected downstream of the hardpoint or cutoff wall where flow velocities will increase and large amounts of energy will be released.

b. A vertical cutoff wall can be effective in preventing excessive scour caused by headcutting in the spillway discharge channel. The cutoff wall may be placed at the downstream end of the spillway apron or at an alternate location in the discharge channel provided sufficient channel stability exists upstream of the cutoff. The predicted depth of scour for the design flow event or the depth of the existing bedrock layer are factors which should be considered in determining the depth at which the cutoff wall will be placed.

c. A single- or multiple-stepped cutoff wall is a variation of the vertical wall which may be an appropriate modification in some instances. This option would be advantageous in a channel which has abrupt changes in channel gradient such as natural overfalls, scour holes, or headcutting caused by previous flow events. The stepped cutoff wall not only seals off the upstream channel to

prevent further excessive scour from headcutting but also may produce substantial energy losses which would tend to decrease scour in the downstream channel reaches.

d. Addition of a chute extension and stilling basin to an existing emergency spillway is an expensive means of lowering the discharge channel invert elevation at the structure to a stable grade. Combined with the energy dissipating ability of the stilling basin, this modification practically eliminates the potential for excessive scour near the structure. However, all material downstream from the structure and above the established stable grade is subject to scour.

e. Flow contractions around the spillway abutments of an emergency spillway can produce an uneven flow distribution across the spillway apron. The concentrated flow entering the discharge channel from the apron can be a cause of excessive scour. Streamlined walls originating at the spillway abutments and extending upstream into the approach channel can be used to eliminate the flow contractions. Model tests have indicated that this arrangement produces a more even flow distribution and reduces the potential for excessive scour.

f. A laterally sloping spillway apron can also produce flow concentrations in the discharge channel. The lateral slope causes flow to concentrate near the center of the apron. Flow concentrations enter the discharge channel, producing excessive scour near the structure. Model tests have indicated that eliminating the lateral slope of the apron produces a more even flow distribution.

g. Other modifications:

1. Grasslined Channels: In some cases where subcritical velocities are expected, a grasslined channel will provide minimal protection against scour.

2. Roller-Compacted Concrete: Application of roller-compacted concrete to critical areas in the discharge channel has proven to be a viable option.

3. Geomembranes: Placement of geomembranes beneath a layer of topsoil immediately downstream of the spillway has been used as a successful means of scour protection.

EVALUATION CONSIDERATIONS: Energy dissipation within the concrete lined section of the emergency spillway channel is preferable to dissipation in the natural channel. Dissipation within the concrete lined section may eliminate the need for protective armor in the natural channel while reducing or eliminating excessive bank erosion. Spillway channels lined with vegetation (grass, topsoil over geomembrane which may then be invaded by vegetation) provide greater habitat value when the spillway is not in use than those lined with concrete or similar material.