

## **8.5 Related Designs**

### **8.5.1 Buoyancy Protection**

Headwalls, endwalls, slope paving or other means of anchoring to provide buoyancy protection shall be considered for all flexible culverts. Buoyancy is more serious with steepness of the culvert slope, depth of the potential headwater (debris blockage may increase), flatness of the upstream fill slope, height of the fill, large culvert skews, or mitered ends.

### **8.5.2 Outlet Protection**

Outlet protection consists of the construction of an erosion resistant section between a conduit outlet and a stable downstream channel. Erosion at an outlet is chiefly a function of soil type and the velocity of the conduit discharge. Therefore, in order to mitigate erosion, an adequate design must stabilize the area at the conduit outlet and reduce the exit velocity to a velocity consistent with a stable condition in the downstream channel. (See Section 11.13.)

The design procedure for outlet protection will consist of:

- the calculation of the discharge velocity for the design flow
- an assessment of the erosion potential at the outlet and other critical site factors
- the selection of an appropriate design which protects the site to a degree consistent with the standards and criteria listed herein.
- an investigation of the possibility of higher velocities than the design flood such as a lower tailwater during other storm events

### **8.5.3 Relief Opening**

Where multiple use culverts or culverts serving as relief openings have their outlet set above the normal stream flow line, special precautions shall be required to prevent headcuts or erosion from undermining the culvert outlet.

### **8.5.4 Erosion And Sediment Control**

Temporary measures shall be included in the construction plans. These measures include the use of silt boxes, straw silt barriers, brush silt barriers, filter cloth, temporary silt fence and check dams in accordance with the "Connecticut Guidelines for Soil Erosion and Sedimentation Control" Manual.

### **8.5.5 Environmental Considerations And Fishery Protection**

Care must be exercised in selecting the location of the culvert site to control erosion, sedimentation and debris. Select a site that will permit the culvert to be constructed and will limit the impact on the stream or wetlands. The ConnDEP's Fisheries Division shall be contacted early in the design process if the site is considered to be a watercourse, to determine the need for fish passage and to solicit their recommendations. See Chapter 9, Section 9.2.3 for additional ConnDEP requirements.

### 8.5.6 Design Philosophy

The design of a culvert system for a highway crossing of a floodplain involves using information from the following chapters in this manual (hydrology, channels, bridges and storm drainage systems). Each of these should be consulted as appropriate. The discussion in this section is focused on alternative analysis and design methods.

#### Alternative Analysis

Culvert alternatives shall be selected to satisfy topography and design practice and criteria. Alternatives shall be analyzed for environmental impact, hydraulic equivalency, risk and cost.

Select an alternative which best integrates engineering, economic, and environmental considerations. The chosen culvert shall meet the selected structural and hydraulic criteria and shall be based on:

- utility accommodation
- construction and maintenance costs
- risk of failure or property damage
- traffic safety
- environmental or aesthetic considerations
- political or nuisance considerations
- land use requirements
- availability of detour or alternate routes
- constructability

**Design Methods:** The designer shall determine whether it is most appropriate:

- to assume a constant discharge or upon approval from the Hydraulics and Drainage Section, route a hydrograph
- to use nomographs or computer software

### 8.5.7 Performance Curves

Performance curves shall be developed for all culverts for evaluating the hydraulic capacity of a culvert for various headwaters, outlet velocities and scour depths. These curves will display the consequence of high flow rates at the site and provide a basis for evaluating flood hazards.