1.3 General Hydraulic Design Practices

1.3.1 Introduction

An adequate drainage structure (culvert or bridge) may be defined as one which meets the following:

- the design of the structure meets or exceeds ConnDOT standard engineering practice
- the design is consistent with what a reasonably competent and prudent designer would do under similar circumstances
- the design is consistent with environmental concerns and regulations, where applicable

The studies listed below are normally conducted as a part of the design of highway drainage structures and serve as a means of achieving an adequate drainage design:

- hydrologic and hydraulic analysis
- engineering evaluation of selected alternatives

1.3.2 Hydrologic Analysis

Present state-of-practice formulas and models for estimating flood flows are based on statistical analyses of rainfall and runoff records. The recommended practice is for the designer to select appropriate hydrologic estimating procedures, and obtain runoff data where available for purposes of evaluation, calibration and determination of the predicted values for the desired flood frequencies. The predicted value of the flood flows represents the designer's best estimate, with varying degrees of error. The expected magnitude of this variation can be determined for some formulas or models as a part of the hydrologic design procedure.

1.3.3 Hydraulic Analysis

The next step in the design process involves preliminary selections of alternative designs that are judged to meet the site conditions and to accommodate the flood flows selected for analysis. The hydraulic analysis is made utilizing appropriate formulas, physical models or computer programs for purposes of defining, calibrating and checking the performance of the preliminary designs over a range of flows.

1.3.4 Engineering Evaluation

The final step in the design process is the engineering evaluation of the preliminary designs and approval of the selected final design. This process involves consideration and balancing of a number of factors. Some of these factors are:

- legal considerations
- flood hazards to highway users and neighboring property owners
- hydraulic efficiencies
- costs
- environmental and social concerns
- other site specific concerns

1.3.5 ConnDOT "Standard Engineering Practice"

Hydrologic analysis and hydraulic analysis set forth the design process representative of the ConnDOT present "standard engineering practice." Engineering evaluation outlines the approach to be followed by a "reasonably competent and prudent designer" in evaluating, selecting and approving a final design. The following considerations are made in regard to this design process.

- It is the designer's responsibility to provide an adequate drainage structure. The designer is not required to provide a structure that will handle all conceivable flood flows under all possible site conditions.
- The detail of design studies should be commensurate with the risk associated with the encroachment and with other economic, engineering, social, or environmental concerns.
- The overtopping and/or design flood may serve as criteria for evaluating the adequacy of a proposed design. The "overtopping flood" is the smallest recurrence interval flood which will result in flow over the highway or other watershed boundary. The "design flood" is the recurrence interval of the flood for which the drainage structure is sized; to assure that no traffic interruption or significant damage will result. The overtopping flood and the design flood may vary widely depending on the grade, alignment and classification of the road and the characteristics of the water course and floodplain.
- The predicted value of the 100-year or base flood serves as the present engineering standard for evaluating flood hazards and as the basis for regulating floodplains under the National Flood Insurance Program. The designer must make a professional judgment as to the degree of risk that is tolerable for the base flood on a case-by-case basis.
- The developed hydraulic performance curve of a drainage structure depicts the relationship between floodwater stage (or elevation) and flood flow magnitudes and frequencies. The performance curve should include the 100-year flood. With the performance curve, the designer can evaluate the adequacy of the design for a range of flows and take into consideration variations caused by the hydrologic estimating procedure. It is standard engineering practice to use the predicated value of the 100-year flood as the basis for evaluating flood hazards for drainage structures which convey a watercourse greater than $1km^2$ (mi^2); however, flows larger than this value may be considered for complex, high risk or unusual cases that require special studies or risk analyses. See Chapter 8, Culverts and Chapter 9, Bridges.