# BRIDGE HYDRAULICS PERFORMANCE SPECIFICATION

## A. SCOPE

This work consists of performing all of the necessary site investigation, surveying, hydrologic and hydraulic calculations, design and drawings for bridge replacement, rehabilitation, or repair. The findings of this work will be clearly summarized in a hydraulics report.

### 1. Hydraulics Report

The hydraulics report will include hydraulic data on the existing structure and provide comparison with proposed alternative bridge designs. The report will:

- Provide design data on the existing bridge condition and proposed bridge design alternatives.
- Address the possible long term effects of channel aggradation/degradation.
- Discuss the effects of lateral channel migration.
- Summarize any parole evidence gathered about past conditions at this site.
- Provide a temporary water management plan.
- Address environmental concerns and furnish information needed for applicable permits or jurisdictional requirements, such as, no-rise certifications in FEMA floodways or floodway revisions.

Design calculations and supporting drawings will be provided to clarify the findings stated in the report.

### 2. Designer's Performance Parameters

The designer shall perform all investigation, design, drafting and calculations needed to produce the hydraulics design.

The designer shall perform all design in accordance with all applicable standards, manuals, procedures and laws. The designer shall coordinate with ODOT staff, FHWA, FEMA, contractors and other agencies as necessary to acquire project related reports and information, and resolve questions, comments and information inquiries.

The designer shall be a Registered Professional Engineer licensed in the State of Oregon and shall affix his seal and signature to the hydraulics report.

## B. APPLICABLE STANDARDS AND REFERENCES

The hydraulic design shall be in accordance with this Performance Specification and the relevant requirements of the following Standards and References, unless otherwise stipulated in this specification. Standards and References specifically cited in the body of the specification establish requirements that shall have precedence over all others. Should the requirements in any reference conflict with those in another, the reference highest on the Standard or Reference list shall govern. It is the designer's responsibility to obtain clarification of any unresolved ambiguity prior to proceeding with design or construction. Questions regarding the interpretation of ODOT's Hydraulics Manual and other publications shall be directed to the Senior Local Bridge Standards Engineer.

## 1. ODOT Publications

- *Hydraulics Manual*
- *Oregon Standard Specifications for Construction*
- *Bridge Design Drafting Manual*

## 2. FHWA Publications

- HDS-6, River Engineering for Highway Encroachments
- HEC-18, Evaluating Scour at Bridges
- HEC-20, Stream Stability at Highway Structures
- HEC-11, Design of Riprap Revetment
- Federal-Aid Policy Guide, 23 CFR 650A, Location and Hydraulic Design of Encroachments on Flood Plains
- TS-84-204, Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains
- HEC-25, Tidal Hydrology, Hydraulics and Scour at Bridges
- HEC-23, Bridge Scour and Stream Instability Countermeasures
- HEC-21, Design of Bridge Deck Drains
- HEC-9, Debris Control Structures
- HDS-2, Highway Hydrology
- HEC-22, Urban Drainage Design Manual
- HDS-5, Hydraulic Design of Highway Culverts
- HEC-15, Design of Roadside Channels with Flexible Lining
- HEC-14, Hydraulic Design of Energy Dissipaters for Culverts and Channels

## 3. AASHTO Publications

- Manual for Highway Drainage Guidelines

It is the responsibility of the designer to become familiar with these standards and determine which are appropriate.

## 4. Additional References

- ODOT' Qualified Products List
- 'As Constructed' Bridge Drawings
- Bridge Inspection Reports
- Bridge Structure and Inventory Appraisal Report
- National Flood Insurance Program Regulations in 44 CFR 1
- ODOT Standard Drawings
- NCHRP Project 24-19: Environmentally Sensitive Channel and Bank Protection Measures
- Other NCHRP publications as applicable

## 5. Methodology and Reports

### a. Hydrology Methodology

Three common methods of calculated flood flows are described in the Hydraulics Manual along with additional information on each method. The methods are:

- Flood Insurance Study Data.
- Gaging Station Data.
- US Geological Survey Regression Equation; and in very limited situations.
- Local Regional Methods.

The calculated flows shall be in agreement with eye-witness testimony and parole evidence gathered from historical records. If ice and/or debris passage are a concern the proposed structure designs must address how these problems will be managed.

### b. Hydrological Report

Provide the flood flows expected at the site and the recurrence intervals for these flows. The report should include, but is not limited to the:

- Sources of flooding.
- Contributing drainage area at the site.
- Time of year when floods usually occur.
- Method used to determine the hydrology.
- Flood recurrence interval versus peak discharge relationship at the site. (The 2-year, 5-year, 10-year, 25-year, 50-year, 100-year and 500-year flows should be calculated.
- The roadway overtopping flood will also need to be calculated if its recurrence interval is less than the 500-year flooding event).
- Design flood recurrence interval can be determined from ODOT's Hydraulics Manual, Chapter 3 and Table 3-1.

## 6. Hydraulic Design

### a. Waterway Opening Design

The criteria used to size the waterway opening of the proposed structure should be described in the reports. Freeboard recommendations are provided in ODOT's Hydraulics Manual. The backwater created by the proposed structure should not exceed that of the existing structure. If additional backwater is created, a justification must be submitted explaining the effects of the increased flooding on the site and what liability the local agency may incur by causing a rise in water surface elevations on the surrounding community. If the rise is proposed for a regulated FEMA floodway, the designer must obtain approval from ODOT's GeoHydro Unit in accordance with their exception process before proceeding. Any rise in the floodway will require permission from the local land use authority. The process takes a considerable amount of time and engineering cost, so it must be addressed as soon as possible.

If a channel modification is proposed, a justification on why the change is needed and how it will be maintained for the life of the bridge shall be submitted.

The hydraulic design should be presented using a combination of drawings, hydraulic data sheets and written narrative. The waterway openings of the existing and proposed bridge designs shall be shown in the accompanying drawings to the hydraulics report. The report shall include the following:

- A description of the existing bridge and drainage area.
- The design flood, base flood and maximum flood data and the roadway overtopping flood (if applicable).
- The skew of the bridge to the stream flow.
- The water surface elevation at the downstream, upstream and at the approach section of the bridge during the design flood.
- The width and area of the waterway at the downstream face of the bridge during the design flood.
- The average velocity at the downstream face of the bridge opening during the design flood.

The narrative for the proposed bridge will typically include the following information:

- The minimum recommended bottom of beam elevation.
- The types of abutments (vertical and spillthrough), end slopes, waterway area and opening (If the bridge is skewed, it should be noted whether these dimensions are normal to channel centerline or parallel to the roadway centerline).
- The number and type of piers.
- The bottom of beam elevation should be listed if the bridge is in pressure flow during the design flood.

## b. Scour

This section of the report presents the results of analyses on possible long term changes in channel geometry due to either aggradation or degradation, possible shifts in channel alignment due to lateral instability, clear-water or live-bed contraction scour, local scour and pier scour. The methods and assumptions used to determine potential scour elevations shall be stated and any past problems with aggradation, degradation, lateral stability, debris, ice, or scour discussed.

Scour depths are calculated for the following floods:

- Scour depths during the overtopping flood are analyzed if the roadway overtopping flood recurrence interval is less then the recurrence interval for the 100-year flood.
- Scour depths during the 100-year and overtopping floods are analyzed if the roadway overtopping flood recurrence interval is greater then the recurrence interval for the 100-year flood, but less than the recurrence interval for the 500-year recurrence interval flood.

- Scour depths during the 100-year and 500-year floods are analyzed if the roadway overtopping flood recurrence interval is greater then the recurrence interval for the 500-year flood.

Potential scour depths are calculated in accordance with procedures in HEC-18 as modified by ODOT's scour guidelines within the Hydraulics Manual.

### c. Revetment Design

The hydraulics design shall recommend revetment protection in the bridge waterway opening and embankment surrounding the abutments. The waterway opening and surrounding embankment is considered a scour critical zone. A scour critical zone is defined as the area within and outside of the bridge opening where any failure will cause a high potential for loss of human life. The methods given in HEC-11, supplemented and modified by the requirements stated in the Hydraulics Manual shall be used to provide protection for the bridge abutments and surrounding embankments. The revetment is sized for the flood which creates the greatest scour potential.

Environmental concerns will be addressed for the bridge site depending on the requirements of the environmental agencies. There is an industry concern about the longevity and strength of so-called "green" methods used under the conditions of the design and larger floods. The design criteria of HEC-11 will take precedence over design methods based on so-called "green" vegetative solutions. The environmental design can be placed above the countersinked protective blanket.

It is the designer's responsibility to integrate the environmental design with conventional design such that the stability of the foundations of the bridge and the surrounding embankments will not be less stable than would be provided by conventional methods developed using the guidance of HEC-11 or a similar tractive-force based analysis. Refer to the discussion in HEC-23 volume 1, chapter 6, for guidance, implementation and applicability in the Hydraulics Manual.

All abutments and piers shall be protected from flood events up to and including the 500-year recurrence interval flood. Pier rip rap is considered to be temporary protection for piers. If riprap must be used around piers, the analysis must show that the proposed bridge will maintain structural integrity during the flood with maximum scour potential.

### d. Hydraulic Data Sheets

Hydraulic data sheets, examples of which are found in the Hydraulics Manual, shall be included in the report and will clearly state the hydraulic data for the existing and proposed structures in such a way as they can be easily compared.

## e. Temporary Water Management Plan

Chapter 17 of the Hydraulics Manual provides information for the planning and design of Temporary Water Management. Temporary Water Management is water control and treatment when facilities are built or repaired in the riparian zone. These control and treatment measures are temporary. They are typically installed just before construction and removed immediately thereafter. Report and documentation guidelines are discussed in Chapter 4 of the Hydraulics Manual.

The objective of Temporary Water Management is to provide for uninterrupted streamflow through the project site and is required by the permitting regulatory agencies. This continuous flow prevents the downstream channel from drying up and adversely affecting aquatic life.

The report must evaluate and provide fish passage alternatives during predicted flow conditions to regulators for review and comment early in the design stage.

## f. Detour Structures

If a detour is planned for the project, the report should have recommendations for the detour bridge or culvert. The data should include seasonal limitations, flow area of the structure and minimum elevation of the detour structure. A brief statement about the proposed location of the detour will need to be prepared. Other information about the detour may include a discussion of maintenance needs such as monitoring for debris or scour. The detour structure will need to conform to the Temporary Water Management Plan regarding fish passage. Refer to FEMA Region 10 guidelines for detour structure when crossing is located in a FEMA floodplain or floodway located in the Hydraulics Manual Chapter 3.

## g. Drawings

The hydraulics report shall include drawings of the existing and proposed alternative bridges. Examples of the needed drawings can be found in the Hydraulics Manual. For the existing bridge, information shall include:

- Waterway area and waterway width during the design flood (typically this area is parallel to the roadway centerline with the pier area subtracted).
- Profile of the existing bridge and ground line of the waterway opening.
- Recurrence interval and elevation of the design flood.
- Lowest bottom of beam elevation of the bridge.

For the proposed bridge, information should include the following:

- The waterway area and waterway width during the design flood (typically this area is parallel to the roadway centerline with the pier area subtracted).
- The proposed waterway opening and the existing ground line.

- The recurrence interval of the design flood.
- The elevation of the design flood at the downstream face of the bridge opening.
- Minimum recommended bottom of beam elevation.
- The revetment protection details.
- Potential scour elevations.
- A description of the recommended waterway opening, including abutment end slopes, channel bottom elevation and channel bottom width (typically these dimensions are perpendicular to the channel centerline. If not, an explanation is needed).