2 PRELIMINARY DESIGN

2.1 Preliminary Design Report

The Preliminary Design Report (PDR) documents the justification for decisions made in the conceptual design process. Forms are available electronically that assist in completing the PDR. At the end of the preliminary design phase, all those invested in the project have reviewed the scope of work, and this scope is considered final. The PDR is then used as the starting point to proceed to final design.

For those projects with spans of 50 feet or less, consideration should be given to a reduced preliminary design effort, as discussed in Section 1.5 Small Bridge Initiative.

The PDR is organized into the following sections. The depth of study and extent of investigation of options will depend upon the complexity of the project. A description of each section follows the listed sections.

1. Title Page
2. Table of Contents
3. Background Information
4. Existing Bridge Synopsis Form
5. Location Map
6. Bridge Recommendation Form
7. Summary of Expected Impacts
8. Summary of Preliminary Design
9. Hydrology/Hydraulic/Scour Report
10. Preliminary Plan
11. Photographs
12. Summary of Existing Upstream and Downstream Bridges
13. Site Inspection Report
14. Information Reports
15. Survey Plans of Existing Bridges
16. Hydrology/Hydraulic/Scour Data
17. Miscellaneous Information
18. Traffic and Accident Data
19. Estimates

For routine maintenance-type projects such as bridge wearing surface replacements and bridge painting, a one-page “short form” PDR may be used in lieu of the standard forms and sections listed. When warranted, additional information about the project can be attached to this form. Electronic Microsoft Word templates of some common PDR layouts are available on the Department’s website.

2.1.1 Title Page

The Title Page contains the following:

Preliminary Design Report
Bridge Name and Number
over
River Name
Town, Maine
Federal Project Number
WIN Number

2.1.2 Table of Contents

This should be a properly identified index of pages both for sections of the PDR forms and for appendices.

2.1.3 Background Information

This page provides a quick reference for background information on the project. Much of this information is found either in MaineDOT's ProjEx, the Planning Report, or Bridge Management's SI&A sheet, all of which will be provided by the Project Team. The following sections are completed as shown below:

Program Scope: Copy verbatim the scope from the Work Plan.

Program Description: Copy verbatim the contents of the project description in the Work Plan.

Project Background: Provide a brief written description of the project's background covering any previous studies and recommendations, requests by Towns, and any other pertinent information.

2.1.4 Existing Bridge Synopsis Form

This form provides a description of the physical characteristics, history, and condition of the existing structure and should be filled in as completely as possible from information in Bridge Maintenance files and project records. Some terms are defined as follows:

Structurally Deficient: A structure is structurally deficient if the condition rating for the deck, superstructure, substructure, or the culvert and retaining wall is 4 or less. A structure may also be structurally deficient if the appraisal rating for the overall structural condition or waterway is 2 or less.

Functionally Obsolete: A structure is functionally obsolete if the appraisal rating for the deck geometry, under clearances, or approach roadway alignment is 3 or less. A structure may also be functionally obsolete if the appraisal rating for the overall structural condition or waterway is 3. Any bridge classified as structurally deficient is excluded from the functionally obsolete category.

2.1.5 Location Map

This should be from the Maine DOT Map Viewer or another reliable source of road and terrain maps. Do not use copyrighted material such as a DeLorme's Maine Atlas and Gazetteer. Use of images from Google Maps is acceptable under their Terms of Service in November 2015, but that could change at any time that Google wishes.

2.1.6 Bridge Recommendation Form

All portions of the Recommendation Form should be completed as shown below. A complete description of each component should be included under that component. There are several variations to this form depending on the project scope. If there are parts that are not applicable to the structure type, they need not be included.

Approved by – The Senior Structural Designer and the Assistant Bridge Program Manager for Design must both sign off on the PDR

Project - State the type of project. Examples:

> “Bridge replacement with 300 ft of approaches, including transitions”
> “Bridge rehabilitation project with no approach work”
> “Bridge replacement as part of Highway Program project”
> “Bridge replacement with approaches by Highway Program”

Alignment Description - Give a description of the horizontal and vertical alignments at the structure location and the relationship to the existing alignment. Example:

> "1200' horizontal curve located approximately 30' upstream of existing bridge and a 500' sag (crest) vertical curve with a finish grade 3.5' higher than existing bridge."

Approach Section - Give a description of the typical approach section at the bridge, including the type of guardrail. Example:

> “Two 11' paved lanes with 3’ shoulders (30’ rail-to-rail) with standard sideslopes. 21” aggregate subbase course gravel with 3” pavement thickness. Type 3 guardrail.”

Spans - Give the span lengths along the centerline of construction on straight tangents, and along working lines or chord lines for structures on a curve. If on a curve, indicate span lengths as "along long chord" or other descriptive indication. This section is not required for culvert-type structures.

Skew - Give the skew angle of the substructure units, or the centerline of a culvert-type structure, relative to the longitudinal working line of the structure. The skew angle should always be given as "Ahead on Left" or "Back on Left".

Loading - Indicate the appropriate design vehicle loading.

> For a typical superstructure:
> “HL – 93 Modified for Strength 1”

Superstructure - Give the design description and governing parameters of the superstructure. For culvert-type structures, this section is simply called Structure. Examples:

> For a typical superstructure:
> “Five rolled beams of A709, Grade 50W steel with a composite structural concrete slab, elastomeric bearings, one compression seal expansion joint, and a 3” bituminous wearing surface with ¼” (nominal) membrane waterproofing. 36’ curb-to-curb with standard 2-bar steel rail. 2% normal crown."

> For a culvert-type structure:
> "16’-4” span by 8’-2” rise aluminum structural plate pipe arch. Flow line of 1% with Elevation 100.00 at the centerline of construction."

Abutments - State the type of abutment and anticipated support system. Also give any specific features required. This section is not required for culvert-type structures. Example:

> "Stub concrete abutments with return wings on steel H-piles, 1.75:1 (plain or heavy) riprap slopes in front" or "Deep concrete abutments

with approach slabs on spread footings with sandblasted architectural facing".

Piers - State the type of piers and anticipated support system. This section is not required for culvert-type structures. Example:

"Mass concrete pier with distribution slab and concrete seal supported by steel H-beam piles."

Opening and Clearance - For water crossings, give the total area of bridge opening and the area of bridge opening at a common elevation for both the existing and the recommended structures. The areas should be normal to the direction of flow. Also, give the minimum clearance depth at Q50 for both the existing and the recommended structures.

For overpass structures, give the minimum vertical and horizontal clearances for both the existing and the recommended structures.

For culvert-type structures, give the total opening for both the existing and the recommended structures.

Available Soils Information - State what soils information was available during study or was obtained from existing plans. Also indicate if scour analysis should be made in the final design of the foundation.

Additional Design Features - Describe any design features that are not described in any other part of the Recommendation Form (e.g. something that is unusual or experimental), but which are necessary to complete the project description.

Maintenance of Traffic - State how and where traffic is to be maintained during construction of the project, whether one lane or two lanes will be required, and whether signals or flaggers will be required. Also state if maintenance of pedestrian traffic is required. If a road closure is proposed, give the detour length from abutment to abutment.

Construction Schedule - Include any restrictions and/or commitments. Example:

"One construction season with landscaping the following spring. Bridge must be reopened to traffic by Labor Day."

Advertising Date – The current estimated advertise date available in Projex.

Estimated Project Cost - Enter the programmed, available, and the estimated project costs under the appropriate headings.

> *Commentary: The estimated cost of the project is located in 3 places within the PDR: here in the program funding table, summary of preliminary design, and the cost estimate.*

Additional Borings Required and Additional Geotechnical Evaluations Required - Indicate whether or not the information is required.

Approved Design Exceptions - List any approved or pending exceptions to Federal or State Standards that either requires approval from FHWA (for NHS projects only), the Engineer of Design, or the Engineering Council. Examples of exceptions to standards are reduced bridge widths, omitting of the leveling slab on butted precast superstructures, and reduced hydraulic clearances.

2.1.7 Summary of Expected Impacts

This form provides a summary of the expected impacts and the required permitting for the recommended project. These impacts may be right-of-way, utilities, historical, archeological, environmental, etc. The required permitting may include Coast Guard, FAA, and the various environmental permits. Filling in the required information for this form will be a project team effort.

2.1.8 Summary of Preliminary Design

This is a summary of the Preliminary Design performed to determine the project recommendations. It should describe, in an orderly fashion, the alternatives considered, with a summary of the assumptions and comparisons that are pertinent to the justification of the recommendation. It should include a discussion of bridge width, alignment, and maintenance of traffic, with the reasoning used to arrive at the recommendation. It may include a discussion of geotechnical, environmental, or utility issues, if these are pertinent to the project.

The Summary should discuss the pros and cons of the alternatives considered and the reasons for the selection of the recommended alternative. Only the engineering that is pertinent should be discussed. The Summary should be short and to the point and should avoid superfluous and lengthy discussions.

For a water-crossing structure, reference should be made to the Hydrology/Hydraulic/Scour Report with the conclusions repeated as to the feasible structure alternatives and ultimate recommendation.

In some instances, especially on large and expensive projects, there may be several alternatives developed for public or internal review and selection.

These alternatives should be summarized here, with the back-up data and calculations bound and filed elsewhere in the project file.

2.1.9 Hydrology/Hydraulic/Scour Report

This is a summary of the hydrologic analysis that determines the design and check discharges, the hydraulic analysis that determines the structure opening and/or structure alternatives, and the scour analysis that determines the foundation requirements. Normally, this report combines the Hydrology and Hydraulics, but it can be separated into two reports if warranted. The MaineDOT Environmental Office Hydrology Unit provides a spreadsheet with the results of the U.S.G.S. full regression equation. Flows based on other methods should be computed and documented by the Designer. These flows are summarized in this section. Example:

Drainage Area	110 sq mi
Design Discharge (Q50)	1240 cfs
Check Discharge (Q100)	1410 cfs
Scour Check Discharge (Q500)	1660 cfs
Ordinary High Water (Q1.1)	380 cfs
Flood of Record (Q---)	1820 cfs @ Elevation 64.3

If HEC-RAS runs will be necessary for the hydraulic study, stream slopes should be determined. If the structure is in a tidal zone, the following elevation data should also be summarized:

- *Stream data from other agencies* - Stream flow and flood related data are sometimes available from other agencies in the State. The major sources are:

  U.S. Geological Survey: The U.S.G.S. has numerous gage stations on rivers and streams that collect hydrologic information. Through the use of formulae, this information can be transformed to other locations on the same water course. The Bridge Program's Hydraulic Library has copies of U.S.G.S. annual reports and a computer analysis summary of each gage site, which can be used to determine the existence of a gage location. Real time data from USGS gages is available from the U.S.G.S website (http://waterdata.usgs.gov/). If more information is required than can be obtained from these sources, the U.S.G.S. office in Augusta should be contacted.

  Natural Resources Conservation Service (NRCS): The NRCS, formerly known as the Soil Conservation Service (SCS), has studies for many flood control projects that contain information on the hydrology and hydraulics of the involved stream. The Hydraulic Library has a location map indicating completed and planned studies. The NRCS office in Bangor should be contacted for detailed information for each site for which information is desired.

  Maine Flood Plain Management Program: The Maine Floodplain Management Program has gathered flood information for communities with unnumbered "A" zones on their Flood Insurance Rate Map or Flood Hazard Boundary Map. The information is available on the State of Maine website.

  Utilities: Various utility companies have control of many dams in the State, and for most of the larger dams, they maintain flow records and capacity data. The Hydraulic Library has a listing of all known dams in the State with a brief description of the dam and the name of the dam owner.

- *Hydraulic Library* - The Bridge Program's Hydraulic Library has copies of many different Flood Study Reports, such as Corps of Engineer Studies, HUD Flood Insurance Studies, SCS Watershed Studies, and other miscellaneous information pertaining to specific rivers and streams. The Preliminary Engineering Studies and PDRs that have been developed for MaineDOT bridge structures over the years are electronically filed in MaineDOT's TEDOCS document management system. PDRs with hydrology and hydraulic information are generally available for projects starting in about the year 1975.

- *Local newspapers* - Local newspaper files may have stories on previous floods.

- *Flood insurance studies* - River cross sections used to develop Flood Insurance Rate Maps (FIRM) can be obtained through the Maine Floodplain Management Program in the Department of Economic and Community Development. These cross sections can be used in a hydraulic model such as HEC-RAS. The Bridge Program's Hydraulic Library has paper copies of the FEMA Flood Insurance Studies and Flood Insurance Rate Maps. Flood Insurance Rate Maps can also be viewed / printed on-line as well. If you are interested, the Maine Flood Plain Management Program web site has some instructions posted to help you through this process.

All of the above sources of information may provide valuable assistance and supplementary information that can be used advantageously; however, discrepancies sometimes are revealed when these data are compared. This indicates the need for verification and proper evaluation of the flood data, regardless of the source.

2.3.5 Vertical Datum

Since January 2000, all new projects, with a few exceptions, are referenced to the North American Vertical Datum (NAVD) of 1988.

> *Commentary: If there is any doubt about which vertical datum was used for a project, please contact the Survey Coordinator.*

Many of MaineDOT's existing plans, existing flood studies, historical flood information, and U.S.G.S. topographic maps are based on the National Geodetic Vertical Datum (NGVD) of 1929. The elevations based on this older datum must be converted to the newer NAVD of 1988. The elevations are adjusted using the following equation:

Elevation xxx.xxx (NGVD 1929) - datum shift = Elevation xxx.xxx (NAVD 1988)

The datum shift ranges between 0.591 feet and 0.722 feet. The exact datum shift for a specific location in Maine can be found at the following website:

http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl

The following data must be entered on the web page:

in the range of tide. The following examples show how to determine tidal elevations at a reference station and at a subordinate station.

Example 2-3 Tidal Elevation at Reference Station

Determine the following elevations for the Eastport, Maine reference station:

Highest Observed Water Level
Mean Lower Low Water (MLLW)
Mean Low Water (MLW)
Mean Tide Level (MTL)
Mean High Water (MHW)
Mean Higher High Water (MHHW)
Lowest Observed Water Level
Predicted High Tide Elevation for 2003

Step 1: Obtain the tidal datum information from the tidal gage site on the NOAA website (http://tidesandcurrents.noaa.gov). Use the menus at the top of the website or search to find the data for the Eastport tide gauge.

About two thirds of the way down the web page for Eastport, you will find the tidal datums section for the particular site. For example, the tidal datums section will look like the following for 8410140 EASTPORT, PASSAMAQUODDY BAY:

TIDAL DATUMS

Tidal datums at EASTPORT, PASSAMAQUODDY BAY based on:

LENGTH OF SERIES:	19 Years
TIME PERIOD:	January 1983-December 2001
TIDAL EPOCH:	1983-2001
CONTROL TIDE STATION:	

Elevations of tidal datums refer to Mean Lower Low Water (MLLW), in METERS:

HIGHEST OBSERVED WATER LEVEL (01/10/1997)	= 7.383
MEAN HIGHER HIGH WATER (MHHW)	= 5.844
MEAN HIGH WATER (MHW)	= 5.729
NORTH AMERICAN VERTICAL DATUM-1988 (NAVD)	= 3.029
MEAN SEA LEVEL (MSL)	= 2.958
MEAN TIDE LEVEL (MTL)	= 2.932
MEAN LOW WATER (MLW)	= 0.136
MEAN LOWER LOW WATER (MLLW)	= 0.000
LOWEST OBSERVED WATER LEVEL (08/09/1972)	= -1.426

Step 2: Convert the tidal datum information to the correct vertical datum. The tide information needs to be converted to the NAVD. MaineDOT has been surveying using the NAVD since about the year 2000.

Highest Observed Water Level (01/10/1997):
7.383 m – 3.029 m = 4.354 m

MHHW: 5.844 m -3.029 m = 2.815 m

MHW: 5.729 m – 3.029 m = 2.700 m

NAVD -1988: 3.029 m -3.029 m = 0.000 m

MSL: 2.958 m - 3.029 m = -0.071 m

MTL: 2.932 m - 3.029 m = -0.097 m

MLW: 0.136 m – 3.029 m = -2.893 m

MLLW: 0.000 m – 3.029 m = -3.029 m

Lowest Observed Water Level (08/09/1972):
-1.426 m - 3.029 m = -4.455 m

Step 3: Convert elevations from meters to feet. Tidal datum information based on the NTDE from 1983 -2001 is in meters.

Highest Observed Water Level (01/10/1997)
4.354 m x 3.2808 ft/m = 14.285 ft

MHHW: 2.815 m x 3.2808 ft/m = 9.236 ft

MHW: 2.700 m x 3.2808 ft/m = 8.858 ft

NAVD -1988: 0.000 m x 3.2808 ft/m = 0.000 ft

MSL: -0.071 m x 3.2808 ft/m = -0.233 ft

MTL: -0.097 m x 3.2808 ft/m = -0.318 ft

MLW: -2.893 m x 3.2808 ft/m = -9.491 ft

MLLW: -3.029 m x 3.2808 ft/m = -9.938 ft

Lowest Observed Water Level (08/09/1972):
-4.455 m x 3.2808 ft/m = - 14.616 ft

Step 4: Determine the highest predicted tide for the current year.

Go to the NOAA Tides and Currents website and find the Eastport tide gauge data.

Review the Tides/Water Levels data for the entire year and find the date with largest height.

April 19, 2003 12:09 am 22.3 ft (datum is MLLW)

2003 predicted high tide = - 9.938 ft (MLLW) + 22.3 ft = 12.362 ft

Example 2-4 Tidal Elevation at Subordinate Station

Determine the following elevations at West Quoddy Head using Eastport as the reference station.

MLLW
MLW
MTL
MHW
MHHW
Predicted High Tide Elevation for 2003

Step 1 through **Step 4**: See Example 2-3 for the Eastport location.

Step 5: Obtain the values for the mean range, spring range, and MTL for the West Quoddy Head location (subordinate station) from the NOAA Tides and Currents website.

West Quoddy Head
Mean range = 15.7 ft
Spring range = 17.9 ft
MTL = 8.2 ft

Step 6: Compute tide levels at West Quoddy Head

MTL Eastport = MTL West Quoddy Head

MHW West Quoddy Head = MTL Eastport + Mean Range @ West Quoddy Head/2 -0.318 ft + 15.7 ft/2 = 7.5 ft

MLW West Quoddy Head = MTL Eastport - Mean Range @ West Quoddy Head/2 -0.318 ft - 15.7ft/2 = -8.2 ft

MLLW West Quoddy Head = MTL Eastport - Mean Tide Level @ West Quoddy Head -0.318 ft - 8.2ft = -8.5 ft

MHHW West Quoddy Head = MLLW @ West Quoddy Head + Spring Range @ West Quoddy Head -8.5 ft + 17.9 ft = 9.4 ft

Step 7: Determine the highest predicted tide for the current year at West Quoddy Head.

On the NOAA Tides and Currents website, find the Eastport tide gauge, which is the closest reference station. Review the data for the entire year and find the date with largest height.

April 19, 2003 12:09 am 22.3 ft (datum is MLLW)

Get the following reference from the MaineDOT Library:

Tide Tables 2003, High and Low Water Predictions, East Coast of North and South America including Greenland

In Table 2 of the Tide Tables book under West Quoddy Head, find the ratio of height differences at high water.

West Quoddy Head   Ratio = 0.86

0.86 x 22.3 ft = 19.17 ft (datum is MLLW)

2003 predicted high tide = -8.5 ft (MLLW) + 19.17 ft = 10.7 ft

2.3.7 Changes in Sea Level

The level of the sea along the coast of Maine is rising between 0.5 feet and 0.75 feet per 100 years. Bridges along the coast of Maine should take this rise in sea level into consideration when designing bridge projects in tidal areas. Refer to the Sea Level Trends section of the NOAA Tides and Currents website for more information.

2.3.8 Documentation

The PDR includes a hydrology, hydraulics, and scour report and backup information. Backup information should include, but is not limited to, the following: computer printouts (input and output), drainage area map, hydrology computations, hydraulic computations, scour computations, and eyewitness reports about flooding.

The PDR is the main source of hydrologic, hydraulic, and scour information for a bridge project. If there are any changes made to the project after the PDR has been completed that impacts hydrology, hydraulics, and/or scour, it should be documented and included in the PDR as an addendum.

It is often helpful and sometimes necessary to refer to plans, hydrology, hydraulic, and scour analyses long after the actual construction is completed. They can be useful in the analysis of an upstream or downstream structure, in the future replacement of the structure, or in the evaluation of the hydraulic performance of the structure after large floods. Documentation provides a quick reference and a construction aid for the Contractor and the Resident in the construction of a bridge structure. This information is also helpful to other state agencies such as Floodplain Management, as a source of best available data for Q100 elevation when a formal flood study has not been done for a river.

2.3.9 Hydrology

2.3.9.1 Introduction

Hydrologic analysis is a very important step prior to the hydraulic design of a bridge drainage structure. Such an analysis is necessary for determining the flow that the structure will be required to accommodate. The flow, or

2.3.9.4 Rural Watersheds

Most watersheds for bridges in Maine are rural in nature. A rural area can generally be defined as one having a high percentage of woods, mixed cover, or fields, and is essentially an undeveloped area with respect to commercial sites and residences. The best source of flow data for rural watersheds is gaged data from the U.S.G.S. gaging station network. Methods for transposing gaged data are including on the following pages. If gaged data is not available, the U.S.G.S. full regression equation can be used. Appendix C contains this equation, as well as a hydrology tabulation form for use with the equation. The report that explains the 1999 U.S.G.S. full regression equation is "Estimating the Magnitude of Peak Flows for Streams in Maine for Selected Recurrence Intervals" by Glenn A. Hodgkins, published by U.S.G.S. in 1999 and available from their website.

A. Urban Watersheds

The U.S.G.S. full regression equation does not apply to urbanized drainage basins or small drainage basins that may experience future development and land use changes. An urban area can generally be defined as one having a very low percentage of woods, mixed cover, or fields, and is essentially a developed area with commercial sites and residences. Potential future development in the watershed should be considered when determining the design flow.

The following methods can be used for small, urbanized drainage basins:

Size of Drainage Area	**Hydrologic Method**
Greater than 3200 acres	NRCS TR-20 or HEC-1 Method
Greater than 20 acres	Sauer and others (1983)

NRCS TR-20 and HEC-1 Methods are explained in the "Urban & Arterial Highway Design Guide." Sauer and others (1983) is an urban regression equation (Hodgkins, 1999).

B. Hydraulic Analysis

Flows based on observed and recorded high waters at or near bridges may be determined by performing a hydraulic analysis using the methods discussed in 2.3.10.2 Hydraulic Analysis. For culverts, Bodhaine, 1968, can be used.

All of the applicable methods that may be used for the watershed in question should be utilized. However, large variations in answers may

2.3.10.6 Fish Passage

Designers should refer to the latest guidance from MaineDOT's Environmental Office to ensure that fish passage is maintained.

2.3.11 Scour

Commentary: Flooding is the most common cause of bridge failure, with the scouring of bridge foundations being the most common failure mechanism. The catastrophic collapse of the Interstate 90 crossing of Schoharie Creek near Amsterdam, NY on April 5, 1987, is one of the most severe bridge failures in the U.S. Two spans fell into the water after a pier supporting the spans was undermined by scour. Five vehicles plunged into the creek killing 10 people. The National Transportation Safety Board concluded that the bridge footings were vulnerable to scour because of inadequate riprap around the base of the piers and a relatively shallow foundation. The I-90 collapse focused national attention on the vulnerability of bridges to failure from scour and resulted in revisions to design, maintenance, and inspection guidelines.

MaineDOT initiated a scour-screening program in 1987 in response to FHWA Technical Advisory TA 5140.20 (succeeded by TA 5140.21 and TA 5140.23). The advisories ultimately require that a master list be generated of all bridges that require underwater inspection, and that all applicable bridge foundations be evaluated and prioritized according to their vulnerability to scour damage. Reliable equations to compute local scour depths are available for piers. A report by the USGS titled "Observed and Predicted Pier Scour in Maine" is available from their website. The report confirms that the local pier scour predicted by the latest version of the CSU equation in the Hydraulic Engineering Circular 18 Fourth Edition May 2001 on page 6.2 are reasonable.

2.3.11.1 New Bridges

Bridges over waterways with scourable beds should be designed to withstand the effects of scour from a superflood (a flood exceeding Q100) without experiencing foundation movement of a magnitude that requires corrective action. A scour analysis will be performed for all bridge-type structures using the methods in the latest version of HEC-18. The design flood for scour is the lesser of Q100 or the overtopping flood. Maximum scour depths will be produced by the overtopping flood. Scour should also be computed for the superflood, defined as Q500 or the overtopping flood if it is between Q100 and Q500. Q500 can be estimated as 1.18 times the magnitude of the Q100, if Q500 cannot be computed by other means.

The bridge foundation should be designed for the normal factor of safety as specified in AASHTO Standard Specifications below the scour depths estimated for Q100. The bridge foundation should have a factor of safety of 1.0 for scour produced by the superflood. The footings should be placed a minimum of 2 feet below the design flood scour level. Where pile bents are used, the design friction or point bearing should be achieved below the

- Current right-of-way limits
- Geometric alignment
- Traffic volume
- Propensity for growth

2.8.1.2 Collector Roads

The approach guardrail (attached and immediate to the bridge) should be set at the same width as the bridge rail. For bridges on collector roads with extensive approaches, refer to the “MaineDOT Highway Design Guide” for appropriate shoulder widths and guardrail offsets.

2.8.1.3 Arterials

Roadway widths for approaches on arterials should comply with the latest AASHTO A Policy on Geometric Design of Highways and Streets.

2.8.2 Guardrail

2.8.2.1 General

On the NHS, terminal ends must meet the requirements of NCHRP 350 in conjunction with either guardrail type 3d on Interstate projects and 3c on non-Interstate NHS. Refer to Section 10 of the “MaineDOT Highway Design Guide” for further guidance. On non-NHS roadways with an AADT>500, use a NCHRP 350 compliant system for an end treatment with guardrail type 3c as appropriate. On non-NHS roadways with AADT of 500 or less, use the Low Volume Guardrail End with guardrail type 3c as appropriate. For more information on guardrail types, refer to the Standard Specifications and Standard Details.

2.8.2.2 Guardrail Treatment on Local Roads

Bridge approach guardrails protect motorists from roadside hazards such as non-negotiable foreslopes, telephone poles, trees, streams, and rivers, and provide safe transitions to the bridge rail system. For guidance on bridge rail systems, refer to Section 4.4 Bridge Rail. Termination of these systems is controlled by the steepness of the foreslopes, location of obstacles, and the geometry of the stream crossings. Termination design criteria are presented in the current edition of the AASHTO Roadside Design Guide and the “MaineDOT Highway Design Guide”. The use of

7.1.2 Section Properties

When designing beams with composite concrete decks, composite section properties should be computed assuming a haunch dimension of 1 inch and an equivalent transformed width of deck.

7.1.3 Constructability

Structural Designers should be familiar with constructability issues, and incorporate good practices in their designs. An excellent resource is the AASHTO/NSBA website at http://www.steelbridge.org/.

7.2 Materials

7.2.1 Structural Steel

Unpainted ASTM A709 Grade 50W steel (weathering steel) should be used for structures over water, except when such structures have open roadway joints or are located in a coastal, salt spray, or heavy industrial area. Unpainted ASTM A709 Grade 50W steel may be used for structures over railroads and highways except for narrow depressed roadways and similar situations that create tunnel-like conditions.

Weathering steel is resistant to only certain types of atmospheric corrosion. Weathering steel will not develop a protective oxide coating if it remains wet more than 60% of the time. Also, an excessive amount of contaminants in the air or the presence of salt will prevent the oxide coating from forming. For more information on this subject, refer to FHWA Technical Advisory (1989).

Painted, metallized, or galvanized ASTM A709 Grade 50 steel may be used where weathering steel is inappropriate, but only if a concrete superstructure is not a feasible alternative. Refer to Section 7.2.3 for coating requirements.

H-Piles used for bridge foundations should be composed of rolled-steel sections of ASTM A572, Grade 50 steel. Pipe piles used for bridge foundations should conform to the requirements of ASTM A252 Grade 2

7.4.7 Slab Overhang Limits

In order to prevent excessive torsional deflections in beams during placement of the deck concrete, the slab overhang should not exceed the applicable value from Table 7-4. For overhangs exceeding the limits of Table 7-4, a torsional analysis of the exterior beam should be completed. Torsional analysis of the exterior beam should also be completed on all deck replacement and widening projects. As part of the shop drawing submittal, the Bridge Quality Assurance Team will complete a torsional analysis of the exterior beam for construction loading.

Table 7-4 Slab Overhang Limits

Beam Spacing	Maximum Overhang is the lesser of:
Less than 9’-0”	3’-0” or depth of beam
9’-0” to 10’-6”	1/3 of the beam spacing or depth of beam
Greater than 10’-6”	3’-6” or depth of beam

Note: Table 7-4 is for use on straight bridges. Maximum overhang for bridges with curved fascias is limited to 3’-6”, or depth of beam plus 6”, whichever is less.

7.4.8 Composite Design

All new steel girder bridges should be designed as composite structures.

bearing systems, as discussed in Section 10.9 Seismic Retrofit. A widened structure should be fitted with the same bearing type as that installed on the remaining structure for each substructure unit.

10.4 Expansion Devices

On a wearing surface replacement or deck rehabilitation project, the bridge expansion devices (joints) should be examined to determine their condition. The joint armor may be damaged, or the seal may be gone. The value of replacing the seal, repairing the joint armor, or replacing the entire joint should be assessed for each project. The Designer must consider the potential damage to the structure below if repairs or modifications are not made, as well as the expected life of the structure before full bridge replacement is warranted.

Often the joint must be modified or raised to accommodate the increase in grade created by additional pavement. If the joint armor is not damaged beyond repair, and a compression seal can be used, the joint should be modified by welding a round bar to the top of the joint armor. If the joint armor is damaged, the affected steel can be cut out and replaced with a new piece. Keeper bars should be added to the joint armor if not part of the existing joint configuration.

To select a new seal, field measurements must be taken to determine which manufacturer's seal will fit. The existing joint opening should be measured, along with the temperature and the location of the keeper bars if applicable. With this information, the maximum and minimum expected joint opening can be determined. The Designer should then use the manufacturer's literature from the two suppliers listed in Table 4-7 to determine the minimum installation opening and seal depth. A seal can be selected to fit within the given parameters (depth of seal, minimum installation opening, and movement rating) by using Table 4-7 Elastomeric Joint Seal Movement Ratings or the Bridge Compression Seals for Expansion Joints section of the Qualified Products List. The depth from top of new joint to top of seal should comply as closely as possible with the Standard Detail 520(10) minimum of 1/2".

For bridges with differential movement, excessive rotation at the joint, or if the joint space is measured and found to be uneven from one side of the bridge to the other, a gland seal may be selected instead of a compression seal.

In some cases, the existing seal type may be changed without modification of the existing joint armor. Prequalified seals listed in Section 4.8 Deck Joints and Expansion Devices should be evaluated for use inside existing joint armor.

If a prefabricated seal cannot be found to fit the existing joint armor, self-leveling joints can be considered. For the approved list of self-leveling joints refer to the Bridge Expansion Joint Systems section of the Qualified Products List on the

MaineDOT website. These seals are a temporary solution, with a service life of only six to seven years.

Modifications and replacement of existing joints should be specified in accordance with Table 10-1. The descriptions of these joint modifications are not meant to be all-inclusive but merely a broad description. The Designer should use good judgment in determining which type of modification to specify. As a general rule, only the pay items listed here should be used. When two joint modifications required on the same project must be detailed separately, or may have a significant difference in cost, but fall under the same type, use the same pay item number for both modifications and change the pay item description by adding letters to differentiate (i.e. Type 3A and Type 3B would both be paid under pay item 520.243). Construction requirements and modification type descriptions are specified in Special Provision Section 520 Expansion Devices. The Designer must verify that the PS&E package contains this Special Provision.

Table 10-1 Bridge Joint Modification Types

Item Number	Modification	Scope of Work	Examples of Work Scope
520.241	Type 1	Normal maintenance	• Replace seal* • New keeper bars
520.242	Type 2	Steel repair	• Repair joint armor steel • Minor concrete repair
520.243	Type 3	Concrete repair	• Concrete removal and repair
520.244	Type 4	Modification	• Modification to new joint type
520.245	Type 5	Replacement	• Full joint removal and replacement

* Seal replacement is assumed on all other Bridge Joint Modification Types

10.5 Bridge Rail and Connections

10.5.1 General

Bridge rehabilitation projects and resurfacing projects should consider the need for the replacement, retrofitting, or retention of existing bridge rails. In general, bridge rails should be replaced or retrofitted to meet AASHTO LRFD standards. Refer to Section 4.4 Bridge Rail for further guidance.

For rehabilitations where it is desirable to leave the existing end posts in place and the bridge transition is in question, it is acceptable to use Bridge Transition Type 2 as shown in Standard Detail 606(26).

Appendix B PDR Forms (Section Removed)

The PDR form examples have been removed from the Bridge Design Guide and are available as electronic Microsoft Word files instead.