

<b>3</b>	<b>PROJECT DEFINITION AND CONSTRAINTS .....</b>	<b>3-1</b>
<b>3.1</b>	<b>ROADWAY GEOMETRY .....</b>	<b>3-1</b>
3.1.1	Highway Corridor Priority .....	3-1
3.1.2	Complete Streets .....	3-1
3.1.3	Lane and Shoulder Widths .....	3-2
3.1.4	Clearances .....	3-2
3.1.4.1	Grade Separated Crossings .....	3-3
3.1.4.2	Waterway Crossings .....	3-4
3.1.4.3	Railroad Crossings .....	3-4
3.1.5	Alignments .....	3-4
3.1.6	Cross Slope and Superelevation .....	3-5
<b>3.2</b>	<b>STRUCTURE TYPE SELECTION .....</b>	<b>3-6</b>
3.2.1	Project Constraints .....	3-6
3.2.1.1	Environmental Impacts .....	3-6
3.2.1.1.1	Natural Resources .....	3-6
3.2.1.1.2	Dredge Material .....	3-7
3.2.1.2	Historic Sites, Parks, and Recreation Areas .....	3-8
3.2.1.3	Right-of-Way (ROW) Impacts .....	3-9
3.2.1.4	Economics .....	3-10
3.2.2	Bridge Geometry .....	3-10
3.2.2.1	Bridge Width .....	3-10
3.2.2.2	Span Arrangement .....	3-11
3.2.3	Bridge Type .....	3-12
3.2.3.1	Substructure Types .....	3-12
3.2.3.1.1	Foundations .....	3-12
3.2.3.1.2	Abutments .....	3-13
3.2.3.1.3	Piers .....	3-14
3.2.3.2	Superstructure Types .....	3-14
3.2.4	Construction Methods .....	3-17
3.2.4.1	Maintenance of Traffic .....	3-17
3.2.4.1.1	MOT Considerations .....	3-17
3.2.4.1.2	MOT Methods .....	3-19

CHAPTER 3 – PROJECT DEFINITION AND CONSTRAINTS

3.2.4.1.3	Temporary Traffic Barriers.....	3-22
3.2.4.2	Constructability.....	3-23
3.2.4.3	Accelerated Bridge Construction .....	3-24
<b>3.2.5</b>	<b>Ancillary Bridge Components.....</b>	<b>3-26</b>
3.2.5.1	Drains.....	3-26
3.2.5.2	Bearings .....	3-26
3.2.5.3	Deck End Details .....	3-27
3.2.5.4	Approach Slabs .....	3-27
3.2.5.5	Wearing Surface.....	3-27
3.2.5.5.1	Wearing Surface Types .....	3-28
3.2.5.5.2	Waterproofing Membrane Types .....	3-29
3.2.5.6	Railing/Barrier .....	3-29
3.2.5.7	Future Maintenance .....	3-30
<b>3.3</b>	<b>GEOTECHNICAL CONSIDERATIONS .....</b>	<b>3-30</b>
3.3.1	Subsurface Exploration Programs.....	3-31
3.3.2	Number, Layout, and Depth of Borings .....	3-31
3.3.3	Standards for Borings, Sampling, In-Situ Testing, and Boring Log Drafting .....	3-32
3.3.4	High Risk Geotechnical Sites .....	3-32
<b>3.4</b>	<b>UTILITIES.....</b>	<b>3-33</b>
3.4.1	Coordination and Relocation .....	3-33
3.4.2	Aerial Facilities .....	3-34
3.4.3	Underground Facilities.....	3-34
3.4.4	Bridge Mounted Facilities .....	3-34
3.4.5	Lighting.....	3-35
<b>3.5</b>	<b>ADA CONSIDERATIONS .....</b>	<b>3-36</b>

## 3 PROJECT DEFINITION AND CONSTRAINTS

This chapter provides general guidance toward defining the basic project controls (e.g., roadway geometry and structure type), gathering information that will influence project development (e.g., subsurface investigations and utilities), and understanding constraints (e.g., environmental restrictions, maintenance of traffic requirements, and right of way).

### 3.1 ROADWAY GEOMETRY

---

Geometric definition of the roadway should occur during the Preliminary Design phase. This includes a definition of the horizontal and vertical alignments, lane and shoulder widths, any multi-modal accommodations, and clearances. Minor adjustments to roadway geometry and features may occur after the Preliminary Design; however, all roadway design including side slope limits, drainage, and utility relocation shall be complete by the Plan Impacts Complete (PIC) milestone. Refer to Chapter 2 for additional guidance on expectations during the Preliminary Design and PIC phases.

Most roadway design elements fall into one of the controlling criteria categories listed in Chapter 2. Specific design guidance for each of these categories, as well as general highway design practices and procedures, can be found on the MaineDOT Highway Program’s website. Where Department specific guidance is absent, the Designer should default to the most recent version of the American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets*, commonly referred to as the *Green Book*.

Roadway design as part of a bridge project is generally considered a localized improvement that only affects a small portion of a road corridor. Improvements on a geometrically substandard facility should be evaluated on an individual basis and be designed to blend in with the remaining adjacent features, unless a more extensive roadway scope can be justified.

The physical constraints within the limits of a project on an existing roadway will often determine what geometric improvements are practical and cost-effective. These include topography, adjacent properties, available right-of-way, utilities, and environmental impacts. The Designer should review the adjacent roadway geometry and existing corridor design speed when evaluating bridge approach design. Design Exceptions, especially on lower priority roadways, are acceptable to provide a practical design.

#### 3.1.1 Highway Corridor Priority

Highway Corridor Priority (HCP) will factor into many of the design decisions related to roadway geometry. HCP descriptions can be found on the MaineDOT Asset Management website. The HCP for a particular bridge project can be found using MaineDOT’s interactive Map Viewer.

#### 3.1.2 Complete Streets

The MaineDOT “Complete Streets Policy” formalizes the Department’s goals and current practices for providing safe and accessible streets and highways for all users, supporting prosperous communities, villages, downtowns, businesses, neighborhoods, and rural areas. Users include all modes of transit such as

passenger and commercial vehicles, transit riders, bicyclists, pedestrians, and recreational motorists such as ATVs or snowmobiles.

Each bridge project shall reference and implement the complete streets policy where applicable to ensure safe and efficient access to the street and highway system for people of all ages and abilities. Project considerations and process shall be documented in the Preliminary Design Report. The MaineDOT Project Manager and Program Manager will determine the final project merit and feasibility based on the available information. Due to variations in community needs and project constraints, determinations are made on a case-by-case basis. Cost sharing between the MaineDOT and local agencies for specific projects is possible; refer to MaineDOT’s “Local Cost Sharing Policy” for additional information. Final determination on any cost share will be made by the Program Manager.

### 3.1.3 Lane and Shoulder Widths

Engineering Instructions posted on the MaineDOT’s website provide guidance on appropriate lane and shoulder widths. The actual lane and shoulder width for a bridge project will depend on many factors such as the scope of the project (e.g., rehabilitation vs. replacement), design speed, the approach roadway, property and environmental impacts, maintenance of traffic constraints, features to accommodate Complete Streets policies, and potential future improvements to the corridor. Discussion with municipal officials and/or local planning boards, particularly for local road bridges, should be considered when determining the appropriate corridor width.

The lane and shoulder widths should be coordinated with the Project Manager early in the project development process and finalized with the completion of the Bridge Concept Form (BCF).

Where property and/or environmental impacts are critical, the Designer may reduce the berm offset to 2’ instead of 3’ behind guardrail as shown in the MaineDOT Standard Details with approval of the Senior Structural Engineer for the project.

### 3.1.4 Clearances

Bridge clearance requirements ensure that the proper accommodations are made for large vehicles and the transport of people, construction equipment/materials, and domestic products. Minimum bridge vertical clearance requirements for grade separated roadways and ancillary structures over roadways are provided in the Engineering Instructions. New structures should be designed to meet the preferred clearances in the following subsections where site constraints allow. Temporary bridges used to maintain traffic during construction shall be designed to meet the minimum requirements. Generally, each project can be classified into one of these three types of crossings:

- Grade Separated Crossing
- Waterway Crossing
- Railroad Crossing

Each crossing type has different clearance requirements; the unique considerations are highlighted throughout the following subsections. The clearance between parallel structures, regardless of crossing

type, shall be a minimum of 10'-0" to provide room for future maintenance activities, painting, and inspection access. A 6'-0" clearance may be allowed with concurrence from Bridge Maintenance.

#### **3.1.4.1 Grade Separated Crossings**

For new grade separated crossings, the required minimum vertical clearance shall be as defined in the Engineering Instruction. Preferred vertical clearance is an additional 6" above the required minimum. The preferred clearances provide additional height to account for future pavement overlays and construction tolerances. Both new and rehabilitated bridges identified as part of the Strategic Highway Network (STRAHNET) must receive a waiver if they do not meet the required minimum vertical clearance of 16'-0", and any issues relating to vertical clearance should be discussed early in project development. All bridge projects on the STRAHNET shall include coordination with the Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) to ensure compliance with the Highways for National Defense (HND) Program; see the SDDCTEA website for more details (<https://www.fhwa.dot.gov/design/090415.cfm>).

For existing structures that are undergoing major rehabilitation (e.g., deck or superstructure replacement), the Designer shall consider alternatives that provide either the preferred or minimum clearances presented for new structures. However, if the project constraints do not allow for the preferred or minimum clearances, early coordination in the project development process is necessary to achieve a solution that provides a safe and functional structure with consideration of all stakeholder needs. The legal minimum vertical clearance for grade separated crossings without posting is 14'-6".

The Designer shall consider and implement protection measures for fixed objects, such as substructures and retaining walls, that are located within the clear zone of the underlying roadway. Two different protection measures need to be considered:

- Structural Protection: this type of protection is to ensure the structural integrity of the overpassing bridge following an errant vehicle collision with a substructure unit. AASHTO allows structural protection to be addressed through direct design of the substructures and foundations, or by providing a structurally independent barrier system that can absorb and redirect the collision. The preference is the latter.
- Traveler Protection: this type of protection considers the safety of the passenger(s) within the potentially errant vehicle. In this situation, redirection of an errant vehicle to avoid a fixed object within the clear zone is necessary for passenger safety, even if the integrity of the bridge would not be compromised.

The Designer should consider locating substructures and retaining walls outside of the clear zone of the underlying roadway to avoid the need to design the substructures for a collision force and avoid implementation of a redirection system such as guardrail or concrete barrier. Where a decision is made to place substructure units within the clear zone, the Designer shall coordinate protection measures with the Senior Structural Engineer.

The vertical clearance to ancillary structures, overhead cross bracing for through-truss structures, or pedestrian structures should be considered as 1'-0" greater than the vehicular bridge requirements. Pedestrian walking trails or pathways should maintain a 10'-0" vertical clearance to the bridge they cross under whenever possible. In certain special cases, paths used by snowmobiles may require extra vertical clearance to make room for trail grooming equipment. In such scenarios, the Designer should consult with local snowmobile clubs as necessary.

#### **3.1.4.2 Waterway Crossings**

For structures over waterways, the vertical clearances shall meet the requirements defined in **Chapter 4 Hydraulics**. Projects that cross a navigable waterway shall satisfy the requirements of the Coast Guard and the associated project permits.

#### **3.1.4.3 Railroad Crossings**

For all bridge projects over railroads, minimum clearances need to be coordinated with the specific railroad company early in preliminary design. The initial target for vertical clearance should be 23' from the top of the rails and reduced as scope or site constraints dictate. Similarly, preferred initial target for horizontal clearance is typically more than 25' from centerline of track to the nearest structural element; otherwise, the pier or abutment shall be of "heavy construction" or protected by a reinforced concrete crash wall. Refer to the latest edition of the *AREMA Manual for Railway Engineering* for specifics on the definition of "heavy construction" and additional requirements. Often, railroad companies have their own minimum clearance requirements for structures, earthwork, or temporary works crossing their facilities.

For additional information regarding the appropriate collision forces to be considered, refer to **Chapter 5 Loads and Load Combinations**.

### **3.1.5 Alignments**

Bridge alignments will generally be driven by the roadway along which they are situated. However, where site conditions allow, the following conditions should be met:

- Locate the bridge on a horizontally tangent alignment. When a bridge needs to be located along, or partially along, a horizontally curved alignment, the bridge deck should be formed at a constant superelevation (with or without the high-side shoulder broken, see Section 3.1.6) and all necessary superelevation transitions should occur within the approach roadway.
- The desired minimum vertical grade should be 1% to promote drainage. If existing conditions require a grade less than 1%, a minimum of 0.5% would be considered acceptable. For crest curves with a high point on the proposed bridge, the vertical curve shall be set to ensure a minimum vertical grade of 0.5% is achieved approximately 50'-0" from the crest. In constrained areas where these grades are not achievable, such as high-speed crest curves or urban locations, further coordination with the Bridge Program is required.

- The low point of a sag vertical curve should not be located on the bridge or within 20'-0" of any bridge element, including abutments and wingwalls. Consideration for approach slabs and other features past the abutments should be evaluated as well. The Designer should ensure that riprap downspouts are used at the end of precast transition curbs.

### 3.1.6 Cross Slope and Superelevation

The Engineering Instructions provide guidance toward defining the roadway cross slope geometry. In general, a bridge deck should match the approach roadway cross-section. Bridge decks are typically either normal crown or superelevated depending on the approach roadway's horizontal alignment. Multiple cross slope breaks within a bridge deck transverse section can be accommodated; however, the number of breaks and transverse locations of breaks must be assessed to ensure industry standard bridge deck finishers (i.e., screeds) can accommodate the proposed geometry.

- Normal Crown: This is the typical cross section cross slope configuration on a tangent horizontal alignment, with a 2% downward slope in each direction from the roadway center. Sometimes approach roadway shoulders have cross slope breaks to further promote drainage; however, to simplify bridge deck construction, the shoulder cross slope break should be removed on bridges. To accommodate this, the approach roadway transitions the shoulder cross slope to match the lane cross slope leading up to the bridge by rotating the shoulder cross slope upward until it matches the lane.
- Superelevation: Bridge decks with superelevation typically incorporate a constant cross slope the full width of the roadway. In some instances, a single break is incorporated, such as for shoulders 4'-0" or wider, at the high-side shoulder. Refer to the Highway Program's Design Guidance titled *High Side Shoulder Rollover* for additional guidance. Bridge deck finishers (i.e., screeds) incorporate an adjustable crown break to accommodate roadway crowns or breaks for a high-side shoulder. These adjustable crown breaks are manually adjusted and locked in place during the trial run ahead of deck casting. As such, superelevation transitions along the length of a bridge should be avoided due to the corresponding deck construction and finishing complexities. However, transitioning a fully superelevated bridge at an even rate across the entire deck length without introducing a crown break is feasible (i.e., 4% fully down to the left transitioning by rotating the entire deck section to 2% fully down to the right).

## 3.2 STRUCTURE TYPE SELECTION

---

The structure type selection process must balance the project needs, project funding, and stakeholder input. Many projects have multiple possible structure types and span arrangements; the Designer must use their technical expertise and experience to determine the most appropriate solutions and make recommendations. This selection process requires coordination with the project stakeholders, such as the Bridge Program and the Public. When selecting a structure type, the following general criteria should be considered and documented throughout preliminary design:

- Project Constraints
- Bridge Geometry
- Bridge Type
- Construction Methods
- Ancillary Bridge Components (e.g., drains, bearings, joints, railings, etc.)

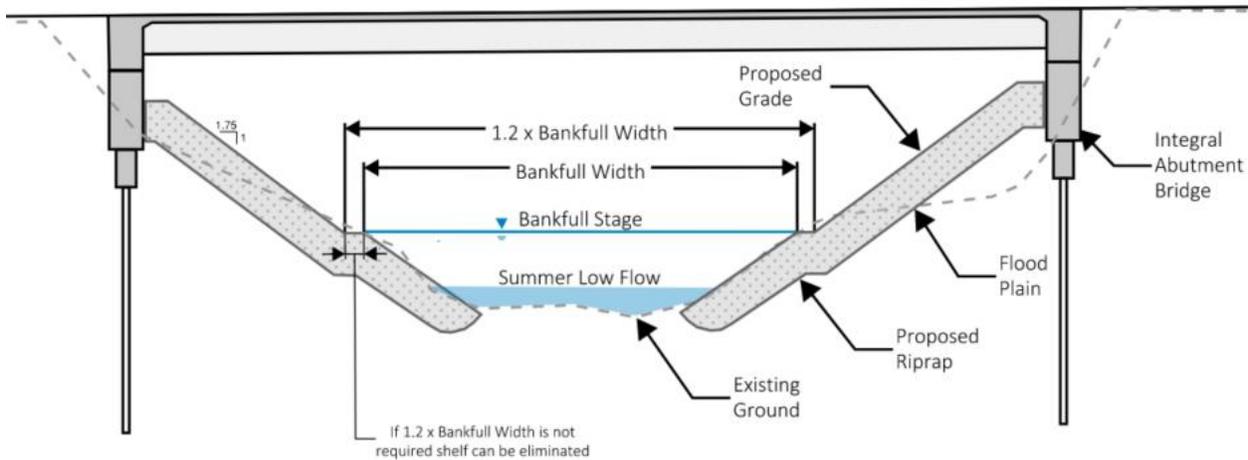
### 3.2.1 Project Constraints

#### 3.2.1.1 *Environmental Impacts*

##### 3.2.1.1.1 Natural Resources

For any project, one of the Designer's goals is to avoid or minimize environmental impacts while balancing competing site constraints and considering implications to project cost, schedule, safety, constructability, and maintenance. Common environmental considerations and constraints include optimizing the structure size to integrate with the natural environment, accommodating wildlife needs, in-water work windows, magnitude of wetland impact, vernal pool avoidance, and clearing limitations. The MaineDOT Environmental Office can provide information about the relative importance of project specific environmental considerations and potential restrictions or mitigation to avoid unnecessary impacts. Specific requirements will vary widely between projects, and early communication between the Environmental Office and the rest of the Project Team is essential to effective design development.

A waterway opening that accommodates the channel's natural bankfull width is a common consideration that often affects the alternatives analysis and permit requirements. Sizing a bridge or buried structure to provide the bankfull width ensures adequate hydraulic capacity at lower flows and supports continuity of natural characteristics and habitat connectivity along the river. The bankfull width requirement varies between projects (e.g., 1.0x and 1.2x bankfull width), and the Environmental Office should be consulted early in the design process to determine the project location needs and requirements. Figure 3-1 illustrates a typical integral abutment bridge with proposed geometry accommodating bankfull width. Bankfull width is measured perpendicular to the waterway alignment; therefore, the opening and bankfull width are measured on sections cut normal to the waterway, not on the bridge centerline profile, for skewed bridges.



*Figure 3-1: Bankfull Width Elevation for Typical Integral Abutment Bridge*

In many instances, accommodating bankfull width defines the span of the proposed bridge. If the established bankfull width requirement is less than or equal to 26'-0", a precast concrete box culvert is the preferred structure type by the MaineDOT. Refer to Section 3.2.3.2 and [Chapter 9, Buried Structures](#) for additional design guidance.

#### 3.2.1.1.2 Dredge Material

Dredge Material is regulated as a Special Waste in Maine and is a common environmental consideration on a project. Dredge is the total volume of material excavated from the area that falls beneath the plane bounded by the OHW/HAT line specified by the Environmental Office, excluding material in man-made embankments (i.e., existing roadway embankments and material under existing pipe/culvert structures). Dredge material that can be used on-site is referred to as Beneficial Use. Dredge material that is disposed of off-site is considered Special Waste, except, Dredge removed from waterbodies classified as A, AA, or SA, which is exempt from consideration as Special Waste. Dredge material from Class A waterbodies still requires quantification for documentation purposes.

Beneficial Use of Dredge material on-site is limited to 500 CY per project. The Beneficial Use location(s) must drain back into the original waterbody. Consider project construction sequence when evaluating Beneficial Use options and adjust Common Borrow and other applicable quantities as necessary. Consult with the Senior Structural Engineer, Project Manager, Geotechnical Engineer, and/or Environmental Office in considering the following (or other) possible Beneficial Use locations:

- Standard Detail 203(01), Muck Excavation and Waste Disposal.
  - Include cross sections with design slopes of 2:1
  - 24-inch vertical dimension does not apply
  - Include grubbing depth in the quantity calculation

- Beneficial Use as Special Fill. Consult with the Environmental Office.
- Beneficial Use as Common Borrow. On a project specific basis, based on the borings or other on-site assessment, some Dredge material may be assumed to meet the Common Borrow gradation requirements.
- Flatten sideslopes or construct a toe berm to the bottom of ASCG. Material must be placed within the State right of way and should consider applicable wetland mitigation limits. If within a wetland, use needs to be clearly beneficial (e.g., flattening sideslopes to 4:1 within the clear zone, shortening guardrail runs).
- Fill voids in riprap. On a project specific basis, some Dredge material may be mixed into riprap.
- Beneficial Use as riprap. Excavated material greater than 12 inches does not qualify as Special Waste. If the borings show cobbles/boulders or some are readily observed in the streambed, a small percentage of the Dredge quantity may be estimated as greater than 12 inches and therefore not classified as Special Waste.
- If the dredge material is expected to have less than 15% fines (material passing the #200 sieve) and all of it will not be used on-site, then consult with the Environmental Office before PIC for possible off-site Beneficial Use.

Special Waste is the difference in the Dredge and Beneficial Use quantities. Special Waste is paid for by the ton and is estimated as 2 tons per cubic yard. Preliminary Dredge, Beneficial Use, and Special Waste quantities should be calculated during preliminary design and possible locations for use on-site identified before the Plan Impacts Complete milestone. Cost estimates shall consider appropriate use or disposal costs.

### **3.2.1.2 Historic Sites, Parks, and Recreation Areas**

The presence of historic sites, public parks, refuges, monuments, and recreation areas can have a significant influence on projects. Impacts to these resources, whether temporary or permanent, should be avoided if possible. The following regulations must be considered when a project has potential impacts to any of these resources:

- Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires federal agencies to consider the effects on historic properties from projects they carry out, assist, fund, permit, license, or approve throughout the country. This can be a direct impact to the historic property, or an impact to a contributing feature of a historic district. In certain cases, the bridge itself can be classified as a historic asset. Section 106 requires that the State Historic Preservation Office (SHPO), in this case, the Maine Historic Preservation Commission (MHPC), and the general public be given reasonable opportunity to comment on undertakings involving historic properties or districts. When impacts are found to be necessary, a project can be approved only if there has been consultation among agency officials and an assessment of adverse

effects has occurred with any identified adverse effects resolved through avoidance, minimization, or mitigation. Alternatives that avoid adverse effects to a historic property need to be considered and exhausted before evaluating alternatives with an adverse effect.

- Section 4(f) refers to the original section within the U.S. Department of Transportation Act of 1966 which provided for consideration of park and recreation lands, wildlife and waterfowl refuges, and historic sites during transportation project development. The law, now codified in 49 U.S.C. §303 and 23 U.S.C. §138, applies only to the U.S. Department of Transportation (U.S. DOT) and is implemented by the Federal Highway Administration (FHWA) through the regulation [23 Code of Federal Regulations \(CFR\) 774](#). Under Section 4(f), right-of-way impacts to publicly owned land, parks, recreation areas, wildlife refuge, or land of a historic site can be approved only if there is no prudent and feasible alternative. The project should include all possible planning to minimize harm to the resource.
- Section 6(f) refers to publicly used lands where the state or local government has used grant monies from the Land and Water Conservation Fund Act (LWCFA) to acquire or make improvements to parks and recreation areas. Section 6(f) prohibits acquisition or conversion of LWCFA funded spaces without approval of the Department of Interior's National Park Service (NPS). If a bridge project requires permanent acquisitions of Section 6(f) property or temporary impacts greater than approximately 6 months, a replacement property must be established of equal fair market value and of reasonable equivalent usefulness and location. Project approval is only achieved when NPS approves the footprint of converted land and replacement property has been identified.

The MaineDOT Environmental Office will assist in the identification of these resources and help guide the Project Team through these regulatory processes. An open line of communication between the Project Team and the Environmental Team is imperative to ensure all regulations are met by the project.

### **3.2.1.3 Right-of-Way (ROW) Impacts**

The Designer shall consider the ROW impact associated with each design decision for all projects. ROW impact minimization efforts should be implemented when possible; in some cases, small adjustments in impact limits can greatly expedite the project delivery process. Minimizing the number of parcels impacted can significantly reduce time associated with title search, appraisals, and negotiations. Potential impact reduction must be balanced against additional project cost, construction schedule, safety, constructability, and maintenance. There needs to be enough ROW or additional rights acquired to ensure each project is constructible. This will often include temporary rights for non-permanent construction features, like access roads and cofferdams. MaineDOT is legally and ethically obligated to acquire the property interests needed for construction while treating the affected individuals fairly and following the necessary legal regulations. Most bridge projects involve impacts to people who live or own property near the project location. At the beginning of each bridge project, the Designer should work with the Property Office to understand existing conditions, property boundaries, and right-of-way

limits (ROW). Throughout preliminary and final design, the limits of ROW impacts must be defined for the Property Office to understand the scope and type of property interests needed for the project. Once final ROW limits are defined at the Plan Impacts Complete project milestone, the Property Office will proceed with property valuation, negotiations, and final coordination with property owners. For additional information regarding the ROW process, refer to the most recent MaineDOT *Right-of-Way Manual*.

#### **3.2.1.4 Economics**

The bridge selection process is to identify the most cost-effective alternative that satisfies the project's purpose. Construction cost determined during the preliminary design process is used to set the funding need for the Department after the original programmed funding. The BCF and/or PDR estimate needs to be accurate and reflect all project costs so that the funding remains adequate as final design is progressed. Any deviations discovered during final design shall be discussed with the Bridge Program Project Manager as soon as possible for adjustment to either design assumptions or funding levels. Additional information is presented in Section 2.9.3 regarding preliminary design cost estimating.

### **3.2.2 Bridge Geometry**

#### **3.2.2.1 Bridge Width**

The required approach roadway width including lanes and shoulders, as defined in Section 3.1.3 Lane and Shoulder Widths, should be the starting point for defining the width of the proposed bridge (curb to curb). Single lane bridges with a 14'-0" curb-to-curb (or rail-to-rail) width may be considered for very low volume roadways (< 400 AADT) with satisfactory geometric characteristics. Converting a two-lane bridge to a one lane bridge must have public input before the preliminary design is approved.

For curved roadway horizontal alignments, the following alternatives should be considered based on the magnitude of curvature and superstructure type/length:

- Straight Girders and Straight Fascias: This concept uses constant width deck overhangs and variable striped roadway shoulders. Straight deck fascias should only be used when the variability in shoulder width on the bridge is less than approximately 2'-0". This concept works well with most conventional superstructure types. This is the only recommended concept for precast concrete slabs and NEXT Beams.
- Straight Girders and Curved Fascia: Curved deck fascias accommodate the curved alignment with variable deck overhangs and constant lane/shoulder widths. The variable overhang width should be greater than the width of the barrier system, a maximum of approximately 4'-6", and allow for construction of the deck drip notch. Refer to **Section 6.xx** for additional guidance on deck overhang limitations and considerations. This concept works well with superstructures with overhangs (e.g., steel girders, NEBTs).
- Curved Girders: The Designer should use a curved girder structural system only if the curved horizontal alignment cannot be accommodated with the above structure types. In this situation, the deck overhangs and shoulder widths should be constant and parallel with the

girders and roadway alignment. Refer to [Section 7.xx](#) for guidance on the design of curved girders.

### **3.2.2.2 *Span Arrangement***

Project site constraints and surroundings will determine appropriate span arrangement for a project. A site visit by the Designer to understand the project surroundings is strongly encouraged.

The available superstructure depth (considering the maximum roadway profile grade and vertical clearance) is a good starting point for evaluating potential span lengths, span arrangements, and structure types. Substructure locations and span lengths should consider the locations of hazards underneath the bridge (such as river channels or roadway lanes) and possible changes in the site conditions (such as erosion, lateral migration, or roadway widening).

Single span arrangements are preferred whenever feasible. When multi-span arrangements are required, a continuous superstructure design is preferred to improve structure efficiency, structural redundancy, eliminate expansion joints, and reduce the number of bearings.

Span arrangement and bearing fixity locations should be designed to accommodate jointless deck ends whenever possible. Jointless deck ends minimize future maintenance and corrosion at girder ends, abutment seats, and bearings. Refer to Section 3.2.3.1.2 Abutments, for additional considerations regarding elimination of expansion joints.

For curved girder structures, the supports should be oriented radial to the girders and alignment. For curved alignment structures with chorded girders, the supports should be parallel with each other and may be skewed to the girders. Consideration of anticipated movement and direction should be completed for the various span arrangement and fixities evaluated.

Skew is usually dictated by project site constraints (i.e., the orientation of the feature intersected); however, Designers are encouraged to eliminate or reduce whenever practicable. Skews less than 20 degrees reduce problems with concrete deck cracking, reduce potential uplift, simplify reinforcement details, and may reduce project costs compared to greater skews. If the proposed bridge skew is less than 10 degrees, the Designer should evaluate project costs and impacts of lengthening the bridge to eliminate the skew in preliminary design. In some cases, such as in-water substructure elements, aligning the substructures with the intersected feature is more efficient than eliminating the skew. Bridge skew affects the span arrangement not only geometrically, but also the superstructure and substructure types. Refer to the following subsections for skew limitations related to specific structural elements (e.g., integral abutments, superstructure types, and joints). Special design consideration is required for skews between 30° and 50° back on the right (skewed either way on the Interstate) because of the hazard of a snowplow blade catching in the joint.

### 3.2.3 Bridge Type

#### 3.2.3.1 Substructure Types

Selection of a substructure type involves evaluating numerous factors and trade-offs. Selected substructure must ensure long-term stability and safety, as well as be compatible with the bridge's superstructure, subsurface conditions, and budget. Substructure selection requires collaborative input from the Project Team to make informed decisions that align with the project specific requirements. The Designer should consider the following factors when determining the appropriate substructure types for each project:

- Site-Specific Conditions: The nature of the site, including subsurface conditions, depth to bedrock, and presence of waterways, plays a significant role in the selection process and constructability evaluation. Existing infrastructure such as foundations that will remain or utilities must be accommodated.
- Geometric Constraints: Bridge width, span, and surrounding site features all significantly affect substructure location.
- Environmental Impacts: Environmental concerns, such as waterway demands, impact minimization, and protection of natural habitats, are vital considerations for substructure type and location.

The following subsections highlight general considerations when selecting the appropriate abutment, pier, and foundation systems. Refer to Section 3.3 Geotechnical Considerations, for additional information related to subsurface conditions for substructure and embankment type selection. Refer to **Section 8.X** for additional design requirements for various types of substructure elements.

##### 3.2.3.1.1 Foundations

Foundation types are selected based on soil and bedrock conditions, overburden depth, scour depth, and load-bearing requirements, among other conditions. Two broad categories are shallow (spread footings) and deep (pile or drilled shaft) foundations. If the depth to competent bedrock is less than 10'-0" to 15'-0" below existing ground, a shallow foundation is likely the preferred solution with some exceptions for rock-socketed piles, micropiles, or other alternative pile solutions. The decision is commonly a balance of depth of excavation, water control, quality of rock, and associated construction costs. The Project Team should evaluate project constraints and requirements considering environmental, geotechnical, hydraulic, construction, and bridge impacts to select a foundation type.

Spread footings may be used on shallow bedrock or on soil units that satisfy bearing resistance, settlement, frost, and scour requirements. Spread footings on soil should be limited to roadway crossings where there is no risk of loss of support from erosion or lateral migration. Comprehensive characterization of rock quality, soil properties, and bedrock profile is required to avoid issues in construction related to differing site conditions.

Deep foundations can include driven piles, drilled shafts, or small diameter drilling methods such as spun pipe piles or micropiles. Each of these options has its unique advantages and disadvantages:

- Driven piles are the first choice because they are economical and can be installed with widely available equipment. Generally, steel H-piles are used for buried piles since they are less sensitive to hard driving conditions, and steel pipe piles are used if the piles will be exposed above ground. If insufficient depth to fixity is available due to shallow bedrock, drilled sockets may need to be used instead of driving the pile. Obstructions, such as remnant structures, timber grillage, or boulders may also lead to a drilled solution rather than driven.
- Drilled shafts are often used when site conditions or in-water noise restrictions prevent pile driving. One benefit is the ability to forgo conventional cofferdam construction and dewatering. The Designer should confirm the availability of equipment for specific sizes of drilled shafts as not all diameters are widely available and can significantly increase construction costs.
- Micropiles are small diameter drilled steel casings that can be installed with limited head room compared to driven piles or larger drilled shafts. Conventional micropiles are reinforced with an internal grouted bar that provides additional capacity and uplift resistance, but requires a secondary drilling process. A variation on the conventional micropile is the “end bearing variant” (a.k.a. “spun pipe pile”) which consists of high strength micropile steel casing advanced into bedrock, and resisting axial loads through end bearing on bedrock.

During preliminary design, the Designer should consider the need for a seal cofferdam or subfooting when evaluating foundation types and estimating costs. Seal cofferdams are generally mass, unreinforced concrete footings supported by an excavated stream bed surface or bedrock. They are used to create a dry, level working platform for construction of either a structural footing or pile cap.

#### 3.2.3.1.2 Abutments

When the Designer is determining an abutment type, the following types, in order of preference, should be considered:

- Integral abutments shall be used whenever the criteria in **Section 8.X** is satisfied. The major limitations are related to bridge length, skew, curvature, wingwall length, and depth to bedrock. Integral abutments eliminate bridge joints, reducing long term maintenance, and initial construction cost due to simplified design and construction.
- Semi-integral abutments should be considered when integral abutments are not feasible and the criteria in **Section 8.X** is satisfied. Although semi-integral abutments require bearings, they eliminate the bridge joint and provide more flexibility for superstructure type and wingwall length compared to integral abutments.
- Conventional abutments should be considered when an integral or semi-integral abutment is not feasible. Conventional abutments can either be stub or full-height depending on site

conditions. Full-height abutments are located near the edges of the feature crossed, while stub-abutments are located near the top of the fore slope of the feature crossed. Full-height abutments are more expensive than stub abutments due to increased concrete, reinforcing, and formwork complexity. Extending the structure to accommodate stub abutments is often more cost-effective and should be evaluated and documented by the Designer if conventional abutments are selected.

- Alternative abutments, such as Geosynthetic Reinforced Soil (GRS) abutments or Mechanically Stabilized Earth (MSE) wall supported integral abutments, may be beneficial for unique project constraints. Consideration of alternative abutment systems will be determined on a case-by-case basis through discussions with the Project Team early in the preliminary design phase.

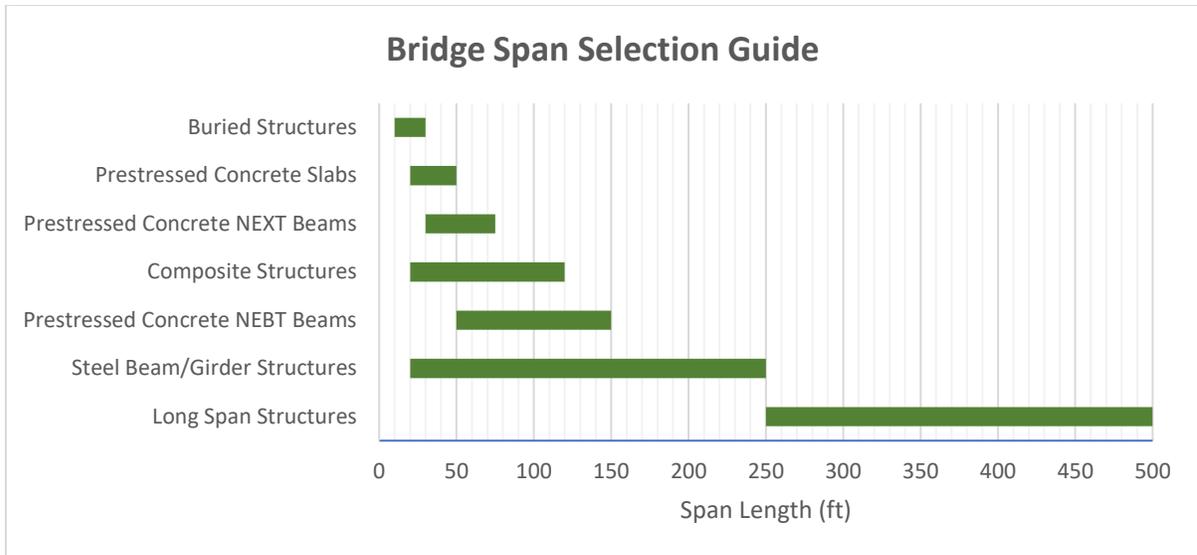
#### 3.2.3.1.3 Piers

There are several types of piers used throughout the State. Specific pier configurations and details (e.g., rounded vs. square ends, cap depth variation, leading-edge plumbness, aesthetic enhancements, etc.) will depend on the project requirements. The list below provides a general overview of types commonly considered:

- Wall piers consist of a solid wall extending up from a footing and are typically constructed without a cap. They are used on both waterway and roadway crossings due to their structural resistance to ice, debris, or collision loading and simple formwork.
- Pile bents consist of a cap supported by multiple piles. The piles can be either driven or drilled and are typically in a single line. This pier type reduces the amount of concrete required and can minimize environmental impacts by limiting subsurface excavation and structural supports or cofferdams. However, they should not be used where significant ice, debris, or collision forces are expected.
- Single column piers have a large central column, widened at the top with a hammerhead. These are typically used on tall river crossings when the cost of a wall pier would be prohibitive.
- Multiple column piers consist of a cap and multiple supporting columns supported on either individual or combined footings. Typically, this type is only used on overpasses. On unusually wide bridges, this can result in significant cost savings over a wall pier; however, collision potential and effects need to be carefully evaluated.

#### 3.2.3.2 Superstructure Types

Most bridges throughout the State are multi-beam steel or concrete superstructures with concrete decks. Figure 3-2 shows common superstructure types and appropriate span ranges. The span ranges are based on historical practice; it is the Designer's responsibility to determine the feasibility of recommended structural systems. Other structure types not listed below should be discussed with the Bridge Program Project Team if identified during the selection process as warranting consideration. Additional details on each of these superstructure types can be found within their respective Chapters.



*Figure 3-2: Common Superstructure Types with Span Ranges*

Notes:

- Buried structures consist of pipes, precast concrete box culverts, and concrete three-sided structures (e.g., arches or frames). In general, box culverts are preferred up to 26'-0" spans. Buried arches or frames consist of proprietary or non-proprietary bridge systems and can be considered for longer spans than box culverts but are typically only used in locations with shallow bedrock or no scour concerns. The Designer should avoid using corrugated metal structures, aluminum box culverts, steel arches or frames, and prestressed concrete elements. If deep foundations are required for a buried structure, consideration should be given to an integral abutment bridge instead.
- Prestressed concrete slabs have a history of long-term performance issues due to longitudinal cracking when the joints are not correctly detailed. A reinforced concrete deck topping slab is required for this structure type.
- Prestressed concrete NEXT (NorthEast eXtreme Tee) beams are advantageous due to the labor-efficiency for both manufacturing and on-site construction. NEXT F is the most common shape, but NEXT D may be used at sites with tight vertical clearances or with Accelerated Bridge Construction. NEXT beams should not be used for skews greater than 30 degrees to limit cracking when prestressing is released during fabrication. Refer to the latest NEXT beam details provided by PCI.
- Fiber Reinforced polymer (FRP) composite beams can be effective in coastal or other corrosive environments where high corrosion resistance is a design requirement.

- Prestressed concrete NEBT (New England Bulb Tee) beams are significantly heavier, have shorter practical span limits than similar steel beams, but may be preferred in some locations for corrosion resistance or aesthetics. Refer to the latest NEBT beam details provided by PCI.
- Steel beam/girder structures with continuous multi-span arrangements are typically the most efficient, from a steel weight standpoint, using the span ratios shown in Table 3-1. The cost savings associated with optimizing span ratios should be balanced with the costs for additional substructure locations. In many cases, site constraints do not allow for optimal span arrangements. Steel beam/girder structures can be either rolled beams or welded plate girders; it is the Designer’s responsibility to verify availability before specifying rolled beams. When possible, a constant depth girder should be used in negative moment regions. However, a haunched girder shape (i.e., variable depth web) can be considered to maximize structure efficiency when adjacent spans have vertical clearance constraints or aesthetic enhancements are desired. Generally, haunched girders are only structurally efficient for longer bridge spans (approximately greater than 200’).

**Table 3-1: Approximate Span Ratios**

Number of Spans	Span Ratio
2	1 – 1
3	3/4 – 1 – 3/4
4	8/10 – 1 – 1 – 8/10

- Timber structures should be limited to specific scenarios such as low-traffic areas or pedestrian and trail bridges. The preliminary design phase of a project may occasionally warrant the inclusion of timber bridge structures and components. Timber structures can serve as an aesthetically pleasing solution when design aesthetics are a primary consideration. However, when evaluating timber alternatives, three key factors to consider are durability, maintenance, and initial cost. Due to potential fabrication and constructability issues, skewed designs should be avoided for timber bridge structures. Furthermore, timber substructures are typically not recommended. It’s important to note that, compared to steel or concrete structures, timber bridges often carry a significantly higher initial cost.
- Published span design aid tables, recent and comparable projects, or AASHTO LRFD Bridge Design Specifications span-to-depth recommendations should be used for initial girder depths. Some design aids may not include the HL-93 Modified live load.

The superstructure design shall consider the future maintenance of traffic through the entire life of the structure. The preferred minimum number of girders is five so that there are at least three girders carrying traffic in a future phased project on a typical two-lane bridge. Four girder bridges may be considered in locations where full closures are likely in the future or site design criteria dictate a narrow

bridge (i.e. less than standard). Four girder bridges and two-unit NEXT beam bridges should be discussed with the Senior Structural Engineer.

When multiple feasible superstructure alternatives with no obvious recommendation are available, the project can be advertised as a Detail-Build contract or with Bid Alternatives. These contracting methods give the Contractor flexibility to choose and construct the most cost-competitive structure. Refer to Section 2.8 for additional information regarding these contracting methods.

### 3.2.4 Construction Methods

#### 3.2.4.1 Maintenance of Traffic

All bridge projects must maintain traffic during construction in a way that provides reasonable protection for motorists, pedestrians, and construction workers. The following workflow for defining maintenance of traffic (MOT) should be followed for each design project:

1. Define and evaluate safe and feasible MOT alternatives during Preliminary Design considering factors and methods presented herein. Coordinate alternatives evaluated with the Project Team.
2. Provide a summary of evaluated MOT alternatives and make a final recommendation in the BCF and/or PDR.
3. Submit the recommended MOT method to the Traffic Analysis Management and Evaluation (TAME) Committee for consideration, comment, and approval – refer to Section 2.9 for additional details. Projects with significant impacts or complex MOT alternatives can, and often will, start the TAME process before the preliminary design phase is complete to solicit initial input from the TAME Committee.
4. Develop final project deliverables to support PS&E and final TAME certification, including a detour plan or staging plans if necessary and the traffic control Special Provisions. The need for detour plans or staging plans should be coordinated with the Project Team prior to development.

A Traffic Control Plan (TCP) must be developed for every project; however, the responsibility for the development of specific TCP details (Project Team or Contractor) is project dependent and generally based upon complexity. Generally, TCPs should be designed using the latest edition of the Manual for Uniform Traffic Control Devices (MUTCD). Refer to the MaineDOT Standard Specifications for additional information pertaining to typical TCP requirements.

##### 3.2.4.1.1 MOT Considerations

The following factors need to be considered when determining an appropriate method for MOT:

- Roadway Width
- Work Zone Speed Limit
- Traffic Data / Public Usage (e.g., vehicular, pedestrian, and other multimodal)

## CHAPTER 3 – PROJECT DEFINITION AND CONSTRAINTS

- Impacts (e.g., property, environmental, ROW, business, emergency vehicles, bus routes, over-width vehicles)
- Economics

Additional discussion of these factors is provided below.

### *Roadway Width:*

The minimum lane width shall be 11'-0" unless otherwise noted below or as determined during project coordination. Shoulder widths should be determined on a case-by-case basis but, in general, 1'-0" or 2'-0" shoulders should be provided when possible. However, it is not uncommon on staged construction projects to have zero shoulder width. If the curb-to-curb width during construction will be less than 16'-0", advanced warning signs for width restriction are recommended to warn wide loads to find an alternate route. In rare cases where wide loads are expected more frequently than normal, signing a wide load detour may be necessary during construction depending on the curb-to-curb width provided. Project and site-specific coordination is required.

Projects with high traffic volumes, high speeds, or a high percentage of truck traffic, 12'-0" lane widths should be provided. All projects on the interstate shall maintain 12'-0" lane widths. Available queue length should be considered for work zone length and the resulting stop times if alternating one-way traffic is implemented. Work zone width, length, and access points should all be considered to ensure a safe and functional working area.

### *Work Zone Speed Limit:*

The speed limit in a work zone or detour route should be lowered if the road conditions pose a risk to drivers and workers. For example, sharp curves, narrow lanes, uneven pavement, or poor visibility may require a slower speed. A State of Maine Licensed Professional Engineer who is experienced in work zone traffic control can approve a speed reduction of up to 10 mph for roads with a speed limit of 65 mph or lower, 15 mph for roads with a speed limit of 70 mph, or 20 mph for roads with a speed limit of 75 mph. A higher speed reduction needs the approval of the State Traffic Engineer or a commission record. The speed limit in a work zone affects the design of the work zone, such as how to access the site, the lane width, the traffic control devices, and the temporary road geometry.

### *Traffic Data / Public Usage:*

Traffic volume must be considered to determine the number of lanes to maintain during construction and where traffic can be detoured without causing traffic congestion in other locations. Maintaining pedestrian traffic, bicycle traffic, local trails/paths, and snowmobile/ATV routes may be necessary depending on existing roadway conditions and available detours. The project requirements for maintaining, detouring, or temporarily closing certain non-vehicular traffic should be discussed throughout the public involvement process to ensure that all stakeholders are aware of the construction impacts. The Project Team should coordinate with the Bridge Program and the Public to understand the needs during project construction. If pedestrian facilities are present in the existing and

proposed conditions, pedestrian access shall be maintained during construction. Where warranted, temporary pedestrian circulation paths or bicycle lanes should be a minimum of 5'-0" wide. In some unique cases, where available space is limited, a width of 4'-0" can be used over a limited length (200'-0" intervals) per *AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities*; however, this shall be coordinated with the Project Team to confirm acceptability. Methods for separating pedestrian and vehicular traffic shall be determined on a case-by-case basis. In these instances, further coordination on project specific design requirements is necessary, refer to Section 3.5 ADA Considerations for more information.

*Impacts (Emergency Vehicles):*

Emergency vehicle response times shall be evaluated when selecting MOT methods. Coordination with local emergency services is imperative for all projects to ensure that construction does not put overall public health and safety at risk.

*Impacts (Business):*

Impacts to businesses near the project, as well as those impacted by bridge closures/ detour routes, should be considered when evaluating MOT options. Although there is no practical way to estimate the cost associated with the impacts on local businesses, they can be significant and should be minimized when possible. The Project Team should review and follow the MaineDOT Bureau of Project Development Policy Regarding Business Notification of Construction Projects which is intended to assure that businesses that are significantly and negatively impacted by MaineDOT projects can express their concerns during the preliminary phase of project design.

*Economics:*

Direct and indirect costs should be considered when evaluating MOT methods. Consideration should be given to costs associated with the following:

- Estimated User Costs
- Utility Relocation
- Right of Way
- Construction
- Maintenance and Removal of the MOT method

Coordination with the MaineDOT Office of Safety and Mobility is necessary to define User Costs on a project-by-project basis.

**3.2.4.1.2 MOT Methods**

The following MOT methods should be considered, discussed, and documented within the BCF and/or PDR when applicable. For projects where a method listed below has been dismissed due to obvious feasibility reasons, a simple statement within the BCF and/or PDR noting the reasoning is all that is necessary.

- Off-Site Detour: This method involves closing the roadway over the bridge to provide the Contractor maximum flexibility to perform work. In addition to providing a convenient and safe work zone for the Contractor, an off-site detour will often have the shortest construction duration and least cost solution. In an off-site detour, the traveling public is rerouted on State Roads or State Aid Highways improving safety for the traveling public by removing the need to navigate a construction site. Detour routes shall be reviewed by the Project Team to ensure that they meet applicable design and safety standards. Alternatively, locally owned/maintained roads can be used for off-site detours, with written agreements between the MaineDOT and the Town(s) establishing responsibilities for maintaining the roads during construction and repairing any advanced deterioration caused by detoured traffic volumes. An off-site detour can have a substantial effect on emergency vehicle operations, trucking, school bussing, among other stakeholders, therefore communication throughout Preliminary Design is critical. Off-site detours may also impact pedestrian and bicycle travel, so accommodations should be reviewed to allow alternate modes to access local businesses, residences, and services. Accelerated bridge construction (ABC) methods can be employed to reduce construction schedules reducing the impact to the traveling public (refer to Section 3.2.4.3 Accelerated Bridge Construction).

Moderately aggressive construction durations may be employed to minimize impacts to traffic in scenarios that do not warrant ABC. Moderately aggressive construction scheduling assumes day work only, tight task durations with little float, and may include simultaneous work activities and multiple crews. This method would generally be for projects with low construction risks, although not in every case.

Box culvert projects with an off-site detour generally should be limited to either 30 or 45 days based on site complexities (e.g. poor soils, difficult water control, etc.). However, with high impacts to traffic, closure durations of 2 to 3 weeks could be considered for simple, low risk scenarios.

- On-Site Detour (Temporary Bridge): This method involves detouring the traveling public onto an on-site temporary bridge to allow for demolition and construction to occur on the existing alignment. Depending on traffic volumes, temporary bridges carry either alternating one-lane traffic or two-lane traffic. The Designer is responsible for developing a conceptual temporary bridge alignment for quantifying impacts associated with the temporary bridge footprint to facilitate accurate environmental permitting documents and adequate right-of-way acquisition. In addition to the considerations noted in Section 3.2.1, the following is a brief list of considerations for the Designer during Preliminary and Final Design:
  - Design assumptions meet the requirements in the Standard Specifications.
  - Location and alignment of temporary bridge should consider Contractor access and impacts associated with constructing the temporary bridge.

- Determine if span length requires in-water work to construct temporary intermediate supports and account for impacts in environmental permitting.
- Ensure that there is adequate geotechnical information to support substructure and embankment design.

The temporary bridge itself (alignment, superstructure, substructure, embankments, etc.) is designed by the Contractor during the Construction Phase. The Resident and/or Designer are responsible for reviewing the Contractor's design prior to construction to ensure compliance with Project Plans and Specifications (Standard Specification 510 – Special Detours). This MOT method is typically the most expensive alternative and should be carefully compared to other feasible MOT methods prior to selection. However, this method is often preferred to Staged Construction due to improved safety and reduced construction time.

- On-Site Detour (Median Crossovers): Some interstate bridges that carry divided directional traffic (i.e., northbound/southbound) can accommodate the construction of median crossovers. Median crossovers involve temporarily removing the median guardrail or barrier on the bridge approaches to divert one direction of traffic across the median to the other, temporarily creating a two-way directional structure. The opposing bound is now free for the Contractor to complete the scope of work. Once the Contractor has completed the work on one side, the crossovers are reversed, and the Contractor completes the work on the other side.
- Staged Construction: This MOT method involves demolishing the existing bridge in multiple stages. Typical staged construction uses part of the existing bridge to carry traffic in the first stage while demolishing part of the existing bridge and constructing part of or the entire new bridge. Traffic is then moved onto the newly constructed bridge in the second stage while demolishing the remainder of the existing bridge and constructing any remainder of the new bridge. In some cases, staged construction involves partial off-alignment construction to maximize available lane widths and construction work zones. This MOT method is dependent on available existing bridge widths, structure type, girder spacing, and the necessary number of traffic lanes to maintain. The Designer shall consider the transverse location of where the barrier is positioned on the bridge deck and large deck overhangs (e.g., 2'-6" or greater) must be checked to ensure that adequate deck capacity is available. Reducing the number of girders supporting traffic can result in overloading the remaining girders or reducing the redundancy of the structure. Staged construction typically increases costs 20% to 30% compared to off-site detours and is generally the least desirable alternative for Contractors.
- Off-Alignment Construction: This MOT method involves constructing the proposed bridge off-alignment, allowing the Contractor to construct the proposed structure away from existing traffic. This method is only employed when the project site and approach roadway alignment can accommodate a change in the current roadway alignment or improves substandard

alignments. However, realignment is frequently cost-effective when compared to a temporary bridge for longer structures.

#### 3.2.4.1.3 Temporary Traffic Barriers

Temporary traffic barriers will be necessary on almost every project to aid in MOT and provide safety for the Contractor. The following temporary barrier types are appropriate when developing MOT methods on bridge decks:

- Temporary Concrete Barrier, Unanchored: Most projects will employ this barrier type. Plan transverse sections should show these barriers as a 2'-0" wide precast concrete double-sided F-Shape section. This system is constructed and installed per MaineDOT Standard Details and Standard Specifications and does not include a positive connection to the bridge deck (i.e., unanchored).
- Temporary Concrete Barrier, Braced: The braced barrier system is comprised of the Temporary Concrete Barrier with an added continuous structural steel bracing system mounted to the barriers. The bracing system provides additional stiffness to the barrier string limiting deflection during a collision. A project Special Provision is required to provide the Contractor with system type and requirements.
- Temporary Concrete Barrier, Anchored: An anchored barrier system is secured to the bridge deck with anchors spaced and installed per MaineDOT Standard Details and Standard Specifications. The use of anchored barrier systems on new bridge decks should be avoided when possible. If project constraints require anchoring into a new bridge, anchor inserts or blockouts must be installed during deck placement. Field drilling for anchor installation is not permitted. Additionally, the final pavement and membrane must be restored to ensure the new concrete deck is protected.
- Other barrier types that may be used in special circumstances are single-slope temporary concrete barrier that is narrower than the standard F-Shape section, contractor designed steel railing that can be as narrow as 1'-0" wide, and lightweight temporary barrier that is easier for the Contractor to move if multiple resets are required between stages.

The selection of temporary concrete barrier type to use on a project is a decision based on construction zone geometry and work zone speed. The Designer may use Table 3-2, which is based on the most recent crash test data, to select the barrier system to use. Table 3-2 presents the allowable barrier deflection (i.e., distance from the back of barrier at the bottom to edge of deck) based on the construction zone speed limit.

**Table 3-2: Temporary Concrete Barrier Selection Guidance\*\***

Barrier Deflection (inches)	Construction Zone Speed Limit (mph)						
	≥ 60	55	50	45	40	35	30
70	Unanchored	Unanchored	Unanchored	Unanchored	Unanchored	Unanchored	Unanchored
60	Braced	Unanchored	Unanchored	Unanchored	Unanchored	Unanchored	Unanchored
50	Braced	Braced	Unanchored	Unanchored	Unanchored	Unanchored	Unanchored
40	Braced	Braced	Braced	Unanchored	Unanchored	Unanchored	Unanchored
30	Braced	Braced	Braced	Braced	Unanchored	Unanchored	Unanchored
24	Anchored	Braced	Braced	Braced	Braced	Unanchored	Unanchored
16	Anchored	Anchored	Anchored	Braced	Braced	Braced	Unanchored
12	Anchored	Anchored	Anchored	Anchored	Braced	Braced	Braced
10 or less	Anchored	Anchored	Anchored	Anchored	Anchored	Anchored	Anchored

*\*\*Reference: Table developed using New York State Department of Transportation Bridge Manual, 2022, Section 3.2.7.4.2 and related New York State Department of Transportation Highway Design Manual, 2023, Chapter 16*

**3.2.4.2 Constructability**

Consideration of how the proposed structure will be built is required for bridge type and MOT selection. Bridge Program Area Construction Engineers are an excellent resource to review and resolve constructability issues. Projects with complex constructability challenges can implement Contractor-In-Design (CID) reviews or use alternative project delivery methods, such as CM/GC, to manage risk. Refer to Section 2.10 for additional information regarding typical workflow for CID reviews and alternative delivery methods. Major considerations for all alternatives are:

- Contractor access affects the cost, property impacts, and risk of any project. The operations (e.g., crane location and sizes, excavator use, pile driving equipment, etc.) must be understood for each alternative. Crane assessments must consider maximum pick radius, pick weights, boom conflicts, and ground/track pressures. Typical cranes owned by local Contractors should be used for the assessments. As a general rule of thumb, most local Contractors have 150-ton crawler cranes readily available. Depending on pick radiuses and site constraints, once a pick weight exceeds roughly 40 to 50 tons, a larger crane or a multi-crane pick likely needs to be considered. Erection methods for the proposed structure should be conceptualized to detail optional field splice locations, define necessary temporary works locations, and identify temporary impacts. Existing utilities, both buried and aerial, can influence the Contractor’s ability to execute the work. Refer to Section 3.4 for additional utility considerations. If a project site has steep embankments, heavy equipment may have difficulty navigating the slope. Access for existing structure demolition may influence proposed structure locations and clearance offsets.
- Shipping limitations may restrict optimal arrangement of structural elements, especially for projects in rural locations where local roads and intersections are narrow. A maximum shipping length of 125’-0” and a maximum shipping height of 10’-0” should be used initially but may be modified based on project constraints and special trucking permits. Many shipping limitations are tied to trucking permits (e.g., weight, width, etc.) and depend on the location and route to

the project site. Conversation with local steel or concrete fabricators may provide insight for the potential alternatives.

- Demolition of the existing structure must be assessed by the Designer. Bridges with limited access or challenging constraints can result in increased demolition costs. All unique challenges with bridge removal need to be identified to ensure the project impacts, schedule, and funding are adequate.
- Temporary works such as cofferdams and temporary earth supports are generally the responsibility of the Contractor. However, the need for these systems for each project should be identified to confirm feasibility based on subsurface conditions, define appropriate foundation elevations, define appropriate project impacts, include appropriate pay items, and adequately estimate the construction cost associated with the effort. Refer to Chapter 8 Foundations, Substructures, and Retaining Walls for additional information.
- Environmental work windows will heavily govern the Contractor’s approach and schedule, particularly in-water work restrictions. Typical in-water work windows are seasonal and will vary depending on the river setting and present habitat. The timeframe is chosen to mitigate impacts on the stream habitat and minimize the effects of isolating and diverting water. In some cases, the required scope of work is not feasible within the in-water work window without the construction duration extending over multiple construction seasons. In these situations, an in-water work window extension can be requested to reduce a Contractor’s total onsite presence and disturbance. However, an extension may include seasonal restrictions to prevent adverse impacts to the local habitat. Coordination with the Environmental Department is necessary early in the project development to understand project specific environmental windows and potential extensions.
- Construction schedule must be evaluated for each alternative to ensure that project environmental work windows are feasible, substantial completion dates can be met, and local constraints (e.g., school schedules, festivals, agricultural activities, and municipal events) are accommodated.

#### **3.2.4.3 Accelerated Bridge Construction**

Accelerated bridge construction (ABC) details and methods are evaluated on a project-by-project basis when project constraints require minimization of user impacts. Accelerated Bridge Construction approaches should be discussed during project scoping and initial team meetings prior to evaluating options in depth.

Generally, ABC methods allow bridges to be constructed quicker than conventional construction and often implement a short-term road closure with an offsite traffic detour. The duration of the roadway closure and onsite construction of ABC projects can range from a single weekend to several weeks or more depending on project complexity and magnitude. Most ABC projects realize the following benefits due to minimizing the construction duration:

## CHAPTER 3 – PROJECT DEFINITION AND CONSTRAINTS

- Reduced impacts to the traveling public due to delays and complicated work zones.
- Improved safety for both construction workers and public by moving traffic away from the construction site.
- Positive public perception of the construction process and agency.

However, before advancing a project using ABC techniques, several aspects warrant careful consideration, such as:

- ABC with a bridge closure and offsite detour should only be considered when all other maintenance of traffic methods have been dismissed due to site constraints or other reasoning. Conventional construction with a bridge closure and offsite detour should be evaluated before advancing ABC.
- ABC requires heightened coordination and attention to construction due to more stringent tolerances, increasing project risk, and cost.
- Contractor staffing for short duration projects can be challenging and increase construction costs.

If a project is advanced as an ABC project, the Designer is responsible to identify appropriate details that satisfy the ABC technique while minimizing risk and cost. Several national guides and/or manuals are available to support ABC project development such as FHWA reports HIF-12-013 and HIF-17-020, the SHRP2-c03 program, and the PCI Northeast ABC manual. The state of the practice is continually changing; therefore, Designers are encouraged to review and discuss similar previous ABC projects from within the State with the Project Team to identify lessons learned.

At a minimum, the selected details should consider the following:

- Project site constraints;
- Capacity or limitations of equipment that may be onsite during construction;
- Shipping restrictions such as weight, height, length, etc.;
- Location of pick points for erection and influence on reinforcement design;
- Required construction phasing and speed of construction;
- Access to prefabricated connections, type of connections (grouted, cast in-place concrete, couplers, etc.), and installation time of connections;
- Onsite curing durations, foundation review or testing, and other specifications that may influence construction duration;
- Ability to accommodate differing field conditions; and

- Construction tolerances and fit-up of the multiple prefabricated elements.

Additionally, the Designer shall consider long-term performance of connection details, their potential for failure and redistribution of forces, and the ability for future maintenance where appropriate.

### 3.2.5 Ancillary Bridge Components

This section provides general guidance for considerations during preliminary design regarding ancillary bridge components. Further detail and preferences are provided in [Chapter 10 Ancillary Bridge Components](#).

#### 3.2.5.1 Drains

Bridge drains should be provided and located to promote efficient deck drainage for traffic safety reasons, to prevent structure deterioration, and prevent damage to expansion joints. Bridge drains are typically not necessary for bridges less than approximately 200 feet in length; however, the need for drains may need to be evaluated for low profile and narrow shoulder bridges to avoid ponding. Proposed bridge drain locations should not be located over roadways or railroad tracks and be preferably positioned at least 10 feet from the face of an underlying substructure. Approach roadways should be designed to handle runoff from the bridge, such as incorporating riprap downspouts after long curb runs.

Drains can influence bridge transverse section geometry in a few different ways:

- Drain grates/openings should be kept out of the vehicular wheel path and preferably out of the travel lane altogether.
- Drain scuppers, downspouts, and connection elements must be accommodated without conflicting with proposed girder flanges, diaphragms, and/or utility conduits.

For bridges with multi-use paths separated from the travel way by a railing or barrier, the direction and type of drainage should be considered. Maintaining a 4-foot unflooded width is considered best practice for pedestrian access. This unflooded width can typically be accommodated without adding drainage structures to the path; however, if design or geometric changes would be required to meet this criteria and avoid drains, coordinate site specific requirements with the Senior Structural Engineer.

#### 3.2.5.2 Bearings

Selection of bridge bearing type depends on the magnitude of vertical loads, thermal movements, and rotations induced by the superstructure elements. The primary bearing types used by the Department include steel reinforced elastomeric bearings and high-load, multi-rotational disc bearings. The reuse of steel rocker bearings or the use of alternate bearings, such as pot, spherical, or uplift bearings, should be coordinated with the Senior Structural Engineer prior to finalizing the preliminary design.

Bearing fixity locations should be determined on a project-by-project basis. In general, multi-span structures should assign the point of fixity near the center of the bridge depending on the number of

spans and the profile geometry. For single span structures, the fixed bearing line should be set at the low end of the bridge.

The bearing and surrounding bearing area should be designed to minimize debris collection, promote drainage away from the bearing, and to maximize flexibility of future bearing repairs or replacements. Accommodating future repairs or replacements can include component connection details that facilitate easy bearing removal and providing adequate clearances for future jacking operations.

### **3.2.5.3 Deck End Details**

Span arrangement and substructure type/details should be evaluated to minimize joints on the bridge to reduce future maintenance. If integral and semi-integral abutments are not feasible, a slab over backwall should be utilized whenever the criteria in [Section 10.1.3](#) is satisfied. If jointless deck end alternatives are not feasible, an expansion joint should be detailed in accordance with [Section 10.1.3](#).

For rehabilitation projects, when an expansion joint over a pier exists, a link slab (i.e., bridge deck constructed between two non-continuous superstructure elements) should be considered to eliminate the joint. Eliminating the expansion joint is desirable since it improves rideability and reduces the potential future maintenance needs of the structure caused by expansion joints failure. Link slabs can result in the need to replace bearings due to existing configurations. This needs to be considered during development of the preliminary cost estimate. Refer to [Chapter 11 Rehabilitation](#) for additional design considerations for link slabs.

### **3.2.5.4 Approach Slabs**

Approach slabs provide a smoother transition between bridge decks and approach roadways. Buried approach slabs per the MaineDOT Standard Details should be included unless specific project constraints preclude their use. At-grade approach slabs may be used in unique circumstances. The Designer should discuss the exclusion or unique detailing of approach slabs with the Project Team on a project-by-project basis. Refer to [Section 8.X](#) for additional requirements regarding approach slab details.

### **3.2.5.5 Wearing Surface**

Bridge wearing surface selection considers roadway functional classification, traffic volumes, bridge location (e.g., higher than usual braking or acceleration forces due to intersections, stop signs, highway ramps, or sharp horizontal curves), and bridge geometry (e.g., profile grade). The following guidelines are for preliminary selection; the final wearing surface system determination shall be a case-by-case basis.

- Bridges on HCP 1, 2, & 3 Roadways: 3-inch thick Hot Mix Asphalt on ¼-inch High Performance Waterproofing Membrane
- Bridges on HCP 4 Roadways (AADT > 1,000): 3-inch thick Hot Mix Asphalt on ¼-inch High Performance Waterproofing Membrane

- Bridges on HCP 4 (AADT < 1,000) & HCP 5 Roadways: 1-inch thick Integral Concrete Wearing Surface
- Bridges on Profile Grades > 7%: 1-inch thick Integral Concrete Wearing Surface
- Bridges with High Braking/Acceleration with or without High Traffic: 1-inch thick Integral Concrete Wearing Surface or other unique wearing surface types that provide additional durability such as Polyester Polymer Concrete (PPC) or Highly Modified Asphalt Pavement (HiMAP)

Refer to **Chapter 11 Rehabilitation** for guidance on wearing surface repair or replacement projects.

#### 3.2.5.5.1 Wearing Surface Types

Typical wearing surface systems are presented below as a reference.

- Hot Mix Asphalt: This wearing surface system is a bituminous pavement material applied in two courses (base course & surface course) to achieve a 3-inch final thickness. The material mixture shall be prescribed in the Project Plans and Specifications. All mix designs shall be coordinated with the MaineDOT pavement specialists. In some cases, a polymer modified variation of hot mix asphalt is used for higher traffic counts or in particular parts of the State.
- Integral Concrete Wearing Surface: This wearing surface system is a 1-inch thick concrete layer placed monolithically with the concrete deck. The 1-inch concrete layer or remaining concrete thickness once the main deck thickness is subtracted shall be included in dead load but ignored for structural capacity. The concrete material shall be consistent with the deck concrete and the exposed surface shall be grooved and coated with a protective coating for concrete surfaces. Grooving is recommended to be oriented longitudinally (i.e., parallel to the baseline of the bridge); however, this should be determined on a case-by-case basis.

For projects where the integral concrete wearing surface will be subjected to tensile stresses (e.g., multi-span bridges in negative moment regions), the Designer should consult with the Senior Structural Engineer to discuss details to control cracking. In addition, for multi-span bridges or bridge decks with construction joints and an integral concrete wearing surface, a methyl methacrylate sealer should be applied to the finished surface.

- Separate Concrete Wearing Surface: This is a 2-inch thick unreinforced concrete overlay on the cured concrete deck. Use of this wearing surface is restricted to rehabilitation projects on a case-by-case basis when the existing structure already has a concrete overlay or site conditions warrant a concrete wearing surface. The concrete shall be Class A and the exposed concrete surface shall be grooved and coated with a protective coating. Grooving is recommended to be oriented longitudinally (i.e., parallel to the baseline of the bridge); however, final determination is a case-by-case basis.

- Alternative Wearing Surface Types: These wearing surface types can be considered on a project-by-project basis. Alternative wearing surfaces include:
  - Polymer Concrete with Epoxy, Polyester, Methacrylate, or Polyurethane binders and either Premixed Polymer Concrete (PPC) or Multi-Layer Polymer Concrete (MPC) placement methods.
  - Resin with Broadcast Aggregate
  - Timber Plank Runners (only timber decks)

#### 3.2.5.5.2 Waterproofing Membrane Types

Waterproofing membranes are used to protect concrete surfaces for improved long-term durability whenever an asphalt wearing surface is used. All membranes shall be selected from the MaineDOT Qualified Products List for “Waterproofing Membranes”. The nominal thickness should be assumed to be 1/4-inch and incorporated into design calculations. The following are the recommended membrane systems to consider for concrete bridge decks with hot mix asphalt wearing surfaces:

- High-Performance Membrane: This membrane system is the preferred method of protecting concrete bridge decks with hot mix asphalt wearing surfaces and is either torch or spray applied.
- Alternative Membrane: In special cases where a higher level of protection is required, products like Stress Absorbing Membrane Interlayer (SAMI) can be specified. However, the decision to use such alternative products requires approval of the Bridge Program Project Team on a project-specific basis. This ensures that the selected product is suitable for the unique requirements of the project.

Sheet Membranes, sometimes referred to as "standard" membranes, shall not be used on bridge decks but can be used for other applications such as buried structures. The top of buried structures shall be covered with sheet membrane and extend one foot down the vertical exterior walls.

#### 3.2.5.6 Railing/Barrier

The selection of a railing/barrier system is typically a decision based on volume of traffic, composition of traffic (i.e., truck percentage), design speed, corridor priority, setting and bridge geometry. All railings/barrier systems for new bridges shall meet the requirements of the AASHTO Manual for Assessing Safety Hardware (MASH) with exceptions handled on a case-by-case basis. As a starting point, MaineDOT’s standard “3-Bar Traffic / Bicycle Steel Railing” will be acceptable for most projects. Other railing/barrier systems may be selected if pedestrian needs exist, or aesthetic enhancements are desired. The use of aesthetic railings or non-MASH compliant railing systems shall be coordinated with the Senior Structural Engineer before implementation. Refer also to the Department’s policy titled *MaineDOT Process for determination of crashworthiness of roadside safety hardware*.

Several common bridge rail types can be found in the MaineDOT Standard Details, including steel and concrete type rails/barriers. Note that not all systems in the Standard Details meet MASH criteria. Steel

bridge rail is typically galvanized. Steel railings can be duplex coated; however, this increases the cost and required maintenance as the coating system ages to maintain the color. Therefore, duplex coated railings require approval by the Bridge Program.

Transitions from bridge railing/barrier to approach roadway guardrail shall also meet the requirements of MASH and shall be selected from the MaineDOT Standard Details. The type of transition will depend on the bridge railing type; however, they are typically either Steel Approach Railings for steel bridge railings or Concrete Transition Barriers for concrete bridge barriers.

### 3.2.5.7 *Future Maintenance*

Proposed bridge type and configuration should be selected to minimize future maintenance costs. Major topics of consideration for any alternative are:

- Protection from corrosion. For example, weathering steel is lower maintenance than steel requiring coatings when used appropriately but will corrode more quickly if unable to dry. Concrete structural elements with corrosive resistant steel, composite structures, or metallized steel girders are better suited to coastal or high salt spray environments. Refer to [Chapter 6 or 7](#) for additional guidance.
- Bridge inspection access for both routine and special inspections (e.g., fracture critical or underwater inspections) must be accommodated. Standard under bridge inspection access equipment cannot clear wide sidewalks (> 8 feet) or tall railings/fences (> 6 feet). However, the requirements of Complete Streets should take precedence before making any accommodations for inspection access. If either of these limits are exceeded, the MaineDOT Bridge Maintenance group should be consulted.
- Fencing should be provided adjacent to structures (e.g., retaining walls and abutments) where there is a significant drop off over the wall to provide safe access to bridge bearing areas.
- Snow removal activities such as plowing must be accommodated. Avoid details that introduce snagging hazards.

## 3.3 GEOTECHNICAL CONSIDERATIONS

Subsurface conditions have a significant influence on bridge project development. It is the Design Team's responsibility to develop adequate subsurface investigations to allow advancement through preliminary and final design while balancing risk and cost. Eliminating borings can reduce costs during design but may result in issues during construction that far outweigh any earlier cost savings.

A subsurface investigation allows informed decisions regarding the foundation type, design approach, and construction risks. Results of a subsurface exploration program are used to develop preliminary foundation recommendations and identify design and construction challenges. Typical project workflow requires both the geotechnical design and structural design be progressed simultaneously. Open communication throughout the project initiation and execution is critical to a successful project.

The Design Team shall develop a risk-based geotechnical scope for subsurface investigations and geotechnical analyses. Boring programs are based on FHWA and AASHTO guidelines and adjusted based on risk, experience, and the consequences of failure. Refer to Section 3.3.2 for specific information related to boring program guidelines.

### 3.3.1 Subsurface Exploration Programs

Geotechnical and Structural Designers shall coordinate to establish a preliminary subsurface exploration program and appropriate design and construction requirements. Final subsurface exploration programs are to address data gaps, reduce conservatism, and control risk identified during preliminary design.

The written boring program includes a summary of all geotechnical activities and defines boring identification numbers, boring stations and offsets (if an alignment is established), sampling protocols, boring termination requirements, and in-situ testing. The boring program also includes an exploration plan showing the existing structure and proposed substructure locations (if known) and proposed boring locations indicated by the standard symbol.

Each boring location must have a unique boring identification number in the following format: XX-YYYY-ZZZ. The X terms will be “BB” for bridge borings. The Y term will be the first letter of the town(s) and the initials of the crossing. The Z terms will be a -100, -200, -300 “series” number. For example, the first series of borings for a bridge crossing Noname River in Anytown is designated as BB-ANR-101, BB-ANR-102, etc. Any additional borings conducted at the site after the preliminary borings have been completed will be designated as 200-series, 300-series and so forth. Borings that refuse on obstructions or are terminated early due to drilling issues, and are relocated at a nominal offset, are designated with a trailing letter term. For example, multiple offsets of boring BB-ANR-101, would be designated BB-ANR-101A, BB-ANR-101B, etc. Bridge probe designations shall use “BP” for the X terms and the Z terms will expand upon the series of bridge boring designations to avoid the confusion of having BB and BP identification numbers that both have the terms -101 , -102, etc.

### 3.3.2 Number, Layout, and Depth of Borings

Borings should be taken for every:

- bridge substructure
- retaining wall
- buried structure
- high mast light foundation
- single support cantilever sign foundation
- other traffic signal sign supports or mast arms which require a foundation
- significant cut and fill slopes

*AASHTO LRFD Bridge Design Specifications* Table 10.4.2-1 and the *FHWA Soils and Foundation Manual* (FHWA NHI-06-088) Table 3-13, should be used to determine the location and depth of borings. Adjust the final exploration program based on risk and the variability of anticipated subsurface conditions. For

feasibility studies or preliminary investigations, fewer borings or more widely spaced borings may be acceptable, especially if the subsurface conditions are uniform or numerous alignments and span configurations will be considered.

Additional borings may be required for constructability, design of staged construction sheet pile, or temporary detours.

### 3.3.3 Standards for Borings, Sampling, In-Situ Testing, and Boring Log Drafting

Borings should be performed using cased, wash boring techniques. In some instances, open-hole hollow stem auger or solid stem auger drilling methods may be used. MaineDOT permits geotechnical drill rigs with rope-and-cathead safety hammers and automatic hammers. Automatic (auto) hammers should have a unique serial number located on the hammer. The “MaineDOT Policy of Energy Measurement Testing (Calibration) of Automatic Hammers” requires that auto hammers undergo an annual calibration in accordance with ASTM D4633 “Standard Test Method for Energy Measurement of Dynamic Penetrometers”. The Geotechnical Engineer is responsible for obtaining the calibration report from the drilling contractor to verify the reported energy transfer ratio (ETR).

Borings, soil and rock sampling, and in-situ testing should be conducted in accordance with applicable AASHTO/ASTM standards and FHWA and MaineDOT procedures. Visual identification of soil and rock samples shall be in accordance with the MaineDOT “Key to Soil and Rock Descriptions and Terms”, January 2020 (a.k.a. Field Card). All pertinent boring identification data, SPT test data, and classification of soil and rock samples shall be recorded in accordance with the MaineDOT Field Card.

Maine has extensive deposits of soft, sensitive, marine clay and silt (known as the Presumpscot Formation). Best practices developed for accurately measuring the in-situ and disturbed shear strengths of these problematic soils are presented in the “MaineDOT Field Vane Shear Strength Testing Procedures Summary”. The MaineDOT procedure requires the use of Geonor field vanes and it is available from the MaineDOT.

Logs of geotechnical borings and auger probes shall be word processed using GeoSystem LOGDRAFT software using the MaineDOT boring log template. Electronic files for the MaineDOT LOGDRAFT boring log templates are available from the Senior Geotechnical Engineer. LOGDRAFT supports the output of AutoCAD DXF files, which aids in the export of the boring logs to plan sheets.

### 3.3.4 High Risk Geotechnical Sites

High-risk sites are locations where subsurface conditions may have significant schedule and cost impacts related to the constructability of staged construction sheet pile, cofferdams, and driven pile foundations. Examples of high-risk sites are:

- Sites with the Presumpscot Formation, which is a weak, soft deposit of silty clay found in the coastal lowlands of Maine and extending inland along the Penobscot and Kennebec River valleys.
- Sites with highly variable and erratic subsurface conditions, such as unknown existing foundations for buildings or other structures that have been removed (i.e., relic foundations).

- Sites with cobbles, boulders, or timber cribbing.
- Sites where the consequences of slope failure are unacceptable.

Best practices for high-risk geotechnical sites include:

- Identify project sites early in the Project Development Process to perform adequate investigations and sufficient technical evaluations.
- Increase schedule and budget (post-preliminary design) to accommodate additional borings or more comprehensive geotechnical evaluation's during final design.
- Supplement borings with advanced geotechnical exploration methods, such as cone penetrometer tests (CPT's), seismic refraction, and borehole acoustic and optical televiewer (ATV/OTV) bedrock imaging.
- Discuss risk assignment for temporary detours, support of earth excavations, cofferdams, and equipment or stockpile loads.
- Include items, Special Provisions, and/or plan notes to control risk during construction by establishing limits on contractor means and methods (e.g., limiting/controlling fill rates or load restrictions).
- Establish limitations on the use of equipment or activities that may disturb and weaken soft subgrade soils.

## 3.4 UTILITIES

---

### 3.4.1 Coordination and Relocation

The MaineDOT and Utility companies each have public service responsibilities that involve extensive capital infrastructure and operate under considerable legislative and regulatory oversight. As an extension of the MaineDOT on each project, the Designer should accommodate existing and future utility needs. More guidance regarding utility responsibilities and permitting requirements may be found within the latest versions of the *MaineDOT Utility Accommodation Rules* and the *MaineDOT Memorandum of Understanding for Overhead Utilities*. The Utility Coordinator will facilitate communication between the Design Team and the respective utilities with the goal of establishing final facility locations or relocations to meet the needs of the project. The following workflow should be followed for each design project:

1. Utility Coordinator, Design Team, and applicable Utility Contacts are established through a formal coordination process.
2. Identify all existing utility locations.
3. Preliminary Design determines necessary relocations or utility conflicts.
4. The Utility Coordinator works with the respective utility to determine the best location for proposed or relocated facilities.
5. The respective utility designs the facility and applicable appurtenances.

6. Final permitting for the proposed or relocated facility is completed.
7. Project construction and all necessary utility relocations occur.

Coordination for railroad crossing bridges requires early communication in the design process to define project design criteria (e.g., clearance envelope, construction limitations, security fence needs, etc.).

### 3.4.2 Aerial Facilities

When possible, the relocation or installation of aerial facilities directly adjacent to proposed or existing bridges should be avoided to minimize future conflicts with bridge inspection and construction activities. The vertical and horizontal clearances required for new aerial facilities shall be in accordance with the *MaineDOT Memorandum of Understanding for Overhead Utilities* and the project specific requirements established by the Utility Coordinator and the utility.

The type and location of existing aerial facilities shall be included in constructability assessments of proposed bridge alternatives to determine the impact of pile driving, cofferdam installation, crane lifts for demolition or erection, temporary earth structural support system installations, and bridge inspection access. The United States Department of Labor Occupational Safety and Health Administration (OSHA) requirements must be satisfied for all construction projects. Typically, a 10'-0" offset radius is required around distribution power lines. However, the offset mandated by OSHA varies depending on the voltage of the utility. If the required clearance cannot be provided, aerial facility must be temporarily relocated with temporary poles or alley arms, or deenergized to facilitate construction.

### 3.4.3 Underground Facilities

Proposed foundations shall account for all existing underground facilities to avoid conflict with the facility or infringe on the required offsets. All new underground facilities shall be located and designed to facilitate replacement of the adjacent structure. Locations near bridge substructure elements should be avoided whenever possible and utility location challenges shall be identified by the Designer and communicated to the Utility Coordinator early in the design process. Underground utilities shall not be located within the reinforcement/anchorage limits of MSE retaining walls or other anchored wall systems. All horizontal and vertical clearance offsets between adjacent underground facilities shall be coordinated and approved by the owner of the utility.

### 3.4.4 Bridge Mounted Facilities

It is acceptable to mount utilities on bridge structures if other alternatives are not feasible. The proposed attachment approach to state-maintained bridges must be practical and must be approved by the Bureau of Maintenance and Operations. Attachments shall be included in the original design of the bridge or deemed acceptable by MaineDOT. All other attachments, such as banners, fishing nets, decorations, advertisements, etc., shall not be allowed. Refer to MaineDOT Engineering Instructions for additional information.

The utility company is responsible for the design, construction, maintenance, and operation of its facilities, including the design of the bridge mounted structural supports. For new bridge construction, the Designer

shall coordinate with the respective utility and/or the project Utility Coordinator to ensure that the proposed utility load is incorporated into the final bridge design and load rating.

Proposed bridge mounted facility shall not reduce the as-designed vertical clearance of the bridge. Specific clearances to bridge structural elements shall be in accordance with the *MaineDOT Utility Accommodation Rules* and as established by the Utility Coordinator.

The following limitations apply to all projects; however, additional considerations may be required on a project-by-project basis:

Concrete Deck:

- Bridge mounted facilities shall not be connected to the bottom of the bridge deck.
- Bridge mounted facilities shall not be located within the concrete deck.
- In certain cases, roadway lighting conduits may be located within the concrete sidewalks or curbs if a 2-inch clearance is provided to all formwork, reinforcing steel, and other conduits.

Steel Girders/Beams:

- Attachments to girders shall use bolted connections; welded connections will not be permitted.
- Connections to webs are allowed; connections to flanges will not be permitted.
- Attachments shall be between girders. Mounting to the beam fascia is not permitted unless all other alternatives are infeasible.

Precast Concrete Elements:

- Attachments that are not incorporated in the original bridge design will not be permitted.
- Attachments shall be cast-in threaded inserts; drilled or post-installed inserts will not be permitted.
- Utilities shall not be passed through internal voids.
- Attachments shall be located between interior beam elements when possible. Mounting to the fascia of adjacent box and voided slab structures is permitted when necessary.

Truss Elements:

- Attachments that are not incorporated in the original bridge design will not be permitted on main truss members.
- Applicable criteria listed in the Steel Girders/Beams section shall be followed.

### 3.4.5 Lighting

The MaineDOT Project Manager, via the Project Team, will recommend to a municipality that a bridge should be lighted when it would be in the best interest of the public. The Project Manager will be the point of contact with the municipality and responsible for coordinating agreements with them. Lighting needs of a project should be determined during the preliminary design process and documented within the BCF and/or PDR.

MaineDOT's Traffic Engineers will determine the need and design for lighting on or under a bridge. The following policy for overhead lighting of bridges is provided for reference:

- Controlled Access Highways: Bridges will be lighted when they are part of an interchange, where continuous lighting exists, and/or a need for lighting is established during preliminary design.
- All Other Roadways: A bridge should be lighted when at least one of the following is satisfied:
  - Lighting is requested by the municipality.
  - Both approaches are lighted.
  - Significant pedestrian traffic is present.
  - Other safety issues are identified.

Lighting shall be engineered to provide both vertical and horizontal illumination for pedestrian safety. All lighting installed will be Illuminating Engineering Society (IES) full cutoff lighting unless specifically allowed by the Commissioner of MaineDOT. Bridge lighting conduit is allowed to be installed within the curb or sidewalk, refer to Section 3.4.4 Bridge Mounted Facilities for additional information. For grade separation structures that require lighting below, the location of fixtures and level of illumination should be in accordance with the latest version of the AASHTO publication *Roadway Lighting Design Guide*. Navigational lighting, if required, shall be provided as directed by the agency requiring it (e.g., US Coast Guard).

The Designer should note that National Electric Code (NFPA 70, 2020) only allows one electrical service per structure. In special circumstances, such as border crossing structures additional services may be necessary due to the safety concerns associated with temporarily shutting off one electrical service during maintenance or construction.

The total cost of installation of the lighting system is paid by MaineDOT on all bridges and MaineDOT will retain all ownership of the lighting system. However, maintenance of the wiring, lighting controller, and luminaries, as well as the cost of electricity, are the responsibility of the municipality, except on controlled-access highways where MaineDOT will be responsible. This split of responsibilities requires a State-Municipal agreement on a project-by-project basis. Additional costs to provide enhancements such as ornamental lighting equipment or aesthetic lighting may be subject to the *MaineDOT Cost Sharing Policy*. These types of non-standard installations shall be reviewed with the MaineDOT's Traffic Engineers to verify compliance with applicable laws, rules, and regulations.

### 3.5 ADA CONSIDERATIONS

The Americans with Disabilities Act (ADA) protects people with disabilities from discrimination. In accordance with the ADA, public transportation systems must provide people with disabilities an equal opportunity to benefit from their services. ADA requirements shall be included in the design of new bridges and on a case-by-case basis on rehabilitation projects. Items that may be controlled by ADA requirements include, but are not limited to, curb ramps and sidewalk widths, cross slopes, longitudinal grades, and pedestrian signalization at intersections. Considerations of both the permanent and the temporary construction condition must be provided. The Designer should coordinate with the Project Manager and

## CHAPTER 3 – PROJECT DEFINITION AND CONSTRAINTS

the MaineDOT ADA Coordinator for project specific ADA requirements. For more information see MaineDOT's ADA Accessibility Program webpage:

<https://www.maine.gov/dot/doing-business/civil-rights/ada>