Title

Vertical Clearance Considerations for Bridges and Buried Structures for Water Crossings

Purpose

To provide information and guidance for designers on how to determine vertical clearance.

Guidance

Background

All water crossing structures require inspection, monitoring, and potential maintenance activities during their life cycle.

- The streambed channel within Fish bearing water crossing structures is periodically monitored to ensure fish passage
- Water crossings in the Federal Culvert Injunction area require streambed channel monitoring at least three times within the first 5 years of correction, and then once every 10 years in perpetuity to ensure fish passage. Correction is required if determined to be a fish barrier.
- WDFW Hydraulic Project Approval (HPA) permits require streambed channel monitoring on two-three occasions within the first 2 years after the water crossing structure is constructed to ensure it is performing as expected.
- WSDOT Bridge Preservation performs structural integrity inspections every 2 years for all structures with spans ≥8 feet. Note, these inspections are federally mandated for all structures with a Structural Clear Span ≥20 feet.

There are two elements that must be considered while determining the appropriate vertical clearance under bridges and inside buried structures. The first is 100 Year Design Freeboard (Freeboard), and the second is Maintenance Clearance. Both terms are defined in the Definitions section below.

Freeboard is related to the hydraulic capacity of the structure, and is required by state and federal guidance. Typically, all bridges and buried structures are required to have a minimum of 1-3 feet of freeboard above the 100 year water surface elevation. The State Hydraulics Engineer determines the Freeboard, and it is documented in the Preliminary/Final Hydraulic Design Report (P/FHD). Approval from the State Hydraulics Engineer is required for Freeboard less than what is documented in the P/FHD.

Direction to Designers

Providing Maintenance Clearance beyond the minimum Freeboard is beneficial for required monitoring and inspections, as well as any maintenance activities that may be required during the life of the structure. Generally, these activities include staff walking through the culvert, taking measurements and photographs, but could also involve the use of machinery within the structure limits. Evaluate and document the type of activities that will be conducted in collaboration with Region Maintenance, Bridge Preservation, ESO/Stream Restoration Biologists, and other key stakeholders.

For design-build projects, Maintenance Clearance must be evaluated by the design team and incorporated into the Request for Proposal (RFP) prior advertisement.

Maintenance Clearance Target

Each water crossing location has site specific considerations that must be evaluated in order to determine the appropriate Maintenance Clearance. Provide as much clearance beyond the minimum Freeboard called out in the Preliminary/Final Hydraulic Design Report (P/FHD) as feasible.

Use 6 feet from the Thalweg elevation to the Controlling Top Elevation (CTE) as the initial Maintenance Clearance target. This initial target has been found to provide reasonable access for inspection, monitoring, and maintenance staff to go into and under the structure in a mostly erect position. Note, research as shown that 10 feet minimum vertical clearance is required for machinery access and operation. It is good practice to evaluate the list of Considerations below with Region Maintenance and the Bridge Preservation Office when determining the appropriate Maintenance Clearance.

Considerations

- For buried structures, evaluate the embankment depth over the structure in order to increase the Maintenance Clearance without raising the roadway profile. In most cases it likely will not be feasible to raise the roadway profile, but there may be exceptions such as a requirement for providing minimum Freeboard or, the stream is located below a sag curve, etc.
- Consider minimum fill requirements over the buried structure. For concrete structures, if the fill depth is less than 2 feet, measured from the top of slab to the roadway surface, the top slab may become the driving surface, thus triggering structural design requirements. Contact the Bridge Office for a determination. For metal plate structures, minimum fill depths may control as required by the design specification.
- Consider fill depth needed over buried structure to allow for standard guardrail post installation. There may be a balance between maximizing the Maintenance Clearance and allowing for the use of standard guardrail.
- Consider overall structure height. It is good practice to check with industry suppliers in order to understand the costs associated with increases in structure height. If the Maintenance Clearance can be provided without exceeding typical forming system maximum height the additional cost may be negligible.
- Consider the overall length of the structure. Longer structures increase the risk for potential monitoring and maintenance, and access is difficult if there is insufficient height.
- Consider constructability for placing the streambed material. Often the streambed material must be placed inside the structure prior to placing the overhead part of the buried structure and backfilling if there is not enough vertical clearance. This may require a longer roadway closure, and may add risk during the closure.
- Consider delivery of the precast sections. There may be height restrictions along the delivery route.
- Consider placement of precast sections. For constrained locations evaluate appropriate space for crane set up, delivery of the structure sections, and crane picking operation to place the sections.

Approvals

The Region ARA for Development (or delegate) has the final approval for Maintenance Clearance. As previously mentioned, it is good practice to consult Region Maintenance and the Bridge Preservation Office when evaluating Maintenance Clearance.

Documentation

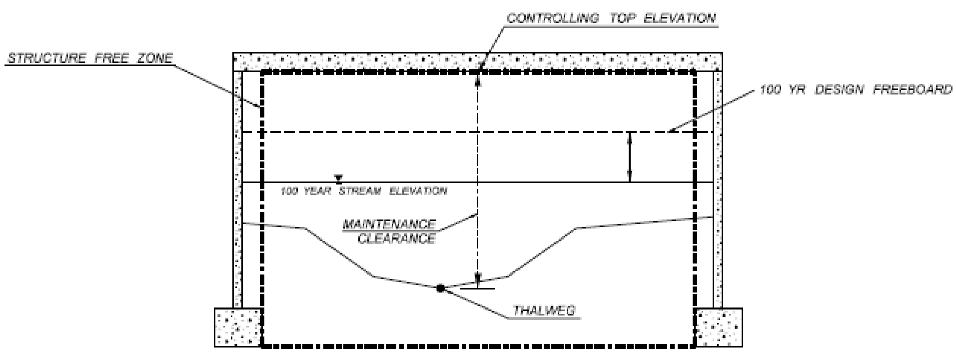
Decisions regarding Maintenance Clearance shall be documented in the Basis of Design (BOD), Design Parameters Worksheet, or a design decision and included in the Design Documentation Package (DDP). The documentation should include conclusions for the aforementioned considerations, and concurrence from the approval authority.

Definitions

- 100 Year Design Freeboard (Freeboard) – The minimum dimension from the 100 year water surface elevation to the Controlling Top Elevation (CTE) as defined by the State Hydraulics Engineer.
- Controlling Top Elevation (CTE) – An imaginary surface that represents the top boundary of the SFZ.
- Maintenance Clearance – At any given cross section of the SFZ, Maintenance Clearance is a vertical dimension added to the Thalweg elevation, which is used to evaluate the elevation of the CTE.
- Structure Free Zone (SFZ) – An imaginary prism that represents the minimum boundary within which no part of the fish passage structure shall be allowed.
- Thalweg – The line of the lowest streambed elevation within the watercourse.

Exhibits (see next page)

Exhibits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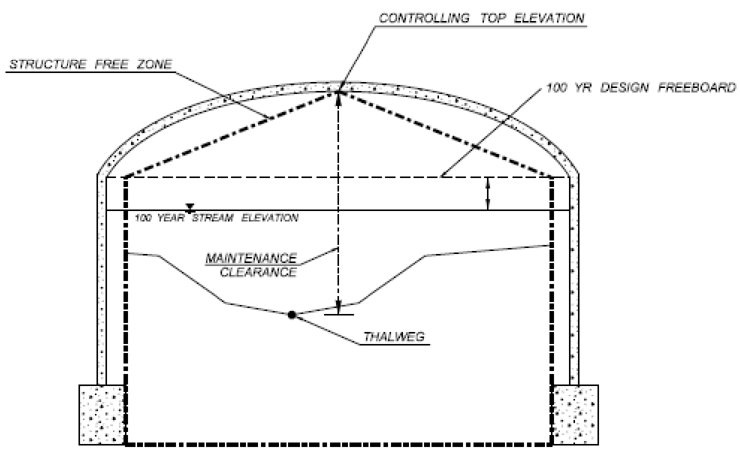
100 YEAR STREAM ELEVATION
MAINTENANCE CLEARANCE
THALWEG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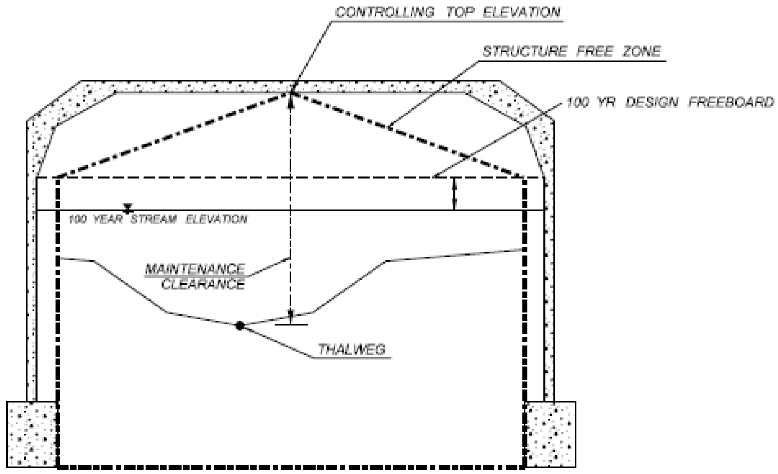
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