Foundation Location Based on WSDOT Scour Policy

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WSDOT Policy Updates

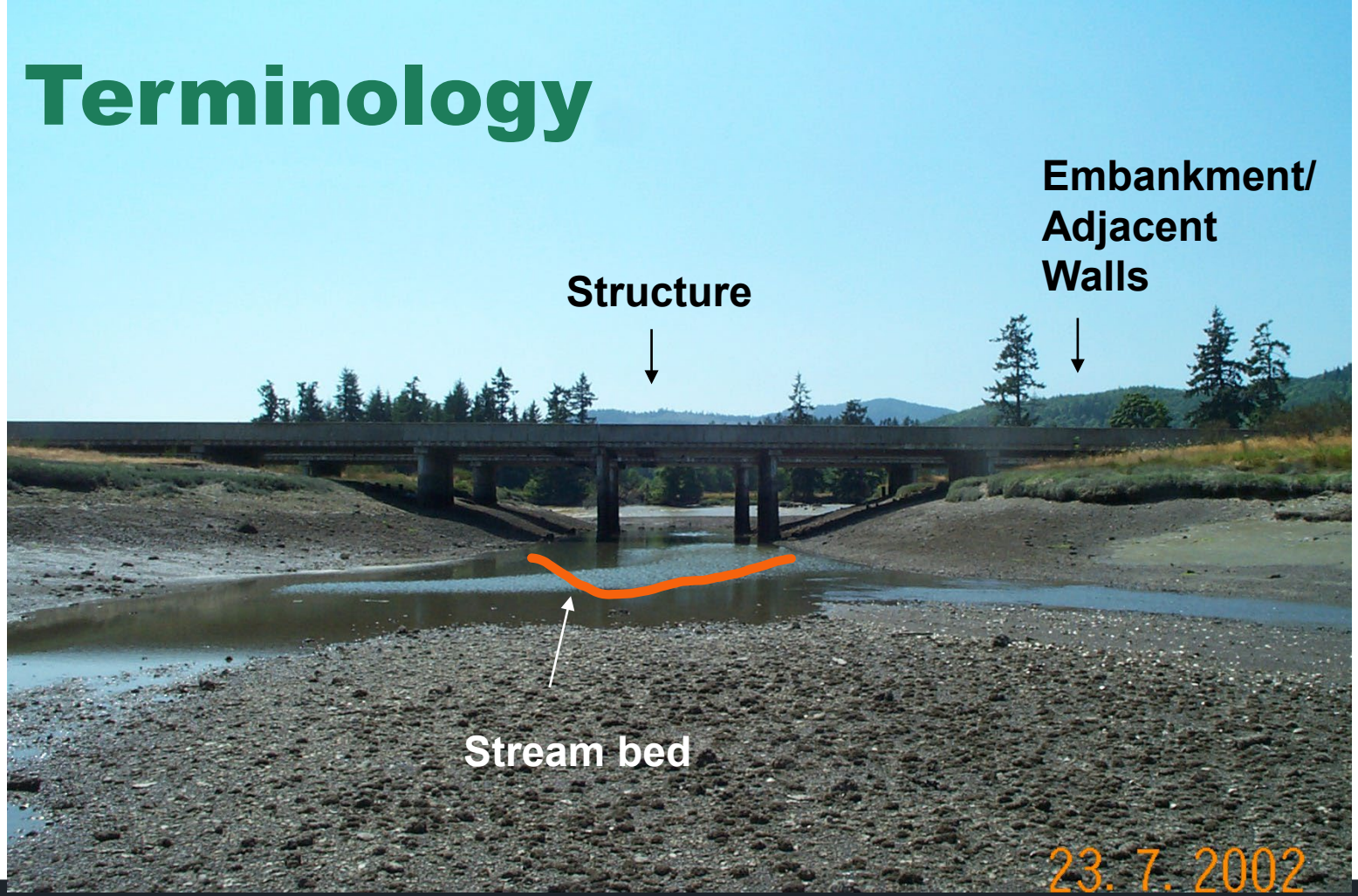
Who is involved

- Hydraulics
- Geotech
- Bridge Design
- Bridge Preservation
- Environmental
- Maintenance

Manuals Updated

- Hydraulics
- Bridge Design
- Roadside Maintenance Manual
- Design Manual

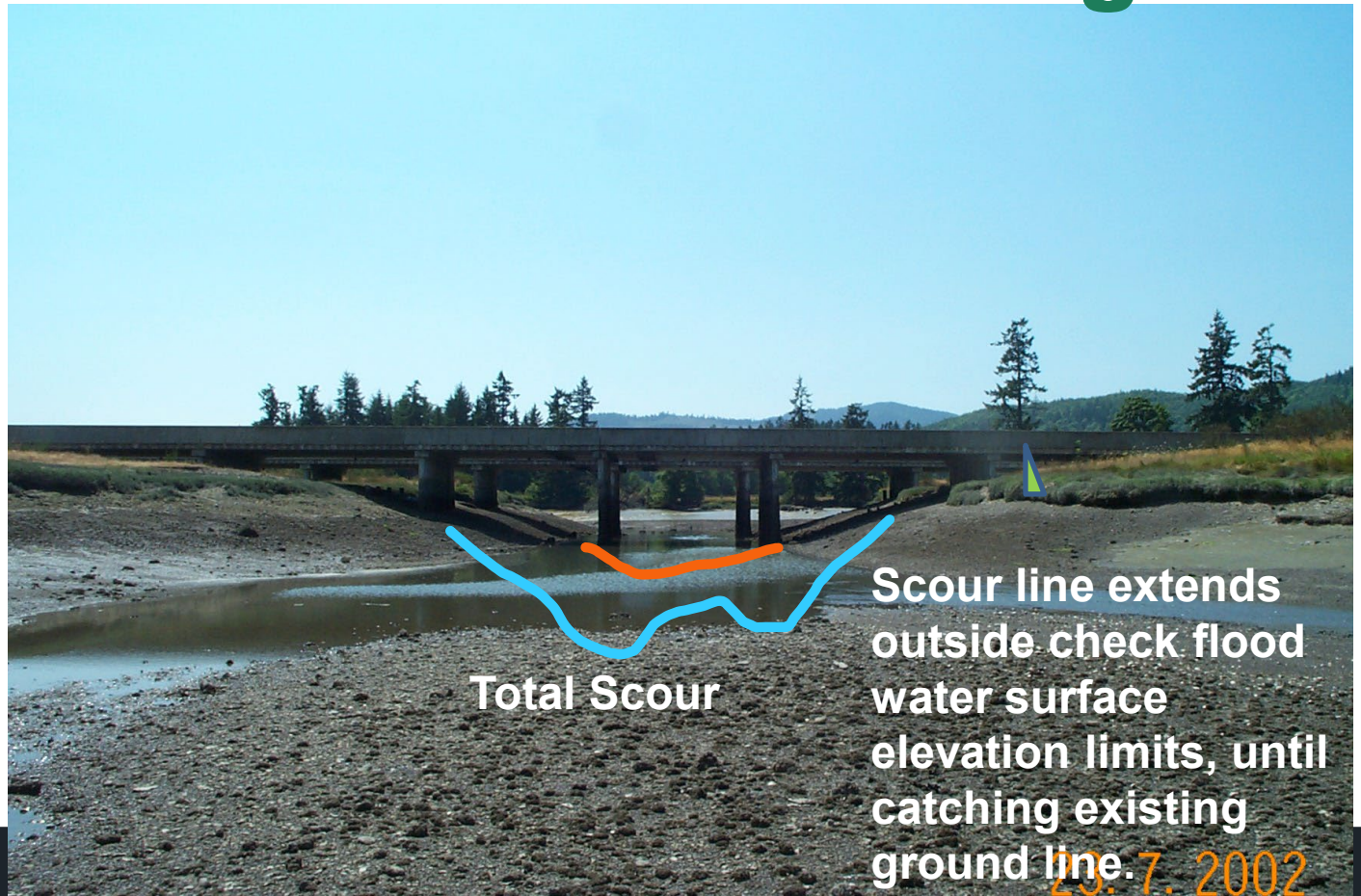
Terminology



Scour Requirements – BDM 7.1.7

- Scour can affect the bridge structure, adjacent wall structures, and the bridge embankment.
- All bridge foundations shall be designed for total scour regardless of bridge type, location, and usage.
- Total scour for the bridge structure may take into account scour countermeasures, if certain criteria are met.
- If scour countermeasures are designed and constructed following guidance from the most recent version of the Hydraulics Manual, then walls and embankments benefit.
- Total scour accounts for lateral migration.

Scour Without Lateral Migration



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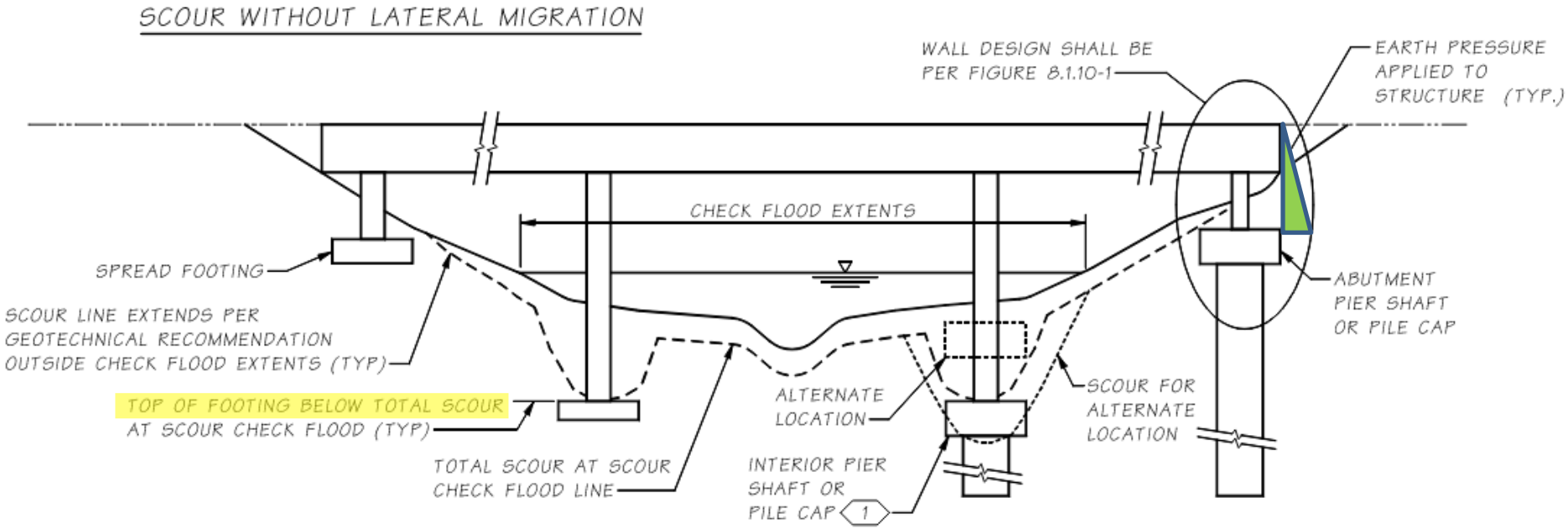

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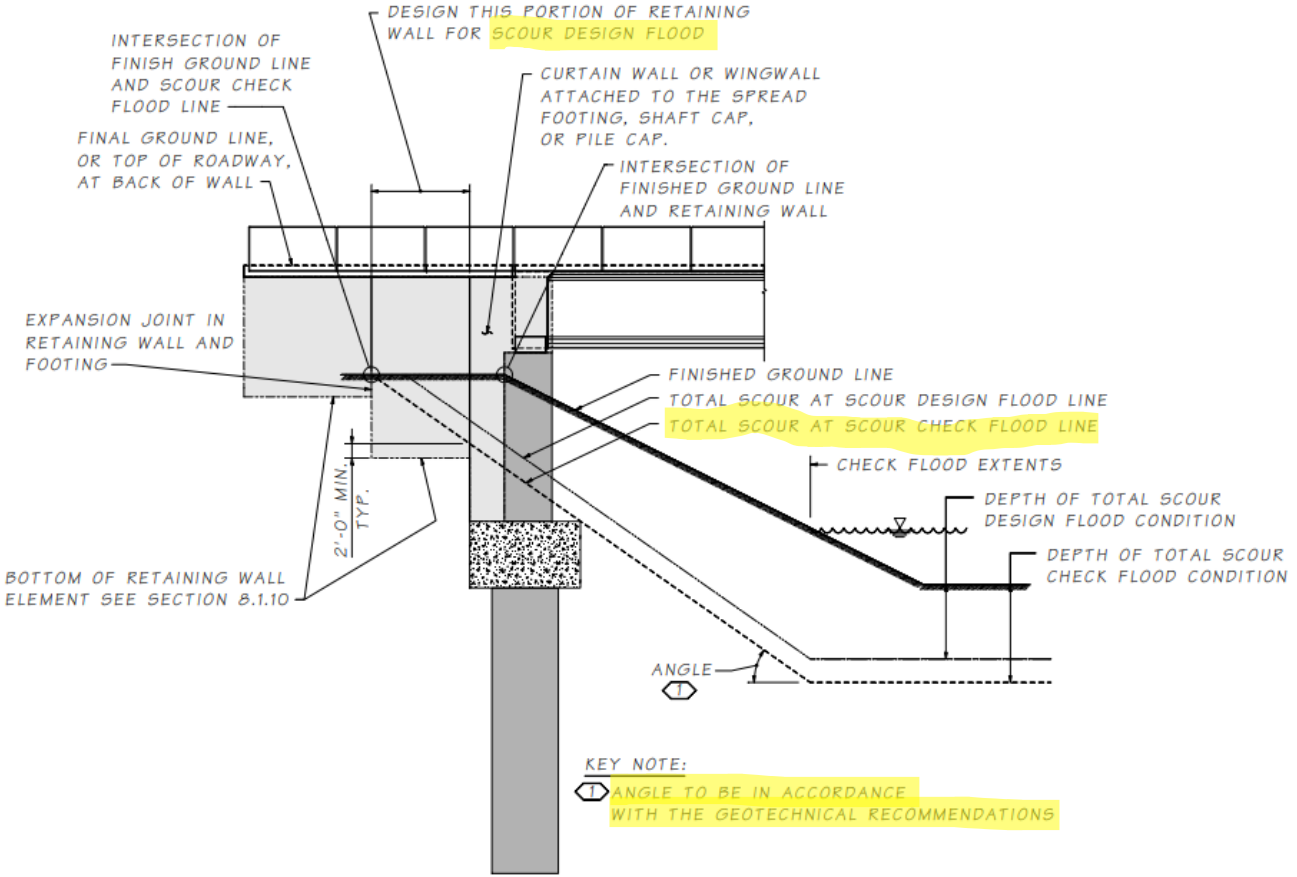

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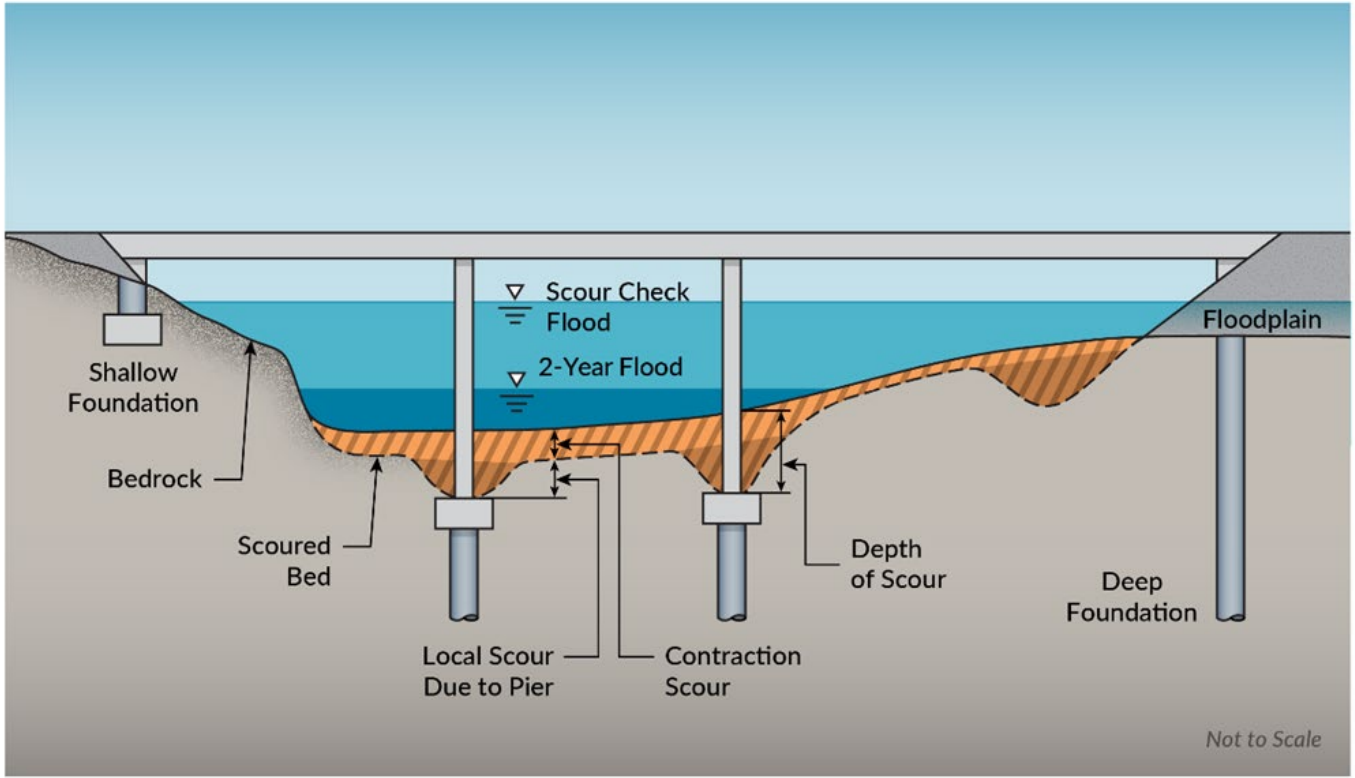


Scour with Lateral Migration

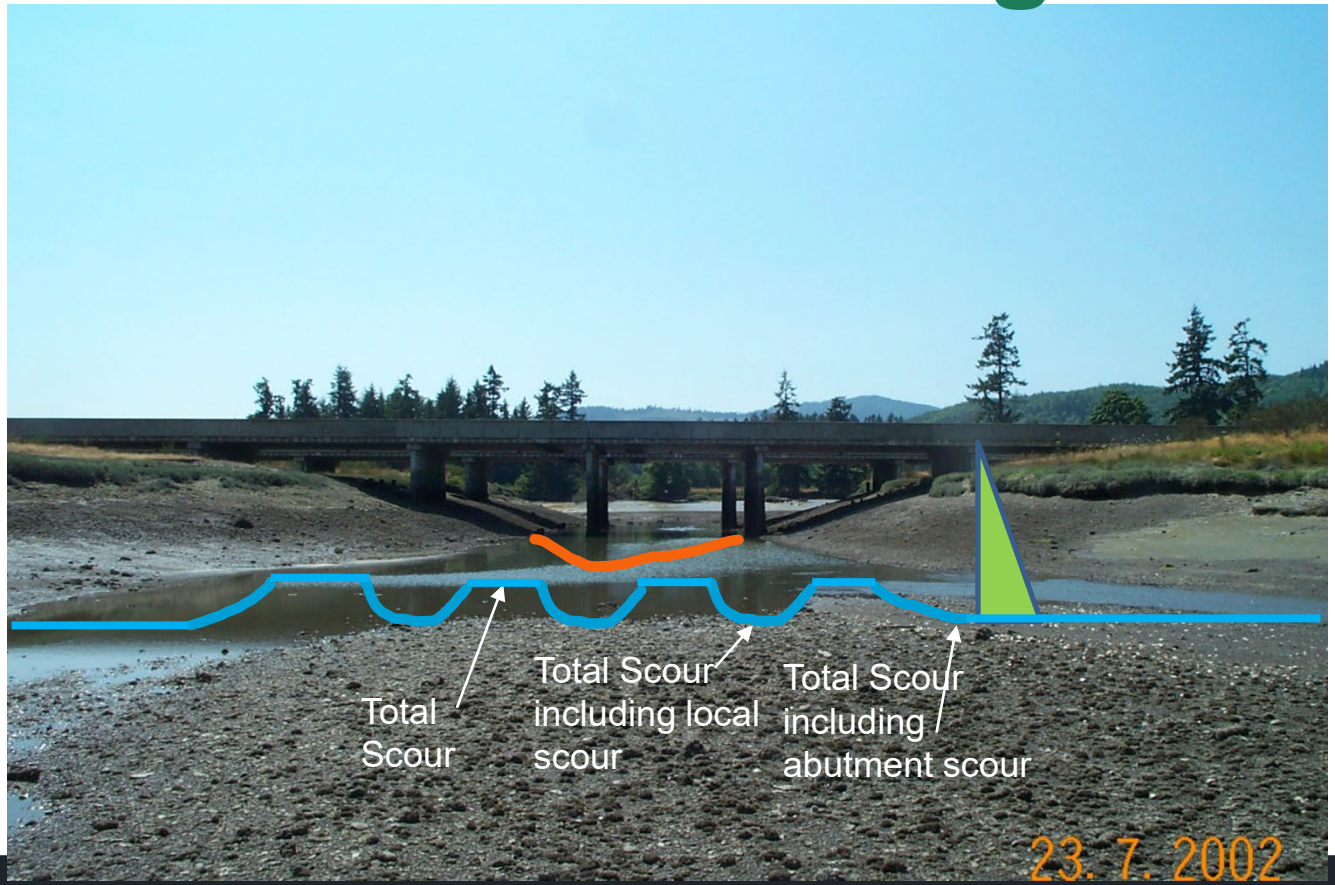
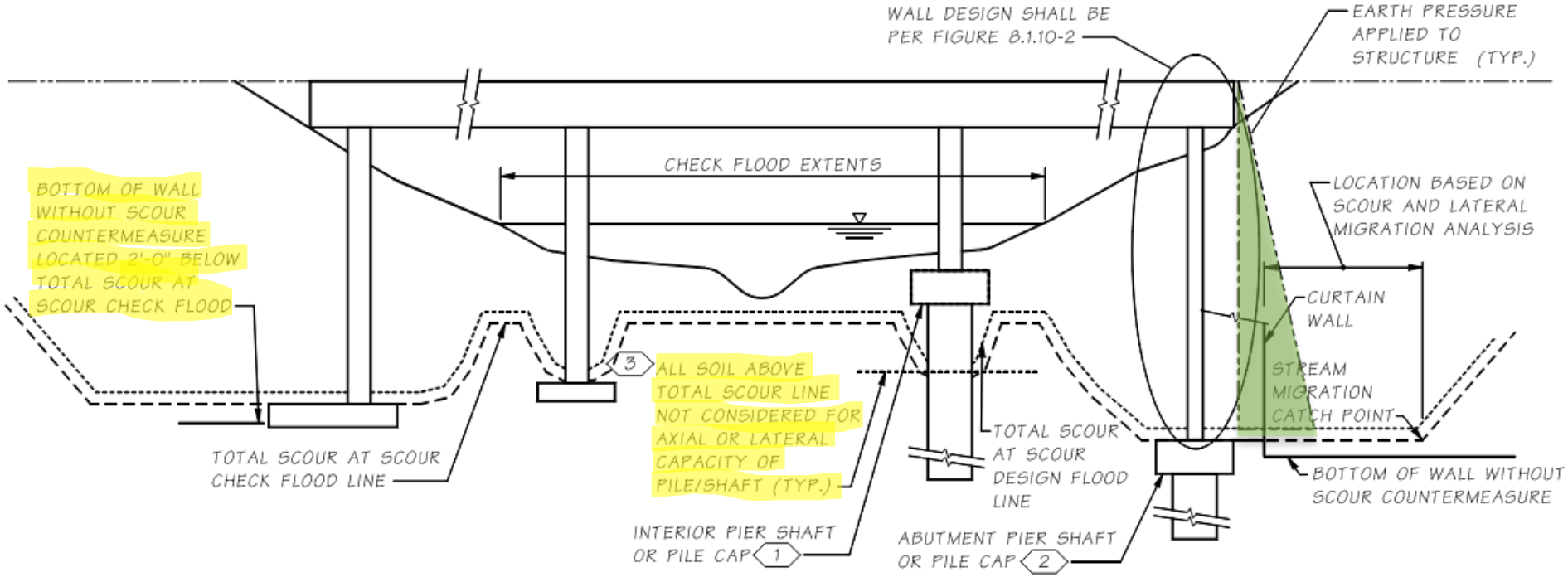


Image Source: WSDOT

Scour With Lateral Migration



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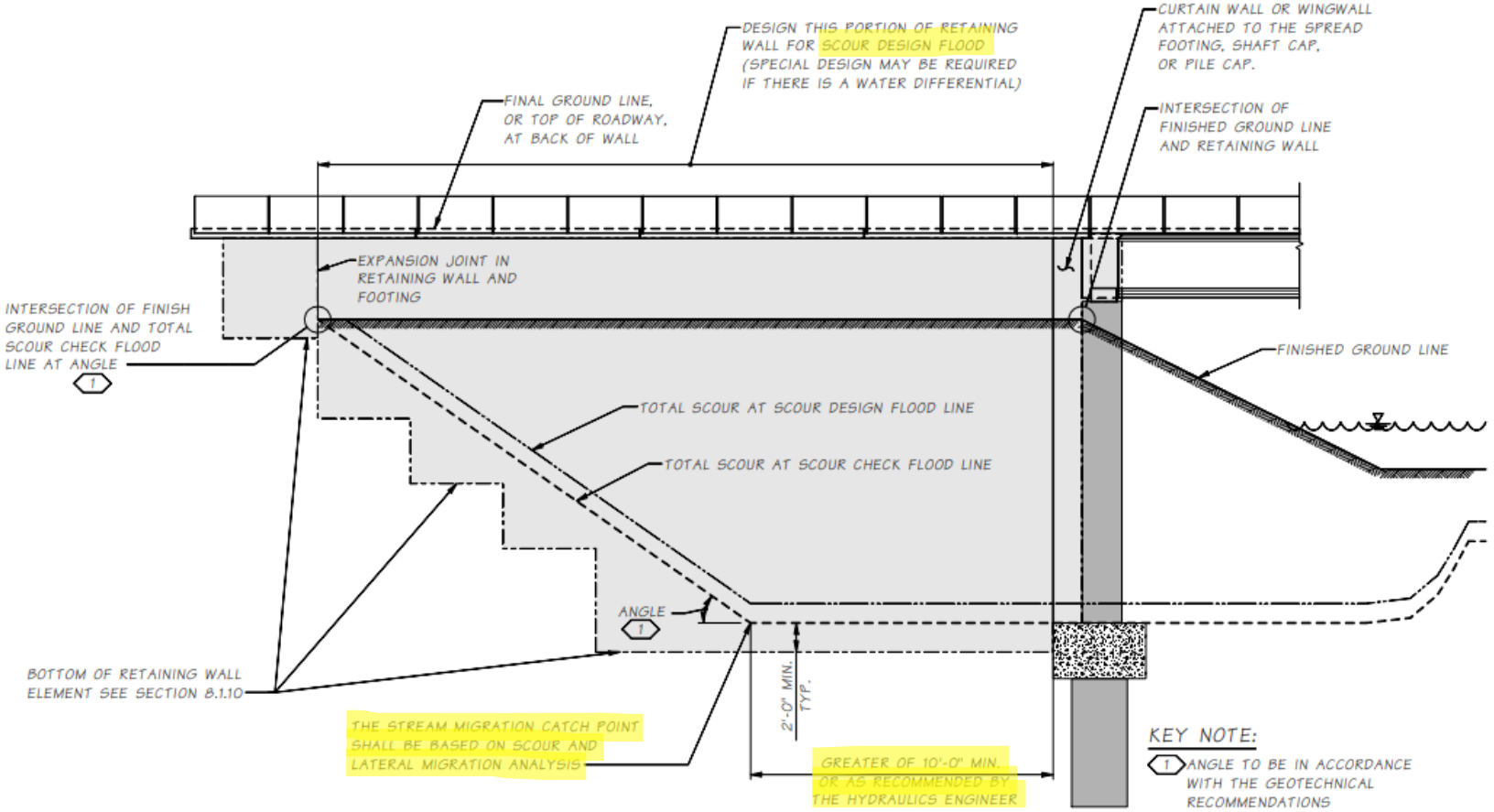


Scour With Lateral Migration

Foundation Design Allows Countermeasure to Retain Soil

Deep Foundation Only

Maintenance Access Required

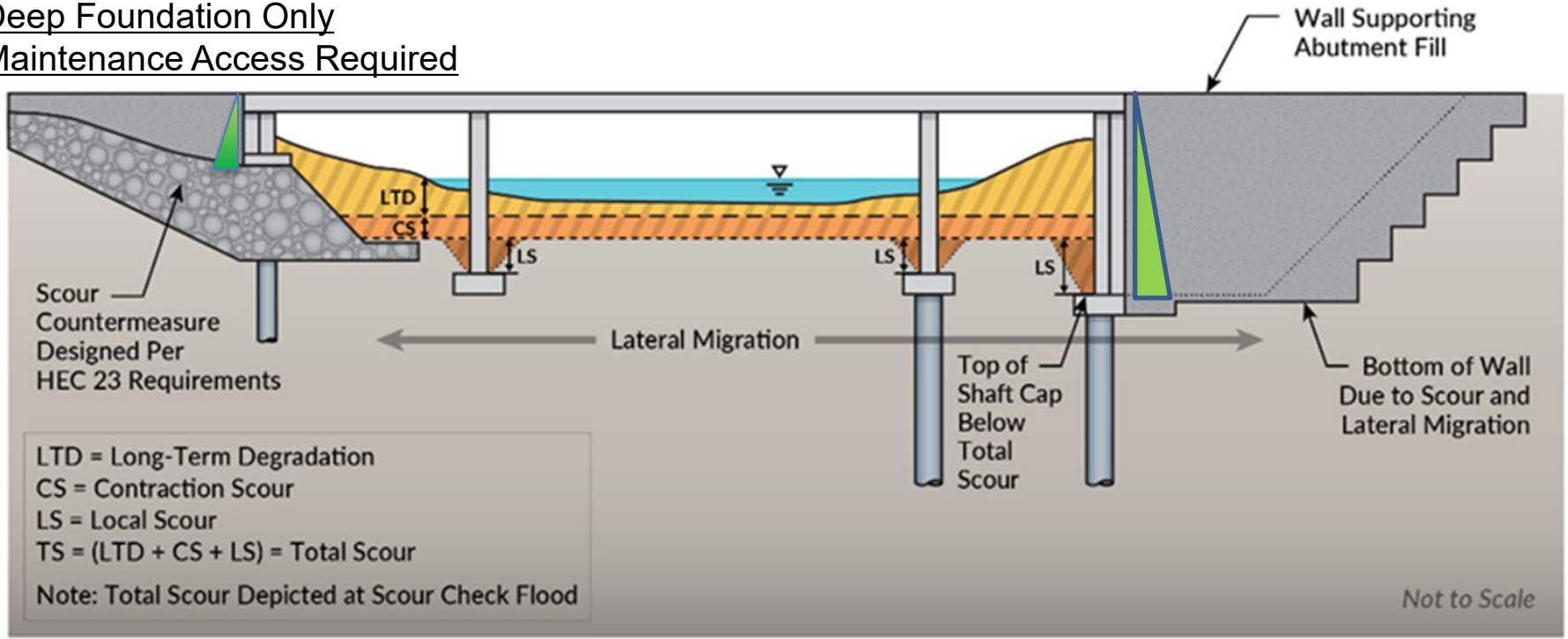


Image Source: WSDOT

Countermeasure – Shallow Foundation WSDOT BDM Requirement

Shallow foundations supporting interior piers and abutments on soil or erodible rock shall be located so that the top of footing is below the total scour at the scour check flood. The presence of scour countermeasures does not change the elevation in relation to scour of the shallow foundations.

If a bridge abutment footing is reliant on a retaining wall, the wall shall be designed for the total scour depth, regardless of the presence of a scour countermeasure. The retaining wall shall have continuous structural concrete or continuous fascia that extends 2 feet below the total scour at the scour check flood. The length of such a wall shall be determined by performing an assessment to ensure the stability of the wall and structure element through the range of anticipated scour and lateral migration.

Countermeasure – Shallow Foundation AASHTO 10th Ed. Requirement

Shallow foundations ~~S~~(i.e., spread footings) supporting intermediate piers and abutments on soil or erodible rock shall be located so that the ~~bottom~~ top of footing is below scour depths determined for the scour design and scour check floods, and other more frequent flood (discharge) events that could result in deeper scour. ~~For scour~~. In this case, the top of the spread footings shall be located below the total scour depth (i.e., long-term degradation, contraction scour, and local scour) regardless of the presence of scour countermeasures. If the bridge abutment footing is placed on top of a retaining wall, the wall shall be designed for the total scour depth, regardless of the presence of a scour countermeasure.

Countermeasure – Deep Foundation WSDOT BDM Requirement

At bridge abutments without scour countermeasures designed and constructed per the most recent *Hydraulics Manual*, deep foundations such as drilled shafts or driven piles, with pile or shaft caps, shall be located such that the top of pile or shaft cap is located below the total scour at the scour check flood. Scour countermeasures shall not be placed at interior piers. For interior piers, or at bridge abutments with scour countermeasures designed and constructed per the most recent *Hydraulics Manual* guidelines, the top of foundation may be located above the total scour at the scour check flood elevation. There may be select structures where the pile or shaft cap may be located above the total scour at the scour check flood at abutments without scour countermeasures if there is concurrence with the State Hydraulic Engineer, the State Foundation Engineer, the State Bridge Design Engineer, and the Region Manager, as well as the structure not being located on a T1 freight route or a lifeline route.

When the top of shaft or pile cap is located above the total scour elevation, the hydraulic and geotechnical recommendations shall account for the exposed foundation geometry. The foundation shall be designed assuming that the soil above the total scour elevation has been removed; or half the depth above the total scour at the scour design flood in Extreme Event Case I.

Deep Foundation – BDM Continued

The deep foundation abutment (those supported on drilled shafts, piles, or concrete filled steel tubes (CFST)) may be designed assuming the soil protected by the scour countermeasure remains in place if the following conditions are met:

1. Maintenance access is provided from the roadway to the countermeasures. See Roadside Manual 830 for more information related to maintenance access.
2. Rock for Erosion and Scour Protection gradation shall exceed the required gradation by one class.
3. All requirements are met per the *Hydraulics Manual*.
4. A general note shall be added to the bridge sheets indicating that the deep foundation design assumed the soil protected by the scour countermeasure remains in place.
5. Deep foundations shall extend below the lowest design elevation of the adjacent scour countermeasure at least to a minimum vertical distance that is the greater of 15 feet or 50 percent of the height between roadway grade near top of abutment and the lowest design elevation of the adjacent scour countermeasure. The bearing pressure under a pile or shaft cap shall not contribute to the resistance of the vertical loads.

Countermeasure – Deep Foundation AASHTO 10th Ed. Requirement

For bridge abutments supported on deep foundations, if a properly designed scour countermeasure, as described in HEC-23 (FHWA, 2009), is present to protect the abutment, the foundation may be designed assuming the soil protected by the scour countermeasure remains in place. In this case, the top of the toe of the scour countermeasure shall be located at or below the depth of long-term degradation plus contraction scour at the scour check flood. If properly designed countermeasure is not present, the foundation shall be designed assuming that the soil above the total scour depth has been removed.

Hydraulics Manual 7-4.11

For new structures, scour countermeasures shall not encroach within the MHO, unless approved by the State Hydraulics Office. The design of scour countermeasures first relies on an understanding and agreement of the asset they intend to protect and the required design standard for the asset. Elements of a water crossing that may need a scour countermeasure include but are not limited to the abutments, roadway approach walls, and the roadway embankment. Each of these elements can have varying levels of acceptable risk and thus different design standards. Scour countermeasure may be used to prevent scour at deep foundation abutments when recommended by the hydraulic engineer of record and the project shall require maintenance access per the Roadside Manual 830. When used with deep foundation, scour countermeasure rock class shall exceed the required design by one rock class. Figure 7-18 and Figure 7-19 provide conceptual sketches for where a scour countermeasure can be placed in relation to the MHO and depth of scour for a water crossing in a fish-bearing stream with and without abutment scour, respectively. The limits of scour countermeasure shall be determined based on the lateral migration determination process; see Sections 7-2.5.3 and 7-4.9. In the examples shown in Figure 7-9 and Figure 7-10, the bridge is founded on deep foundations, which are designed to meet HEC-18 requirements and do not rely on the integrity of the scour countermeasure.

Scour with Lateral Migration and Countermeasure

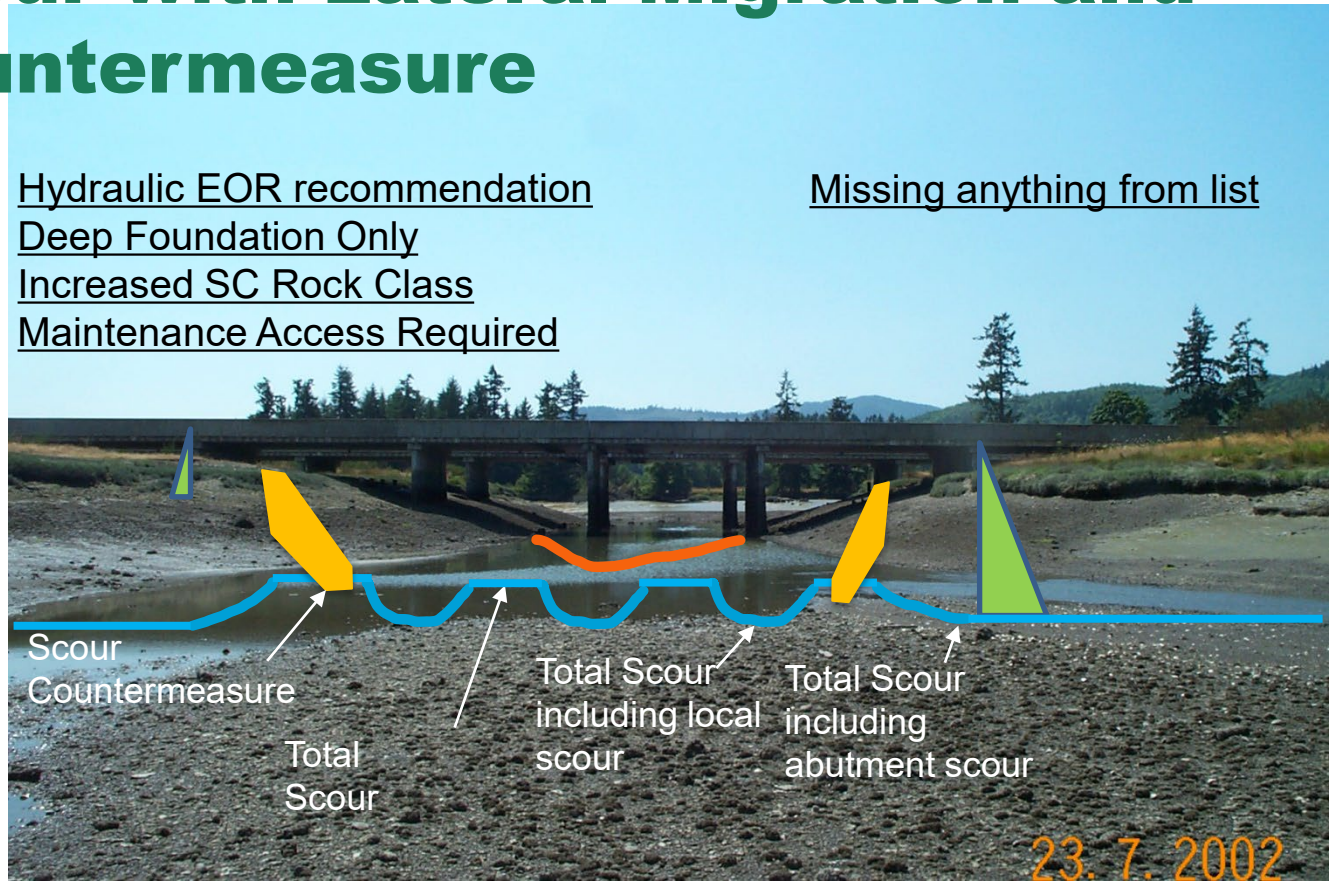
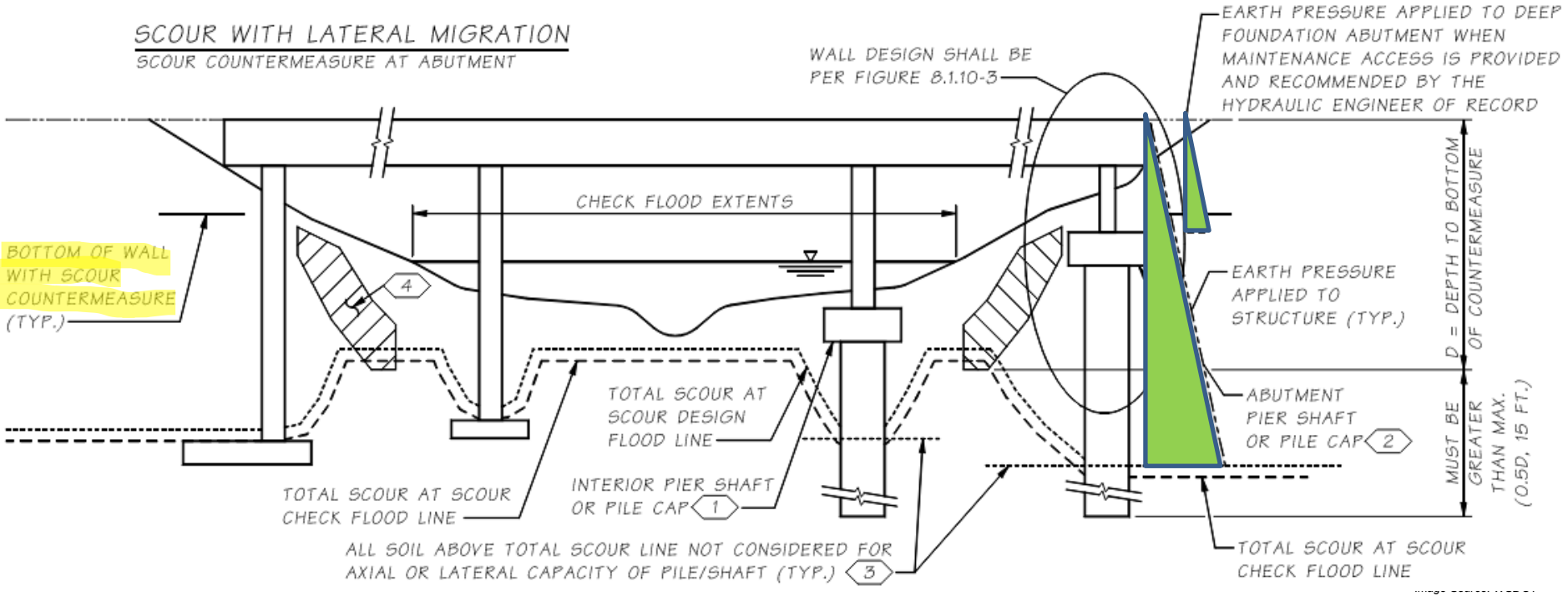


Image Source: WSDOT

Scour with Lateral Migration and Countermeasure



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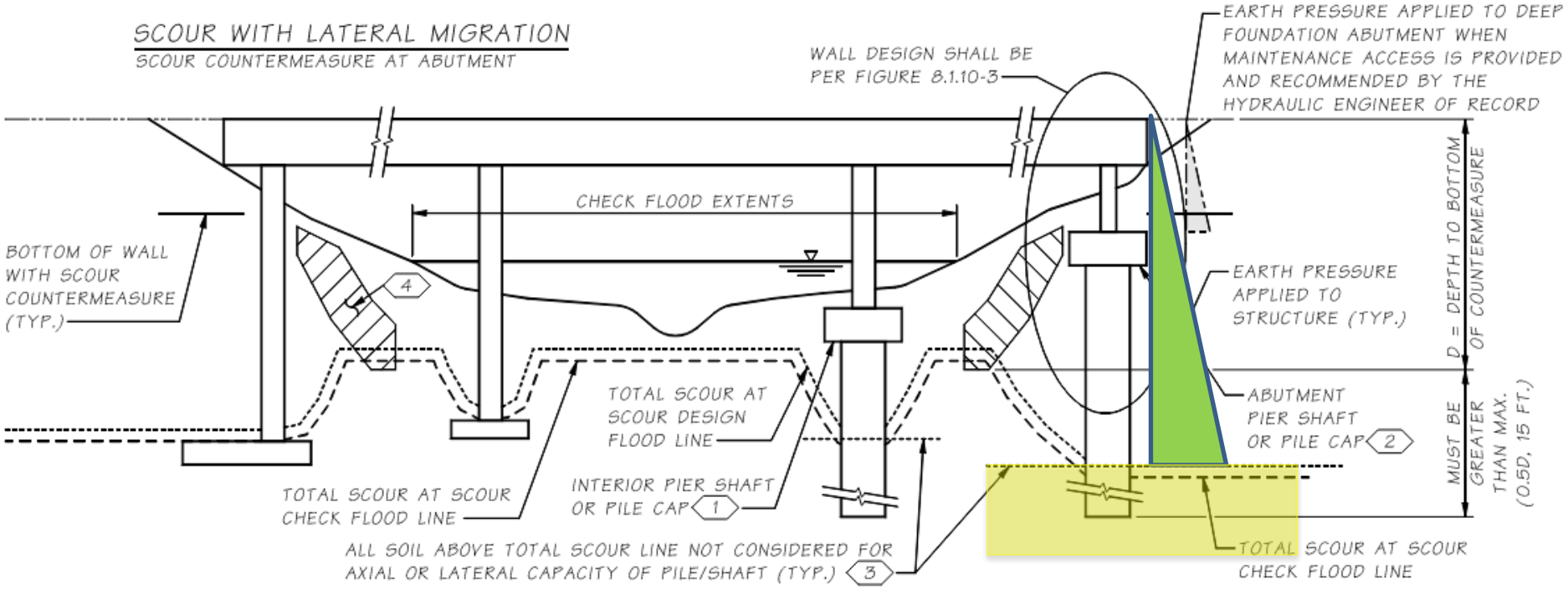
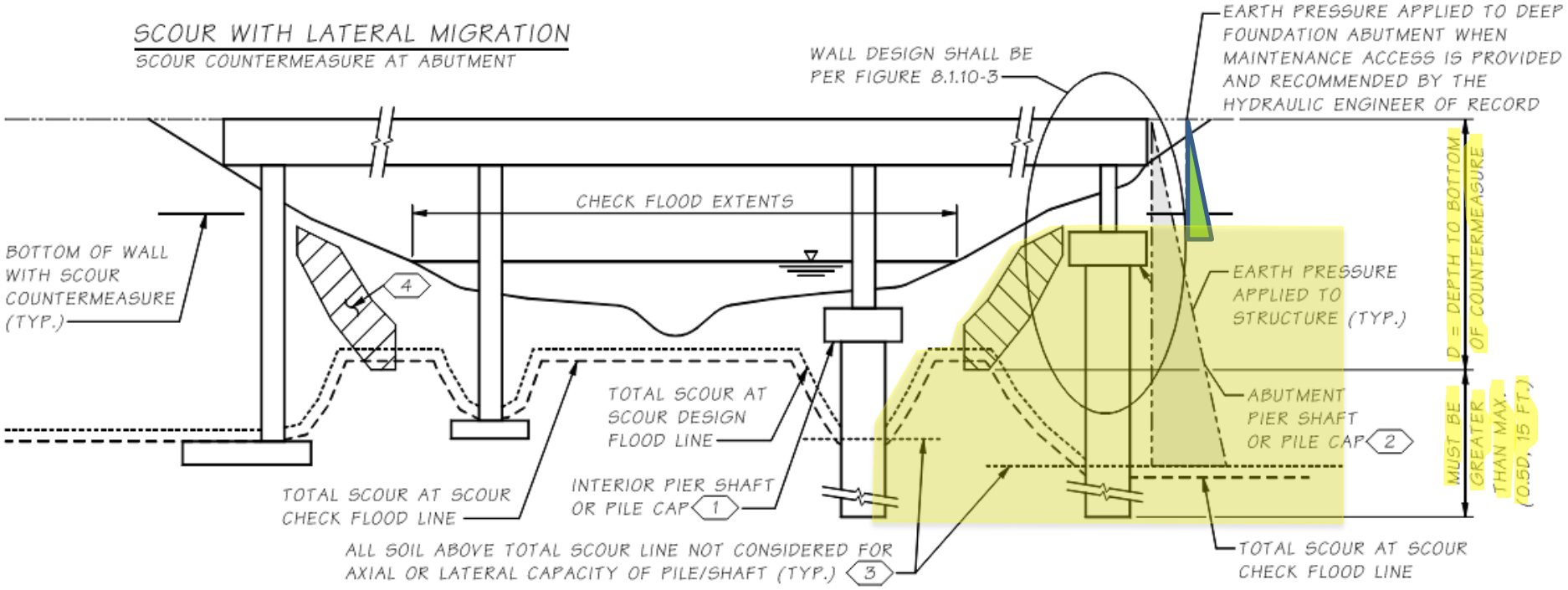


Image Source: WSDOT

Scour with Lateral Migration and Countermeasure and meeting 7.1.7B



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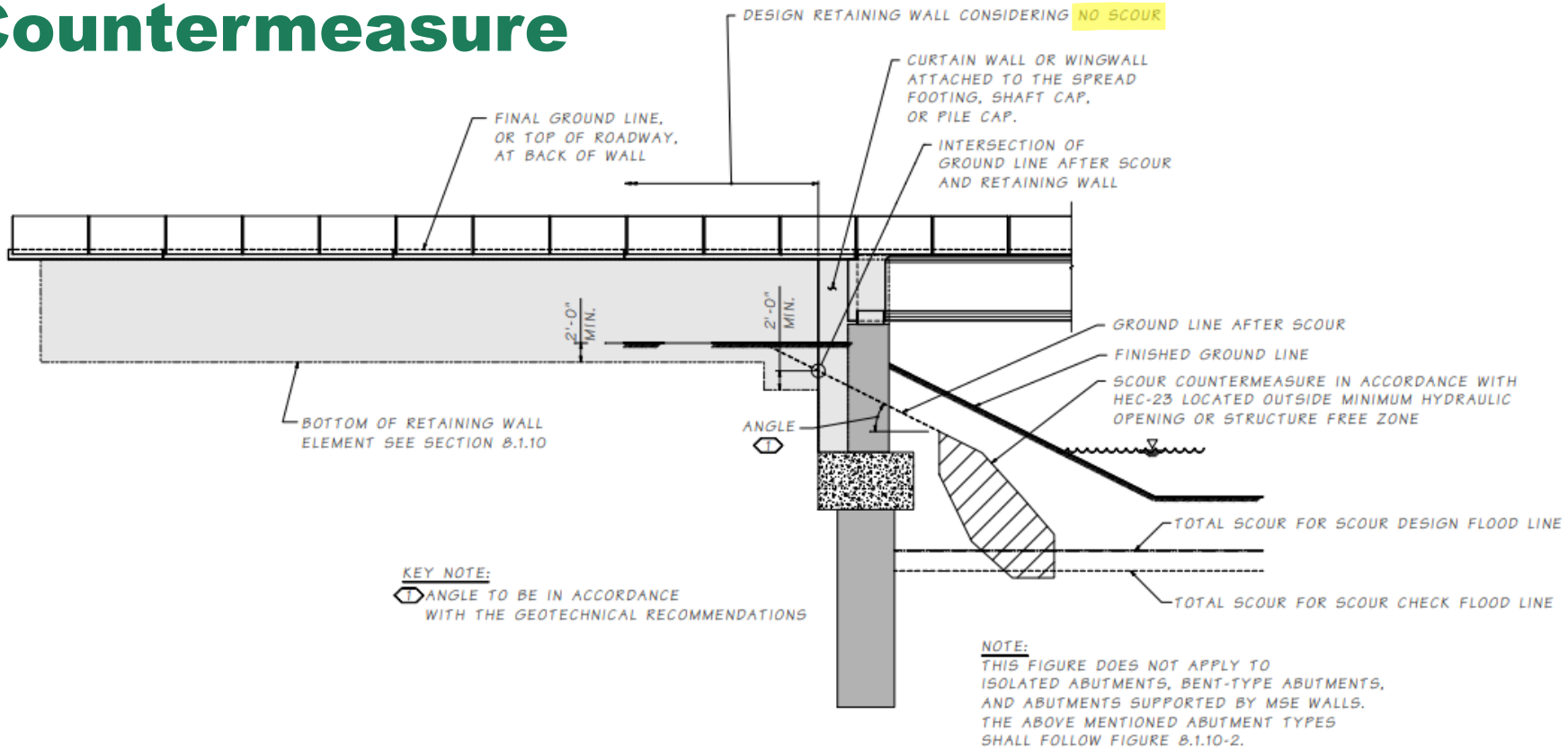
Scour with Lateral Migration and Countermeasure



720.03(15) Maintenance Access

Provide permanent maintenance access from the roadway to all scour countermeasures when a bridge abutment is supported by a deep foundation (e.g., piles, drilled shafts) and the foundation is designed assuming the soil protected by the scour countermeasures remain in place. Additional consideration may include adequate maintenance staging area(s).

Design any necessary highway elements such as the road approach to the highway (see Section 1340), access gate(s), roadside safety hardware and other highway features in accordance with Design Manual guidance. The width, grade and other features associated with the maintenance access beyond the highway features are designed on a case-by-case basis to reflect the needs of the individual location and the area maintenance's equipment and ability to conduct potential scour countermeasures repair work. The Assistant Region Administrator for Maintenance & Operations must concur with the design of the maintenance access beyond the roadway features.

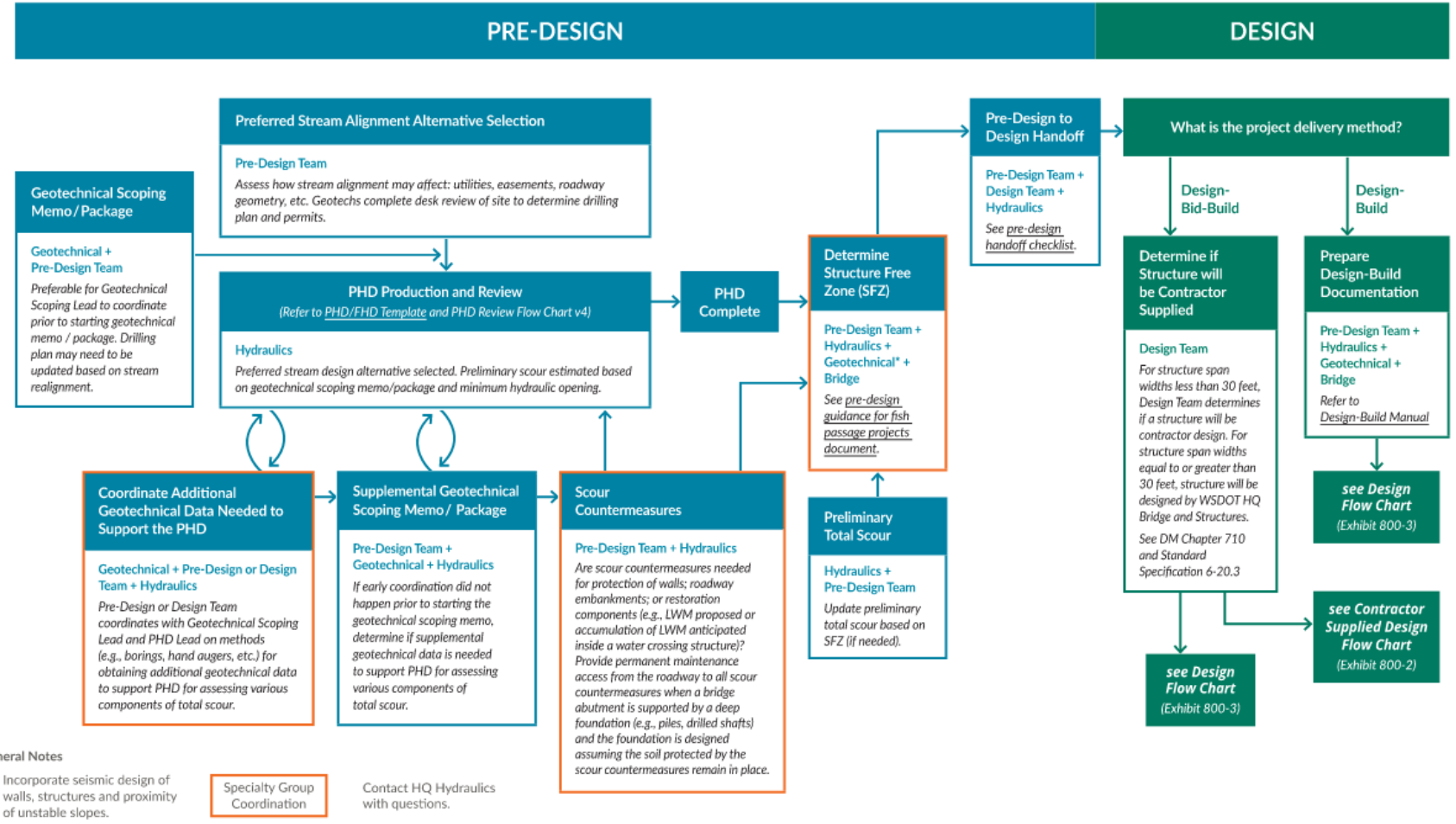
The project's required restoration, right of way, and environmental footprint may be impacted. For example, the access road will be planted with vegetation that can be infrequently mowed or is easily removed and restored following the scour countermeasure maintenance activities (see Roadside Manual 830.06(3)). To ensure impacts and other considerations associated with the maintenance access to the scour countermeasures are adequately addressed, coordinate with subject matter experts such as region hydraulics, region landscape architect, environmental coordinator, area maintenance, materials engineer, right of way and others when developing the maintenance access.

Roadside Manual 830

Criteria for Inclusion		
Alluvial Fan Influence[2]	No Sediment Concerns	1
(Chronic Environmental Deficiency)	Reoccurring Sedimentation	2
	Structure Within Deposition Area	3
Deep Foundations with Scour	~~Yes~~No	1~~3~~*
	Yes ~~No~~	3*~~1~~
Amount of Fill Under Pavement	< 5’	1
	5 -10’	2
	10 - 20’	3
	> 20’	4
Access Driving Surface	Native Soil and Vegetation	1

[2] Individual situations such as reoccurring alluvial deposition may be sole criteria justifying post construction access.

*~~Individual situations such as~~ Provide maintenance access from the roadway to all scour countermeasures when a bridge abutment is supported by a deep foundation (e.g., piles, drilled shafts) and the foundation is designed assuming the soil protected by the scour countermeasures remain in place. ~~deep foundations may be sole criteria justifying post construction access.~~See Design Manual 720.03(15) for more information.


PRE-DESIGN
DESIGN
Preferred Stream Alignment Alternative Selection
Pre-Design Team
Assess how stream alignment may affect: utilities, easements, roadway geometry, etc. Geotechs complete desk review of site to determine drilling plan and permits.
Geotechnical Scoping Memo / Package
Geotechnical + Pre-Design Team
Preferable for Geotechnical Scoping Lead to coordinate prior to starting geotechnical memo / package. Drilling plan may need to be updated based on stream realignment.
PHD Production and Review
(Refer to PHD/FHD Template and PHD Review Flow Chart v4)
Hydraulics
Preferred stream design alternative selected. Preliminary scour estimated based on geotechnical scoping memo/package and minimum hydraulic opening.
PHD Complete
Determine Structure Free Zone (SFZ)
Pre-Design Team + Hydraulics + Geotechnical* + Bridge
See pre-design guidance for fish passage projects document.
Pre-Design to Design Handoff
Pre-Design Team + Design Team + Hydraulics
See pre-design handoff checklist.
What is the project delivery method?
Design-Bid-Build
Design-Build
Determine if Structure will be Contractor Supplied
Design Team
For structure span widths less than 30 feet, Design Team determines if a structure will be contractor design. For structure span widths equal to or greater than 30 feet, structure will be designed by WSDOT HQ Bridge and Structures.
See DM Chapter 710 and Standard Specification 6-20.3
Prepare Design-Build Documentation
Pre-Design Team + Hydraulics + Geotechnical + Bridge
Refer to Design-Build Manual
see Design Flow Chart (Exhibit 800-3)
see Contractor Supplied Design Flow Chart (Exhibit 800-2)
see Design Flow Chart (Exhibit 800-3)
Coordinate Additional Geotechnical Data Needed to Support the PHD
Geotechnical + Pre-Design or Design Team + Hydraulics
Pre-Design or Design Team coordinates with Geotechnical Scoping Lead and PHD Lead on methods (e.g., borings, hand augers, etc.) for obtaining additional geotechnical data to support PHD for assessing various components of total scour.
Supplemental Geotechnical Scoping Memo / Package
Pre-Design Team + Geotechnical + Hydraulics
If early coordination did not happen prior to starting the geotechnical scoping memo, determine if supplemental geotechnical data is needed to support PHD for assessing various components of total scour.
Scour Countermeasures
Pre-Design Team + Hydraulics
Are scour countermeasures needed for protection of walls; roadway embankments; or restoration components (e.g., LWM proposed or accumulation of LWM anticipated inside a water crossing structure)? Provide permanent maintenance access from the roadway to all scour countermeasures when a bridge abutment is supported by a deep foundation (e.g., piles, drilled shafts) and the foundation is designed assuming the soil protected by the scour countermeasures remain in place.
Preliminary Total Scour
Hydraulics + Pre-Design Team
Update preliminary total scour based on SFZ (if needed).
General Notes
* Incorporate seismic design of walls, structures and proximity of unstable slopes.
Specialty Group Coordination
Contact HQ Hydraulics with questions.

Two Structures

No scour for bridge, and wall is designed for scour and is outside the structure free zone.

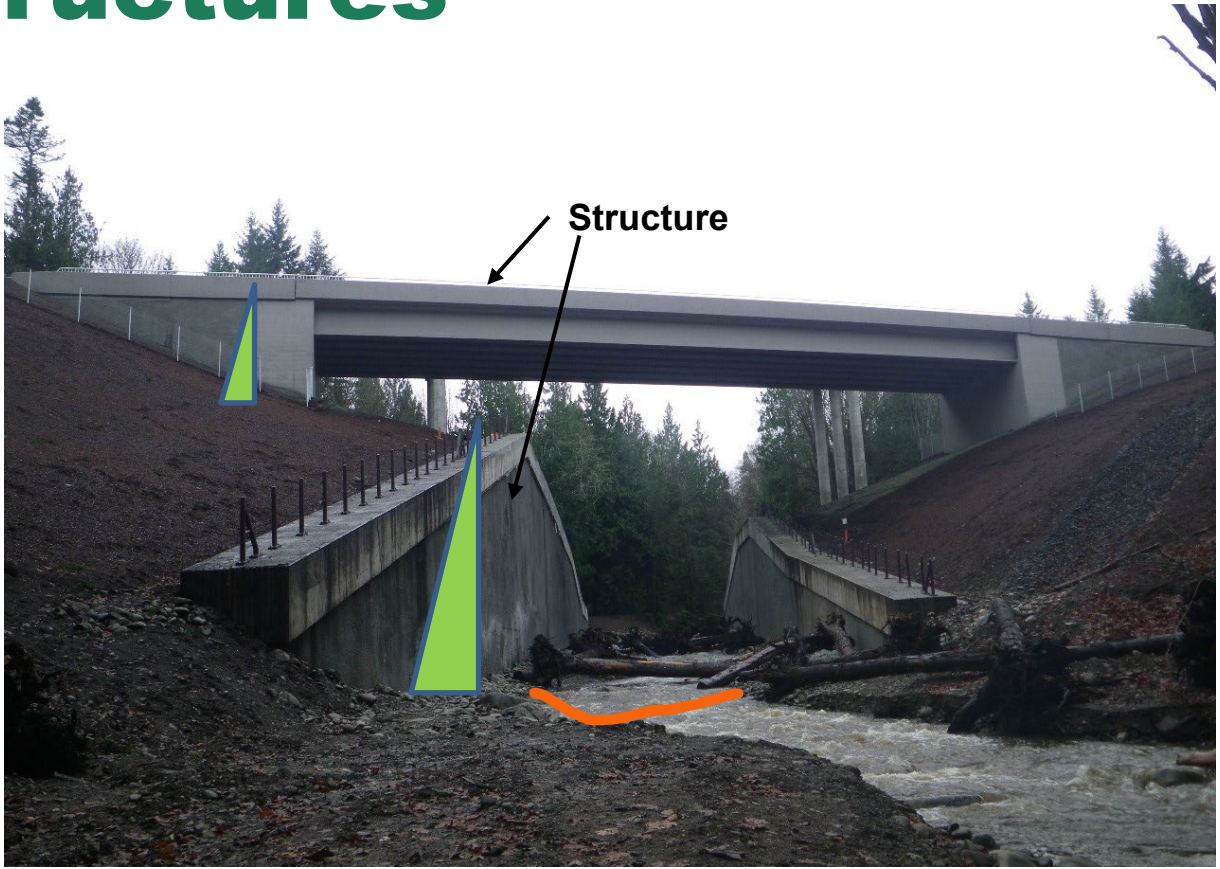
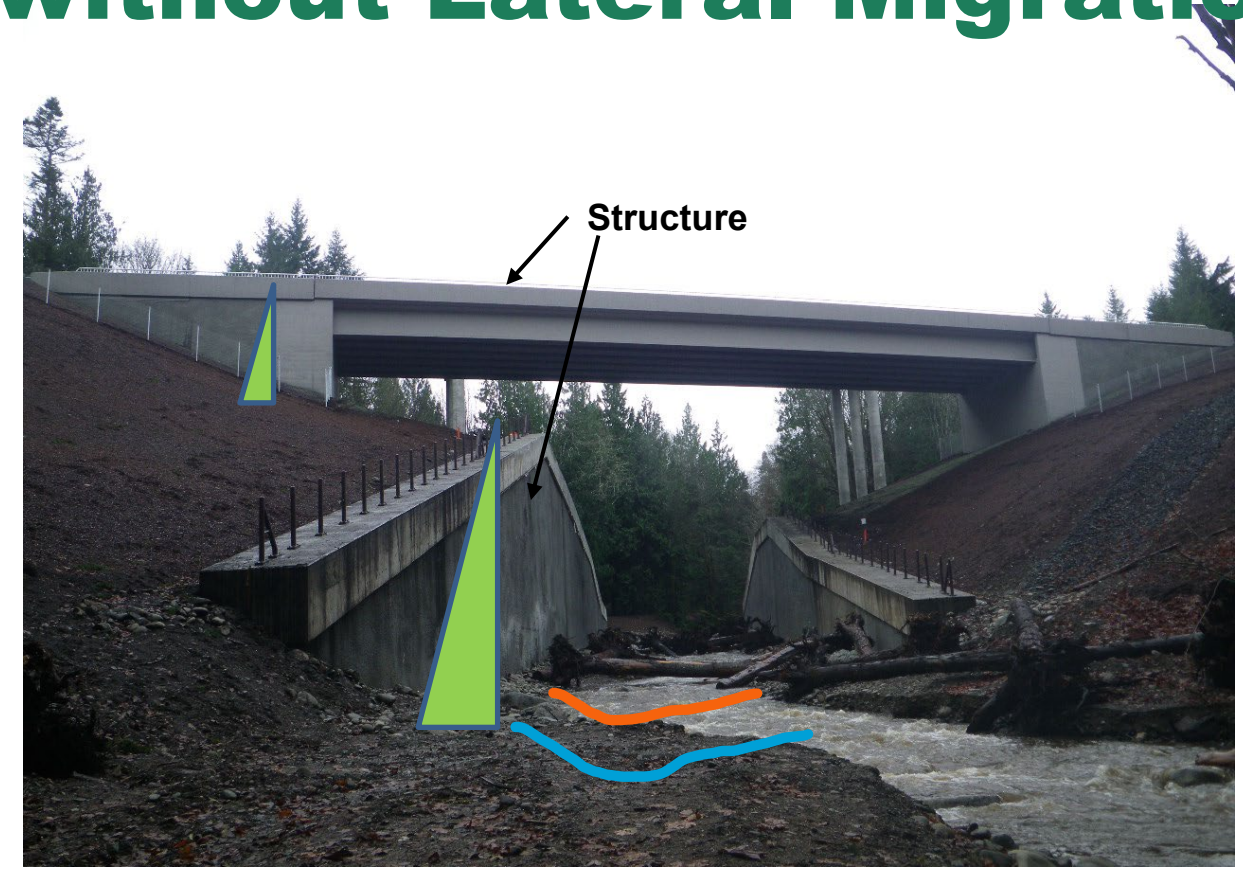


Image Source: WSDOT

Scour without Lateral Migration

Length of wall determined by performing an assessment to ensure the stability of the wall and structure element through the range of anticipated scour and lateral migration. Bottom of wall element or fascia 2 ft below total scour.



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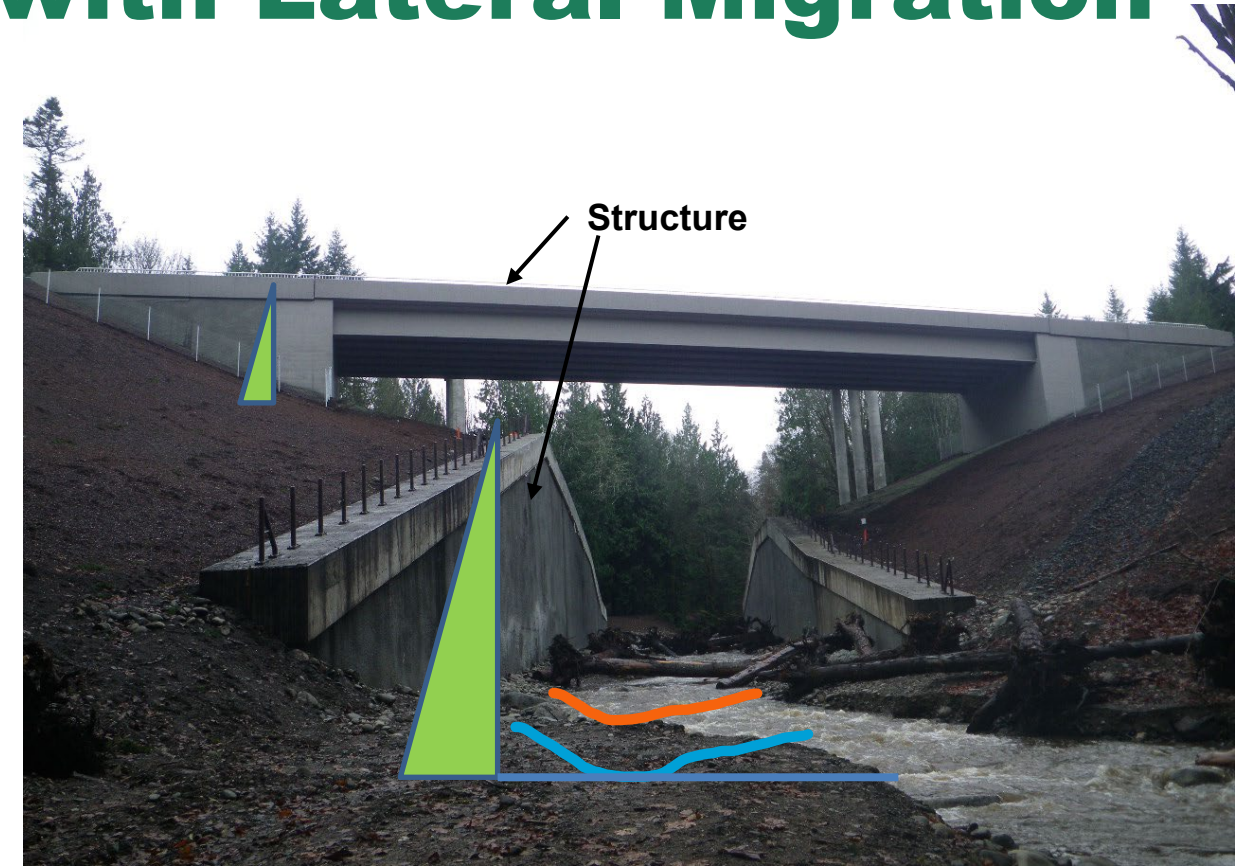
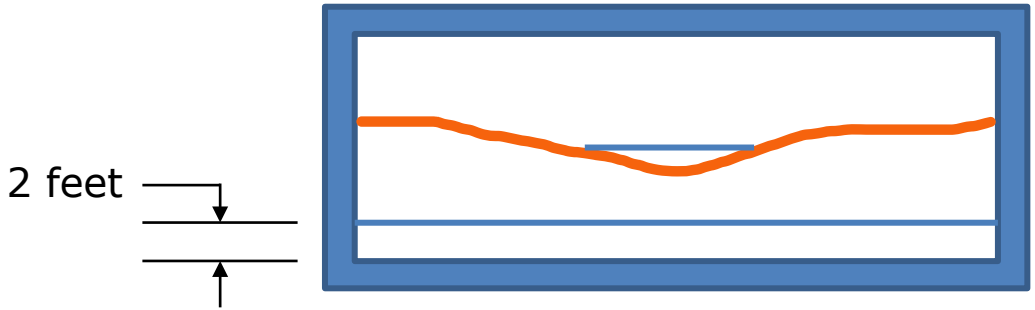


Image Source: WSDOT

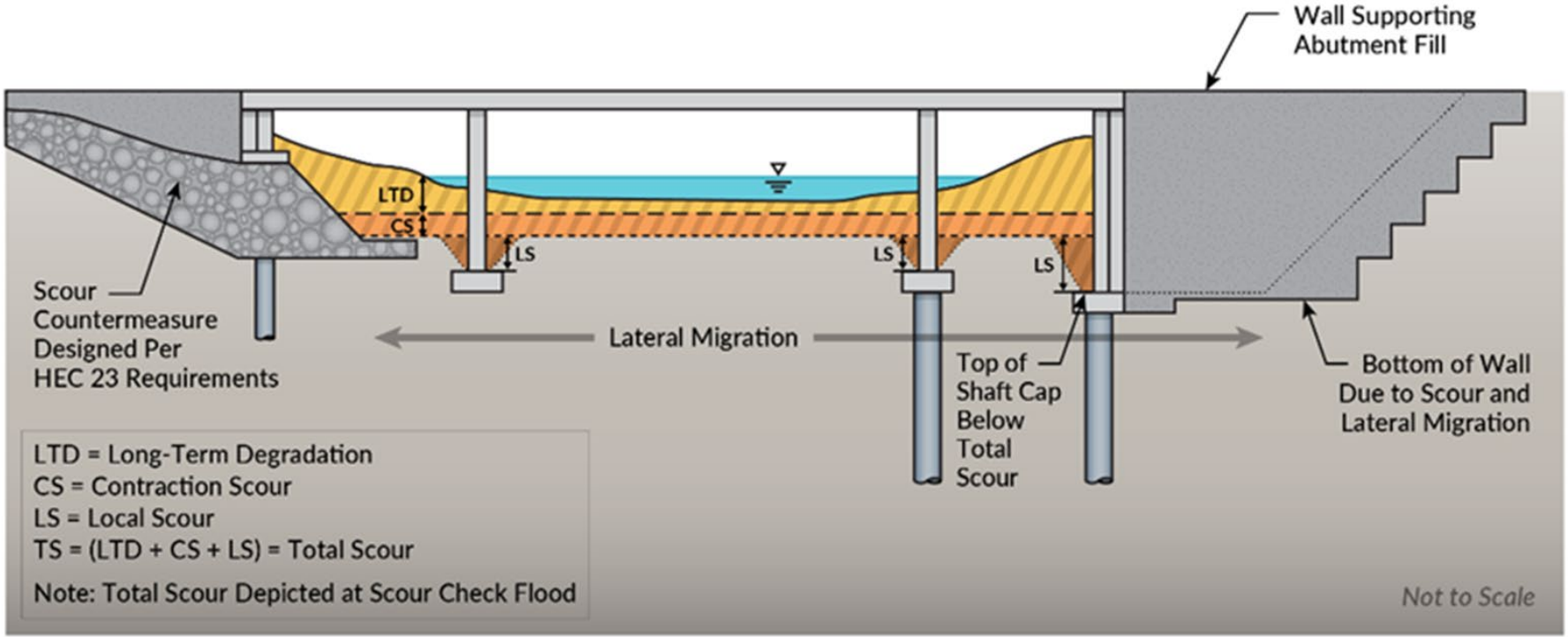
Scour for Buried Structures (BDM 7.1.7E)

- Three sided – follow guidance for bridges
- Four sided – top of bottom slab located a minimum of 2 ft below total scour at the scour design flood



- Wall lengths shall be determined by performing an assessment to ensure the stability of the wall and structure element through the range of anticipated scour and lateral migration.

Questions?



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