1

I405 Brickyard Sediment Sizing Discussion
Agenda

- Scour Elements
- Sediment Depth
- Structure Depth

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2

I405 Brickyard Sediment Sizing Discussion

Agenda

- Scour Elements
- Sediment Depth
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3

I405 Brickyard Sediment Sizing Discussion

Scour Elements

3.2 TOTAL SCOUR

Total scour at a highway crossing considers three primary components:

1. **Long-term degradation** of the river bed
2. **Contraction scour** at the bridge
3. **Local scour** at the piers or abutments

These three scour components are added to obtain the total scour at a pier or abutment. This assumes that each component occurs independent of the other. Considering the components additive adds some conservatism to the design. In addition, there are **other types of scour** that occur in specific situations as well as **lateral migration** of the stream that must be assessed when evaluating total scour at bridge piers and abutments.

Excerpt from HEC-18

- **Long term aggradation/degradation** – "Long-term bed elevation changes may be the natural trend of the stream or the result of some modification to the stream or watershed. The streambed may be aggrading, degrading, or in dynamic equilibrium above, below, or in the vicinity of the bridge crossing. […] These long-term changes are the result of modifications to the stream or watershed. Such changes may be the result of natural processes or human activities." – *HEC-18*
- **Contraction Scour – "**Contraction scour results from contraction (or constriction) of the flow, which results in removal of material from the bed across all or most of the channel width." – *HEC-18*
- **Local scour** – "Local scour involves removal of material from around piers, abutments, spurs, and embankments. It is caused by an acceleration of flow and resulting vortices induced by obstructions to the flow." – *HEC-18*
- **Other Types of Scour** – "Other scour conditions such as flow around a bend where the scour may be concentrated near the outside of the bend, scour resulting from stream planform characteristics, scour at confluences, or a variable downstream control can also influence the total scour in a bridge reach." – *HEC-18*
- **Lateral Migration** - Per Contract, risk of lateral migration at fish passage crossings is LOW and is excluded from this analysis

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4

I405 Brickyard Sediment Sizing Discussion
Scour Elements

- **Long term aggradation/degradation** - ranges from 0.0 to 0.2 for all sites. *Consistent with page 2 of the RFE scour analysis memo.*
- **Contraction Scour –** 0 for all sites. *Consistent with page 6 of the RFE scour analysis memo for all sites other than NFP, which went from 0.32 in the RFE phase to 0 currently*.
- **Local scour** – Local scour is 0 for all sites, due to the lack of bridge piers in the structures. *Consistent with the page 4 of the RFE*.
- **Bend scour** – During the RFE phase, bend scour was only estimated for Stream 25.0L due to the 90-degree bend the stream takes prior to entering the structure. In further coordination with WSDOT, bend scour is included in the total scour calculation at all sites; however, note that the bend scour at Stream 25.0L has gone from the original estimate of 3.25 ft to 0.7 ft, while other sites' bend scour is at or below 1.0 ft.

	Scour Design Flood					Scour Check Flood				
	Long Term Degradation (ft)	Contraction Scour (ft)	Local Scour (ft)	Bend Scour (ft)	**Total Scour (ft)**	Long Term Degradation (ft)	Contraction Scour (ft)	Local Scour (ft)	Bend Scour (ft)	**Total Scour (ft)**
NFPC	0.21	0.00	0.00	0.34	**0.55**	0.21	0.00	0.00	0.34	**0.55**
QB405	0.10	0.00	0.00	0.90	**1.00**	0.10	0.00	0.00	0.90	**1.00**
QB527	0.10	0.00	0.00	0.70	**0.80**	0.10	0.00	0.00	0.70	**0.80**
Juanita*	0.36	0.00	0.00	0.20	**0.56**	0.36	0.00	0.00	0.20	**0.56**
25L	0.00	0.00	0.00	0.70	**0.70**	0.00	0.00	0.00	0.70	**0.70**

*final sediment gradation still to be determined

Summary of scour components, all sites (Scour Design Flood + Scour Check Flood)

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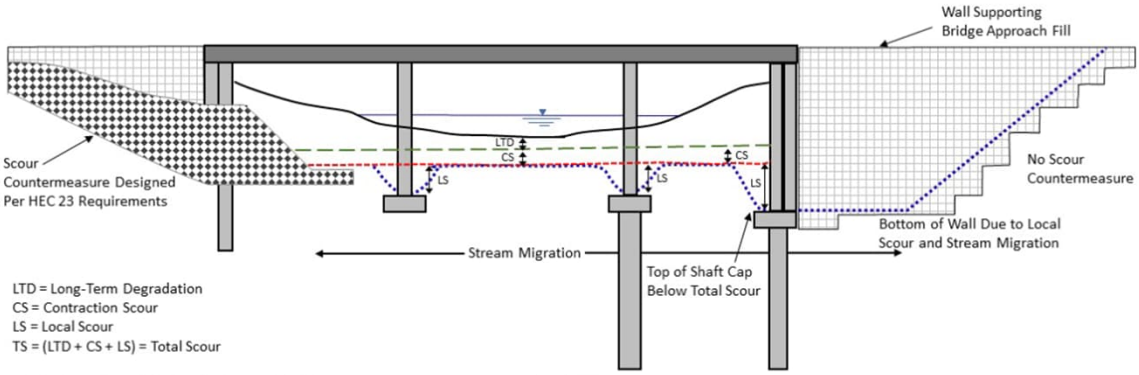
5

I405 Brickyard Sediment Sizing Discussion
Scour Elements

Figure 7-6 **Total Scour Components with Channel Migration and Abutments**



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6

I405 Brickyard Sediment Sizing Discussion

Scour Elements

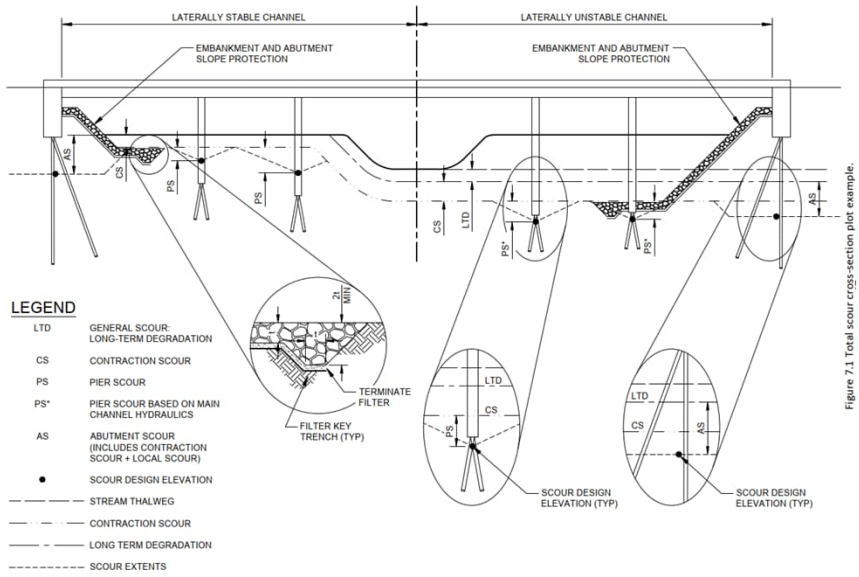

Figure 7.1 Total scour cross-section plot example.

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7

I405 Brickyard Sediment Sizing Discussion

Agenda

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8

I405 Brickyard Sediment Sizing Discussion

Sediment Depth – Inside Structure

Where a culvert or buried structure(s) is allowed and is proposed by the Design-Builder, the minimum thickness of streambed aggregate, between the interior structure bottom and the lowest point of the channel cross section, shall equal a minimum of the Total Scour from the Scour Check Flood plus 2 feet.

Page 2.30-13 from Chapter 2

		Scour Check Flood				
	Long Term Degradation (ft)	Contraction Scour (ft)	Local Scour (ft)	Bend Scour (ft)	**Total Scour (ft)**	**Total Scour (ft) + 2 ft**
NFPC	0.21	0.00	0.00	0.34	**0.55**	**2.55**
QB405	0.10	0.00	0.00	0.90	**1.00**	**3.00**
QB527	0.10	0.00	0.00	0.70	**0.80**	**2.80**
Juanita*	0.36	0.00	0.00	0.20	**0.56**	**2.56**
25L	0.5	0.00	0.00	0.20	**0.70**	**2.70**

*final sediment gradation still to be determined

AECOM Calculated Scour Values, Scour Check Flood

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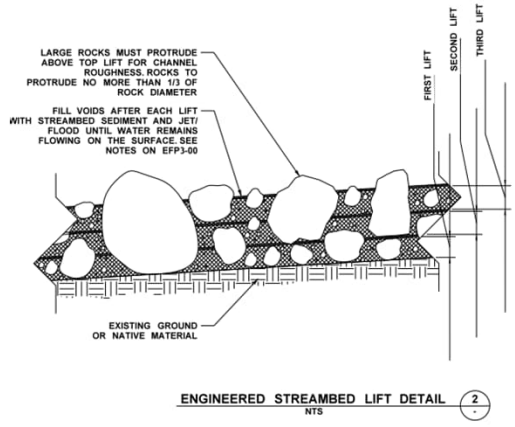
9

I405 Brickyard Sediment Sizing Discussion

Sediment Depth – Outside Structure



Excerpt from AECOM Construction Plans (NFPC, QB405, 25.0L, Juanita, QB527)

- The depth of streambed sediment outside of the structure is driven by the **maximum specified diameter of the material**.
- For **North Fork Perry Creek, Queensborough I-405, Queensborough at 527 and Juanita Creek**, the maximum sediment size is specified to be **28-inch**, the high end of the range for Type 2 Streambed Boulders that make up the gradation. For these creeks, the streambed must be constructed as shown in the engineered streambed lift detail and described in notes on our construction drawings where larger boulder and cobble pieces are placed in the stream at varying depths and filled with smaller material in lifts. To allow for placing the largest boulder size at varying depths, a **3 ft minimum depth is currently specified for the streambed sediment**.
- At **Stream 25.0L**, the maximum particle size for the streambed was estimated to be smaller than the other creeks, for the preliminary design. Upstream of the crossing the maximum depth of sediment was specified to be 8” and downstream of the crossing, 5”. Because of the smaller particle size, preliminary construction documents specified the depth of the streambed sediment to be a **depth of 2 ft**.

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10

I405 Brickyard Sediment Sizing Discussion

Sediment Depth – Outside Structure

- As a potential solution to reduce the depth of streambed material outside of the structure, AECOM could discuss a 100-foot-long transition from a 3-foot depth of material required inside the structure extents to a 2 ft depth with WSDOT. This would allow for the maximum gradation size of 28” to extend a maximum of 1/3 above the top lift as depicted in our engineered streambed lift detail.
- At **North Fork Perry, and Queensborough at I-405**, the potential reduction of streambed material is quite low, therefore, **we had not intended to pursue additional coordination this material reduction**.
- At **Queensborough at 527 and Juanita Creek**, the material reduction is higher. **We are prepared to discuss and further coordinate a material reduction**.

	Maximum Sediment Size (in)	Length of Regrade US (ft)	Length of Regrade DS (ft)	Bankfull (ft)	Potential Reduction Streambed Sediment (cyd)
NFPC	28	115	71	11.2	9
QB405	28	98	130	10.1	17
QB527	28	247	67	10.1	82
Juanita	28	178	130	12.0	203

Potential reduction in streambed material

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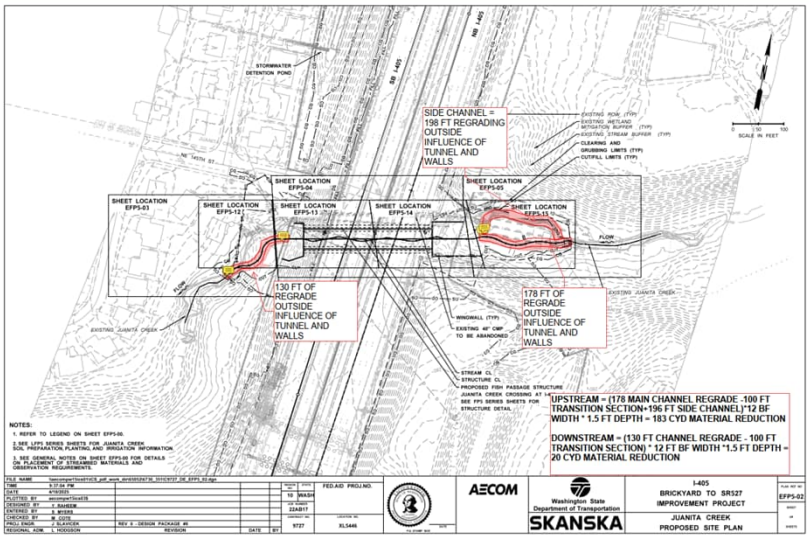
11

I405 Brickyard Sediment Sizing Discussion

Sediment Depth – Outside Structure



Potential reduction in streambed material – Juanita Creek

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12

I405 Brickyard Sediment Sizing Discussion

Agenda

- Scour Elements
- Sediment Depth
- Structure Depth

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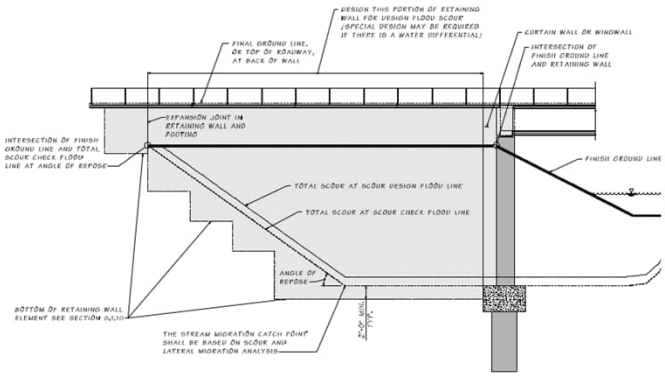
13

I405 Brickyard Sediment Sizing Discussion

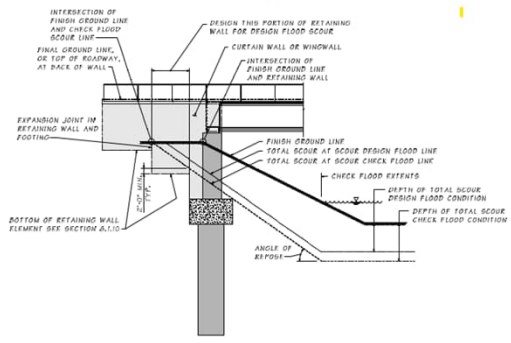
Structure Depth

Figure 8.1.10-2 Scour WITH Lateral Migration



WSDOT Bridge Design Manual, contract version

Figure 8.1.10-1 Scour without Lateral Migration



WSDOT Bridge Design Manual, contract version

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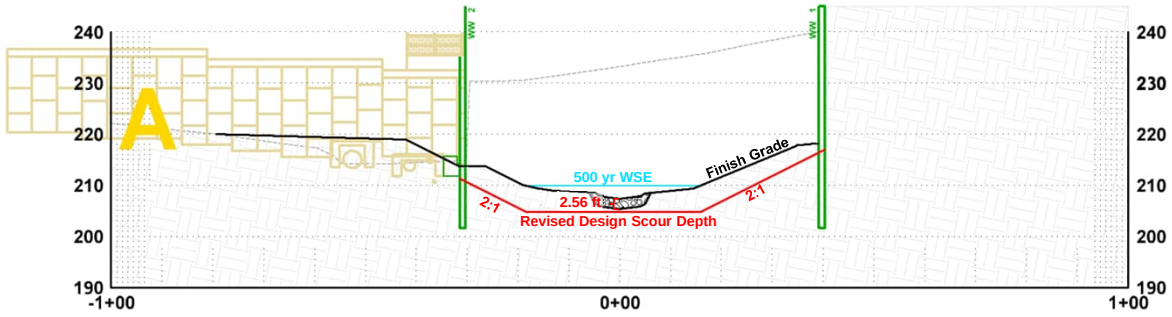
14

I405 Brickyard Sediment Sizing Discussion

Scour Prism



Note: Section Cut looking upstream at the structure

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15

I405 Brickyard - Juanita

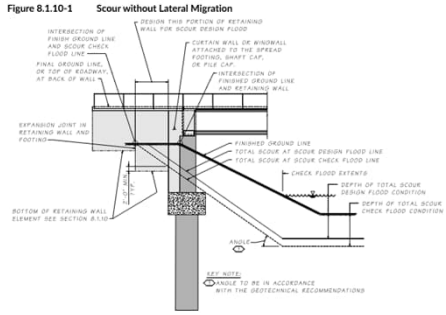
Skanska's Email Questions

Why was lateral migration included here? We fought so hard to not include lateral migration at the Sammamish River but seemed to accept it here. Please explain.

- The version of the FHD cited in the email was from before we received guidance to ignore lateral migration. This section of the FHD will be updated.
- Sonia closed RCSR comments on lateral migration on July 28, 2025

What was the calculation for scour depth including lateral migration versus not including lateral migration inside the tunnel?

- Scour depth within the tunnel is not affected by whether lateral migration is included
- Fig 8.1.10-1 Scour without Lateral Migration, shows bottom of scour prism = check flood extents; check flood reaches tunnel walls --> ignoring lateral migration doesn't impact sediment depth
- Final sediment gradation has not been finalized
- Assuming final D50 is approx. 4", scour depth is less than 1 foot
- Min. thickness streambed sediment = total scour + 2 ft



16

I405 Brickyard - Juanita

Skanska's Email Questions

How much did this affect wingwall design in AECOM's opinion?

- The scour depth directly impacted the fascia elevation, which impacted headwall design
- The final design of the wingwalls and headwall was completed before we received guidance to ignore lateral migration
- Significant effort would have been required to redesign wingwalls and headwall once guidance to ignore lateral migration was provided
- Structures team kept submittal schedule as it was uncertain when/if scour and lateral migration issue could be resolved.
- Today, it is uncertain if/how much wingwall depth could be decreased without requiring additional structural support for headwalls
- Extent and cost of downstream scour protection (buried riprap) would increase if wingwall depth decreased, since wingwalls provide scour protection for MSE wall

Would like AECOM to review the attached and included information and depict in AECOM's opinion how WSDOT influenced the design here on the lateral migration front. From our vantage point it was significant but need to hear AECOM's perspective.

- Did not impact depth of sediment in tunnel
- Did impact wingwall design; design may have been different if received guidance on lateral migration sooner
- Did impact buried riprap design; ignoring lateral migration allowed for a smaller footprint

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17

I405 Brickyard - Juanita

Structure Free Zone

Structure Free Zone (SFZ) – An imaginary, rectangular prism of infinite length both upstream and downstream, that is horizontally centered on the Bearing of Stream, parallel to the Bearing of Stream, and which represents the minimum boundary within which no part of the fish passage structure, including footings, shall be allowed unless meeting the criteria for an allowable exception in this paragraph. The SFZ is bounded on top and bottom by the CTE and the CBE respectively, with minimum interior width equal to the minimum SFZ Width specified in Table 2.30-B. Allowable exceptions are as follows: Fillets or arches may be inside the SFZ provided all three of the following are true: (1) the sum of all fillet areas (or arch encroachment areas) in a given cross section is less than 2 percent of the area calculated as the SFZ Width multiplied by the SFZ Height, (2) all fillet and arch encroachments are entirely above the elevation of the Hydraulic Design Flood plus the Hydraulic Design Flood Freeboard, and (3) all fillet and arch encroachments are entirely above the highest ground elevation within the limits of the Hydraulic Width plus Maintenance Clearance.

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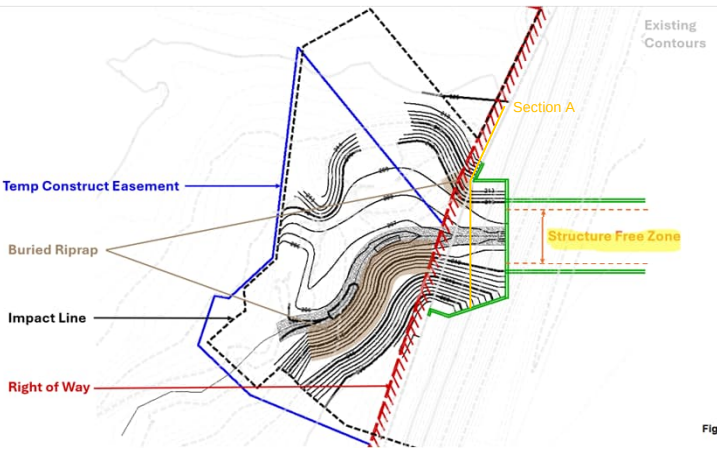
18

Structure Free Zone



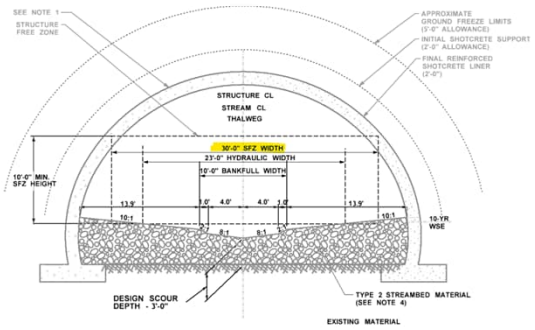


Figure 4-4: Minimum hydraulic opening illustration

- The 30-foot wide SFZ zone is defined as “infinitely long” however this buried riprap is not connecting to or protecting the new structure.
- It is protecting an existing MSE wall downstream of the structure.

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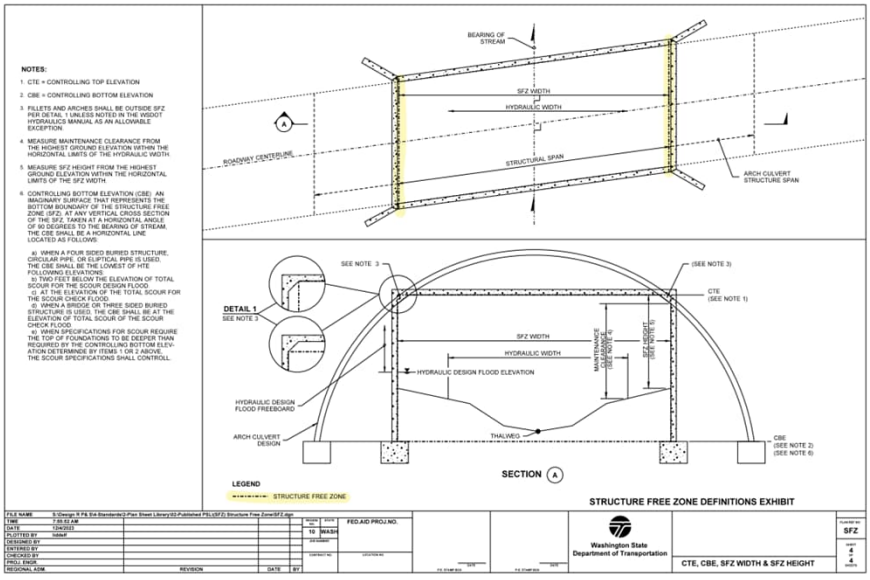
19

I405 Brickyard - Juanita

Structure Free Zone



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20