2.30 Water Crossings

2.30.1 *General*

The Design-Builder shall perform all Work necessary to design, document, obtain permits, and construct fish passage and restoration of natural drainage courses for the Project. At a minimum, elements of Work shall include the following:

- Design and construct new injunction-compliant fish passable stream channels and incorporate stream restoration elements in accordance with the Contract to eliminate the fish barriers at the following locations:

Fish Passage ID Number	SR	Milepost	Name
998602	405	21.94	Juanita Creek
993083	522	11.26	Par Creek
993104	405	25.00	Stream 25.0L
08.0070 A 0.25	405	26.46	North Fork Perry Creek
993084	527	2.76	Queensborough Creek
993109	405	26.90	Queensborough Creek

- The hydrology/peak flows developed by the City of Kirkland are to be used for the Juanita Creek crossing design (Appendix H).
- Realign Stream 25.0L channel through the new injunction-compliant fish passable structure connecting to the existing North Creek wetland to the east of the I-405 crossing, incorporate stream restoration elements in accordance with this Section, Appendix H, and the permit commitments for the Project.
- Prepare a Hydraulic Design Report for the Sammamish River bridge crossing.
- Prepare Specialty Report(s) in accordance with the WSDOT *Hydraulics Manual* and the Contract.
- Host multiple task force and other meetings, as required, to coordinate environmental documentation, permit acquisition, and the design with the WSDOT Engineer, WSDOT Headquarters and Region hydraulics, maintenance, and environmental staff; the Washington Department of Fish and Wildlife (WDFW); the Washington State Department of Ecology; and tribal, City of Bothell, and City of Kirkland representatives.

- Obtain acceptance from the Tribe(s), WDFW, and WSDOT on the entire permit application package before submitting the completed package to the U.S. Army Corps of Engineers.
- The U.S. Army Corps of Engineers considers comments from the Tribes before issuing the Section 404 permit. It is a material requirement of the Contract for the Design-Builder to consult with the Tribes and design and construct fish passages that are acceptable to the Tribes.

The restoration of natural drainage courses for fish-bearing streams identified by the injunction shall meet the requirements of this Section and the Project permits.

2.30.1.1 Forward Compatibility

All new fish passage structures shall be designed and constructed so they are Forward Compatible. Any headwalls or wingwalls shall be designed to allow for their removal to allow these structures to be extended for forward compatibility.

The following fish passage structures shall be Forward Compatible with the Forward Compatible Plans (Appendix M):

- Juanita Creek
- Par Creek
- Stream 25.0L
- Queensborough Creek at SR 527

The following fish passage structures shall be Forward Compatible with the Interim Forward Compatible Plans (Appendix M):

- North Fork Perry Creek
- Queensborough Creek at I-405

2.30.2 *Definitions*

The following definitions apply to the terms used in this Section. The Structure Free Zone Definitions Exhibit in this Section is hereby incorporated into and made part of the following definitions and shall be used in interpreting the meaning of these defined terms.

Affected Tribe(s) – Federally recognized Tribe(s) that have adjudicated off-reservation treaty rights and are affected by the Project. WSDOT will likely conduct government-to-government consultation on aspects of this Project with additional tribes. Affected Tribe(s) for this Project are Muckleshoot Indian Tribe.

Average 100-Year Stream Slope Under Structure (A100SS) – The slope calculated by dividing the difference in the 100-year stream flow Mean Recurrence Interval (MRI) water surface elevations, between the extreme ends of the measurement of Hydraulic Length (using the average water surface elevation across the width of the stream at each end of the Hydraulic Length), by the Hydraulic Length.

Bearing of Stream – The imaginary line that meets all of the following: (1) equidistant between the Structure walls (or abutments) to the left and right of the stream, (2) at the A100SS slope, and (3) at the average 100-year streamflow MRI water surface elevations used to determine the A100SS. This line is irrespective of the location of the thalweg or any sinuosity in the stream bed.

Controlling Bottom Elevation (CBE) – An imaginary surface that represents the bottom boundary of the Structure Free Zone (SFZ) as depicted in the SFZ Drawings in this Section. At any vertical cross section of the SFZ, taken at a horizontal angle of 90 degrees to the Bearing of Stream, the CBE shall be a horizontal line located as follows:

1. When any part of the structure or its foundation is located under the shadow of the Hydraulic Width when the shadow is orthogonally projected toward a horizontal plane below the SFZ, the CBE shall be the lowest of the following elevations:
    a. Two feet below the elevation of Total Scour for the Scour Design Flood.
    b. The elevation of Total Scour for the Scour Check Flood.

    Examples of structure or foundation elements located under the shadow of the Hydraulic Width include (1) the bottom slab of a four-sided buried structure, (2) the bottom arc of a circular or elliptical pipe, or (3) the footings of a bridge or three-sided buried structure for which the footings extend horizontally toward the center of the structure far enough to fall under the orthogonally projected shadow of the Hydraulic Width.
2. When no part of the structure or its foundation is located under the shadow of the Hydraulic Width when the shadow is orthogonally projected toward a horizontal plane below the SFZ, the CBE shall be at the elevation of Total Scour for the Scour Check Flood.
3. When Mandatory Standards for scour require the top of foundations to be deeper than allowed by the CBE determined by 1 and 2 above, the Mandatory Standards shall control.

Controlling Top Elevation (CTE) – An imaginary surface that represents the top boundary of the SFZ. At any given vertical cross section of the SFZ, taken perpendicular to the horizontal alignment of the Bearing of Stream, the CTE shall be the higher of the following elevations:

1. The elevation calculated by adding the SFZ Height specified in Table 2.30-B to the highest streambed ground elevation within the horizontal limits of the Hydraulic Width.
2. The elevation calculated by adding the Hydraulic Design Flood Freeboard to the elevation of the Hydraulic Design Flood.

Design Methodology – Design Methodology has the meaning used in the WSDOT *Hydraulics Manual.*

Draft Preliminary Hydraulic Design Report (Draft PHD) – A draft PHD provided by WSDOT as a Reference Document.

Fish Passage Operationally Complete Date – The date, determined by the WSDOT Engineer, that all construction necessary to begin the fish passage warranty period has been completed. This construction includes all Work of any kind below the 100-year streamflow MRI water surface elevation, including diversion of the stream to its final location. Each fish passage shall have its own Fish Passage Operationally Complete Date.

Hydraulic Design Flood – The discharge and associated probability of exceedance that reflects the desired level of service for a roadway/bridge crossing a watercourse and/or floodplain. This flood drives the capacity design (i.e., size and configuration) of the waterway opening. The approach roadway or bridge should not be inundated by the water levels produced by this flood.

Hydraulic Design Flood Freeboard – The minimum dimension so designated in Table 2.30-B. It shall be measured as shown on the Structure Free Zone Definitions Exhibit.

Hydraulic Length – See Table 2.30-B for the maximum allowable Hydraulic Length. Determine the actual Hydraulic Length by following steps 1 through 10 in the order listed.

1. Establish the following in plan view.
2. Show all structural elements of the crossing, including but not limited to bridges, culverts, walls, wing walls, and scour countermeasures. Include all projections including footings, fascias, parapets, and caps. Include all the preceding without regard to the material from which it is made.
3. Eliminate the portion of the elements in step 2 that is lower than the CBE.
4. Eliminate the portion of the following elements that extends more than 10 feet outside of the SFZ Width: wingwalls, scour countermeasures, and walls whose sole purpose is the prevention of scour.
5. Show the Bearing of Stream.
6. Eliminate the portion of the following items whose centerline is at a horizontal skew angle of 60 degrees or greater from the Bearing of Stream: wing walls, scour countermeasures, and walls whose sole purpose is the prevention of scour. Measure the skew angle of upstream elements in the opposite direction of downstream elements, as shown in the SFZ drawings in this Section.
7. Draw perpendicular offsets from the Bearing of Stream to all structural elements remaining after step 6.
8. Identify the point on the Bearing of Stream that is attached to the horizontal offset which is furthest upstream. Identify this as point X.
9. Identify the point on the Bearing of Stream that is attached to the horizontal offset which is furthest downstream. Identify this as point Y.

10. The Hydraulic Length is the horizontal distance between points X and Y from steps 8 and 9. (See also SFZ Definition Exhibit in this Section)

Hydraulic Width – The minimum width perpendicular to the creek beneath the proposed structure that is necessary to convey stream design flow and allow for stream processes. The minimum acceptable Hydraulic Width shall be as indicated in Table 2.30-B. The Design-Builder shall not use the Hydraulic Width to determine the width of the SFZ.

Injunction – United States of America, et al., v. State of Washington, et al. Permanent Injunction Regarding Culvert Correction, United States District Court, Western District of Washington at Seattle, No. C70-9213 Subproceeding No. 01-1 (Culverts), ordered March 29, 2013.

Lateral Migration (Hydraulic) – The natural geomorphological process that involves the movement of an alluvial channel across its floodplain, but not to the extent it widens the floodplain by eroding the slopes or hillsides above the floodplain.

Lateral Migration (Structural) – Lateral migration of the stream channel in a manner that cuts into side slopes or hillsides above the floodplain to the extent that threatens the integrity of the roadway or structure or the loading conditions which are defined in the structural design code as a result of erosion or scour of the side slopes.

Maintenance Clearance – At any given cross section of the SFZ, Maintenance Clearance shall be measured from the highest ground elevation within the horizontal limits of the Hydraulic Width. The minimum Maintenance Clearance shall be as shown in Table 2.30-B.

Projects of Similar Scope and Complexity – Projects that have the following characteristics:

- Construction of the fish passage(s) was completed within the last 5 years.
- The fish passage(s) was of similar size and cost.
- The fish passage included stream restoration components.
- Design and construction of stream crossings followed the *Washington Department of Fish and Wildlife Water Crossing Design Guidelines* (2013) for Stream Simulation or Bridge Design Methodologies.
- The fish passage structure(s) passed under a facility (such as a roadway) that had a width over the stream and height above the stream equal to or greater than those required on this Contract.
- Construction was delivered utilizing bid-build, design-build, General Contractor/Construction Manager (GC/CM), or an emergency contract.

Regrade, Channel Regrade, Natural Channel Regrade, Natural Regrade – Each of these terms shall be understood to mean the natural process of a stream to establish an equilibrium slope by means of aggradation or degradation over time.

Regrade is expected to effect changes to the stream, its bed and banks, and may include at a minimum, incision, deposition, debris loading, downstream flooding, lateral shifting, and bank erosion. The Regrade process will be set in motion by removal of the existing barrier to fish passage and is intended to allow the stream to return to its natural channel by processes that are unencumbered by the design and construction of a new fish passable stream crossing. Furthermore, the Regrade process may extend to areas outside of State right of way, although the degree, extent, and timing are unpredictable. To determine whether or not a structure is required to be designed to Regrade, refer to Table 2.30-B.

Scour Check Flood – The discharge (flood) resulting from storm, storm surge, tide, or some combination thereof having a flow rate in excess of the scour design flood, but in no case a discharge (flood) with a recurrence interval exceeding the greater of the typically used 500-year or the 2080 100- year projected discharge (flood) (if it has been deemed practicable to do so), that creates the deepest scour at structure foundations.

Scour Design Flood – The discharge (flood) resulting from storm, storm surge, tide, or some combination thereof having a flow rate equal to or less than the 100- year discharge (flood) or the 2080 100-year projected discharge (flood) (if it has been deemed practicable to do so), that creates the deepest scour at structure foundations.

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.

SFZ Height – At any given cross section of the SFZ, SFZ Height is the vertical dimension which, when added to the highest ground elevation within the horizontal limits of the Hydraulic Width, determines the CTE at that cross-section. See Table 2.30-B for the minimum allowable SFZ Height. For structures designed for wildlife connectivity, the SFZ Height shown in Table 2.30-B includes all SFZ Height required for wildlife connectivity.

SFZ Width – A horizontal distance measured perpendicular to the Bearing of Stream, between the nearest surface of the structure to the left of the stream and the nearest surface of the Structure to the right of the stream, at all points between

the CBE and the CTE. See Table 2.30-B for the minimum allowable SFZ Width. For structures designed for wildlife connectivity, the SFZ Width shown in Table 2.30-B includes all SFZ Width required for wildlife connectivity.

Total Scour – the meaning as defined by FHWA *Hydraulic Engineering Circular Number 18* (HEC-18) evaluated at the Scour Design Flood and Scour Check Flood.

2.30.3 *Mandatory Standards*

The following is a list of Mandatory Standards that shall be followed for all design and construction related to this Section as referenced in Section 2.2, *Mandatory Standards*.

If the requirements of a Mandatory Standard, programmatic agreement, or permit issued for the Project conflict, then the provisions within the Project-specific permit shall take precedence.

1. WSDOT *Hydraulics Manual* M 23-03 (Appendix D)
2. United States of America, et al., v. State of Washington, et al. Permanent Injunction Regarding Culvert Correction, United States District Court, Western District of Washington at Seattle, No. C70-9213 Subproceeding No. 01-1 (Culverts), ordered March 29, 2013 (Appendix H)
3. *Washington Department of Fish and Wildlife Water Crossing Design Guidelines* (Appendix H)
4. *FHWA Evaluating Scour at Bridges* (HEC-18) (Appendix H)
5. *FHWA Stream Stability at Highway Structures* (HEC-20) (Appendix H)
6. *FHWA Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance Volume 1 and 2* (HEC-23) (Appendix H)
7. *U.S. Army Corps of Engineers, Hydraulic Design of Flood Control Channels* (EM 1110-2-1601) (Appendix H)
8. WSDOT *Temporary Erosion and Sediment Control Manual* M 3109 (Appendix D)
9. WSDOT *Geotechnical Design Manual* (GDM) M 46-03 (Appendix D)
10. WSDOT *Design Manual* M 22-01 (Appendix D)
11. WSDOT *Bridge & Structures Office Design Memoranda* (Appendix D)
12. WSDOT *Bridge Design Manual LRFD* M 23-50 (Appendix D)
13. WSDOT *Maintenance Manual* M 51-01 (Appendix D)
14. WSDOT *Plans Preparation Manual* M 22-31 (Appendix D)
15. WSDOT *Construction Manual* M 41-01 (Appendix D)
16. WSDOT *Materials Manual* M 46-01 (Appendix D)

17. WSDOT *Environmental Manual* M 31-11 (Appendix D)
18. WSDOT Special Provision regarding temporary stream diversion, either 7-06.SA1.FR7 or 7-06.SA2.FR7, whichever is appropriate for each culvert site. (Appendix B)
19. WSDOT *Guidance on Wildlife Habitat Structures in Wetland Mitigation Sites* (Appendix H)
20. WSDOT Wildlife Habitat Connectivity Considerations in Fish Barrier correction projects (Appendix H) or https://wsdot.wa.gov/engineering-standards/environmental-guidance/wildlife
21. Standard Specifications M41-10 (Appendix B)

2.30.3.1 Approved Design Reference Documents

The WSDOT *Hydraulics Manual* is the primary stream design manual. The following reference documents are accepted by WSDOT for use on the Project. If any conflicts occur in design criteria, the WSDOT *Hydraulics Manual* supersedes the design reference documents listed below.

1. *Washington State Aquatic Habitat Guidelines Program, Integrated Streambank Protection Guidelines* (Appendix H)
2. *Washington State Aquatic Habitat Guidelines Program, Stream Habitat Restoration Guidelines* (Final April 2012) https://wdfw.wa.gov/sites/default/files/publications/01374/wdfw01374.pdf (Appendix H)
3. *Washington Department of Fish and Wildlife Fish Passage Inventory, Assessment, and Prioritization Manual, 2019* (Appendix H)
4. *U.S. Department of Agriculture Forest Service, Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (Appendix H)

2.30.4 *Personnel Requirements*

2.30.4.1 Stream Design Engineer

Stream Design Engineer Job Duties

The Stream Design Engineer (SDE) shall lead the day-to-day effort for designing the stream and its habitat and provide design support for National Environmental Policy Act/State Environmental Policy Act and permitting. This design Work shall include specialty design Work including compliance with the Injunction, hydraulic design, hydrology, stream grading, stream restoration with large woody material (LWM) placement with and without anchor system design, stream restoration with natural habitat diversity features, stream or river embankment stabilization, flood risk analysis, geomorphology, zero rise analysis, scour analysis, streambed material design, and backwater analysis. The channel design and other elements as described above shall be designed by or under the direct

supervision of the SDE. The SDE shall be the Engineer of Record (EOR) for these specialty designs and shall be onsite for all streambed construction and restoration work. The SDE shall be responsible for all hydraulic and hydrology Work revisions for the duration of the Contract and on-site supervision and direction of stream restoration Work.

Stream Design Engineer Required Minimum Qualifications:

- Shall have a minimum of 5 years of experience in the Work listed above.
- Shall have completed the design, within the last 5 years, of a minimum of three successful fish passage Projects of Similar Scope and Complexity. To be considered successful, the fish passage structures shall have been in service and remained fish passable per the requirements in the *WDFW Water Crossing Design Guidelines*, without modification.
- Shall be a Professional Engineer.
- Before the Stream Design Engineer starts any Work on this Project, they shall:
  - Complete all modules of the current WSDOT Fish Passage and Stream Restoration Training and obtain certification.
  - Participate by watching the FHWA *Bridge Scour Regional Workshop*.
  - Attend and receive a passing score on NHI Courses 135046 and 13048, *Stream Stability and Scour at Highway Bridges* and *Bridge Scour and Stream Instability Countermeasures*, respectively.

SDE Desirable Qualifications

Experience includes direct field construction support that facilitated successful implementation and modification on a Project of Similar Scope and Complexity.

2.30.4.2 Stream Team

This Section is intentionally omitted.

2.30.4.3 Peer Review Team

This Section is intentionally omitted.

2.30.5 *Design Requirements*

2.30.5.1 Flood Risk Analysis

All projects, regardless of whether they are in a FEMA Special Flood Hazard Area (SFHA), shall assess potential impacts of the project on effected lands and communicate those changes to WSDOT and the local community.

The assessment shall be documented through the use of the WSDOT Flood Risk Assessment (FRA) Template Resource File located on the WSDOT website:

https://wsdot.wa.gov/engineering-standards/project-management-training/training/hydraulics-hydrology-training

The Design-Builder shall complete FRAs for each crossing during the FHD process.

If the project is within a FEMA regulatory floodway or the local jurisdiction code requires a no/zero-rise assessment, then a no/zero-rise analysis and certification is required per FEMA's Procedures for "No-Rise" Certification For Proposed Development in the Regulatory Floodway (Appendix H). If a no/zero-rise cannot be achieved, then a Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR), or both, shall be required per the FEMA National Flood Insurance Program (NFIP).

If the project changes the effective FEMA SFHA or base flood elevations (BFEs) above FEMA or local jurisdiction requirements, then a Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR), or both, shall be required.

The Design-Builder shall work with the Floodplain Administrator (FPA) or Chief Executive Officer (CEO) of the community, or both, to determine whether a CLOMR or LOMR is necessary based on the Design-Builder's final design. If a CLOMR or LOMR is determined to be necessary, the Design-Builder shall complete hydraulic modeling and design to satisfy the requirements and documentation required by the FPA/CEO.

2.30.5.2 Injunction-Compliant Fish Passable Structures

Fish passable structures shall be in accordance with Section 2.13, *Bridges and Structures,* and this Section.

Galvanizing and zinc coatings shall not be used below the water surface elevation based on the 100-year MRI.

Where aluminum pipe or pipe arch is in contact with cement concrete or controlled density fill, two coats of paint shall be applied in accordance with the Mandatory Standards.

The injunction-compliant fish-passable structure(s) and channel design(s) shall comply with the stream simulation methodology as described in the Mandatory Standards and this Section. Site-specific structure requirements that have been previously negotiated with WDFW and tribal representatives may exceed basic stream simulation methodology. These requirements are documented in the JARPA.

Construction of fish passable structures and support activities shall be included in the Environmental Compliance Plan.

2.30.5.2.1 *Certain Structure and Channel Design Characteristics*

The Design-Builder shall comply with the requirements of Table 2.30-B. Except as otherwise specified, where a conflict exists between Table 2.30-B and another Contract requirement, the requirements of Table 2.30-B shall take precedence.

No part of a foundation shall be inside the SFZ. When specifications for scour require foundations to be deeper than allowed by the Controlling Bottom Elevation of the SFZ, the scour specifications shall control. When specifications for scour require foundations to be set back farther away from the stream than allowed by the SFZ Width, the scour specifications shall control.

Cells in Table 2.30-B that are blank shall be interpreted as meaning that particular characteristic is not stipulated in Table 2.30-B but the Design-Builder shall address that particular characteristic as required elsewhere in the Contract.

Table 2.30-B – Structure and Channel Design Characteristics

Notes	Characteristic	I-405 MP 26.90	SR 527 MP 2.76	I-405 MP 26.46	I-405 MP 25.00	SR 522 MP 11.26	I-405 MP 21.94
		Structure Characteristics					
	Fish Passage and Diversion Screening Inventory site ID #	993109	993084	08.0070 A 0.25	993104	993083	998602
	Bankfull Width (minimum, feet)	10.1	10.1	11.2	9.5	N/A	12.0
	Hydraulic Width (minimum, feet)	20	20	21	19	20	23
4	SFZ Width (minimum, feet)	30	30	30	19	25	30
	Hydraulic Length (maximum, feet)	438.6	250.0	370.1	228.9	322.7	345.9
	Hydraulic Design Flood Freeboard (minimum, feet)	3	3	3	3	3	3
5	Maintenance Clearance (minimum, feet)	10	10	6	10	12	10
4	SFZ Height (minimum, feet)	10	10	6	10	12	10
3	Structure type required	3-sided structure	3-sided structure	3-sided structure	3-sided structure	3-sided structure	3-sided structure

Notes	Characteristic	I-405 MP 26.90	SR 527 MP 2.76	I-405 MP 26.46	I-405 MP 25.00	SR 522 MP 11.26	I-405 MP 21.94
	If a buried structure is used, is it required to be bottomless, such as a three-sided structure?	Yes	Yes	Yes	Yes	Yes	Yes
		Channel Characteristics					
2	Channel morphology	Riffle-Pool	Riffle-Pool	Riffle-Pool	Riffle-Pool and Step-Pool	Riffle-Pool	Riffle-Pool
1	Is the design required to allow, or prohibit, the channel to naturally Regrade?	Allow	Allow	Allow	Allow	Allow	Allow
	Is the risk of Lateral Migration (Structural) low?	Yes	Yes	Yes	Yes	Yes	Yes
3	Proposed bed material	20% (max.) coarser than existing	20% (max.) coarser than existing	20% (max.) coarser than existing	20% (max.) coarser than existing	20% (max.) coarser than existing	20% (max.) coarser than existing
4	Minimum number of Key Piece LWM	24	19	22	47	15	39
	LWM Key Piece Dimensions (minimum)	18 in Diameter at midpoint 30 ft long	18 in Diameter at midpoint 30 ft long	18 in Diameter at midpoint 30 ft long	18 in Diameter at midpoint 30 ft long	18 in Diameter at midpoint 3ft long	18 in Diameter at midpoint 30 ft long
	LWM Mobile Wood Count	50	27	35	69	0	46
	LWM Mobile Wood Dimensions	18 inch Diameter at midpoint 15 ft long	18 inch Diameter at midpoint 15 ft long	12 in Diameter at midpoint 15 ft long	12 inch Diameter at midpoint 15 ft long	N/A	12 inch Diameter at midpoint 15 ft long
	Coarse Band Spacing						
	Meander Bar Spacing	4 times BFW	4 times BFW	4 times BFW	4 times BFW	N/A	4 times BFW
	LWM allowed within the hydraulic length of structure	Yes	Yes	Yes	Yes	Yes	Yes

Notes:

1. If the design is required to allow for Natural Channel Regrading, the structure and channel shall be designed to meet all Contract requirements for both of the following cases: (1) the stream profile before Natural Regrade occurs (i.e., at initial completion of construction of this Contract), and (2) the stream profile after Natural Regrade occurs. "All Contract requirements" includes, but is not limited to, the Structural Characteristics in Table 2.30-B.
2. Morphology and streambed gradation shall support the final design proposed by the Design-Builder.
3. Refer to Section 2.13, *Bridges and Structures* for allowable bridge and buried structure types.
4. For the crossings in this table required to provide for wildlife connectivity, if any, the dimensions shown for SFZ Width and SFZ Height have been increased sufficiently to provide for wildlife connectivity. The Design-Builder need not increase, and shall not decrease, either dimension.
5. The minimum maintenance clearance at Par Creek shall be measured from the thalweg.

Due to downstream impacts, the Par Creek fish passage under SR 522 at MP 11.26 cannot meet the requirement for a minimum of 3 feet of freeboard. The Design-Builder shall provide calculations that show the Par Creek fish passage will achieve the minimum 3 feet of freeboard in the absence of the backwater created by the King County culvert at the trail crossing.

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.

The stream channel profile and section shall transition to match the upstream and downstream channel profile and section within the impact limits.

The Sammamish River "not low" lateral migration determination discussed in the Sammamish River Migration Risk Assessment (Appendix H) shall apply to the new structures within the river flow limits defined by the 500-year flood elevation.

2.30.5.3 Streambed Aggregates

Streambed cobbles, sediment, and boulder sizing for the design of fish passable structures shall be in accordance with the WSDOT Hydraulics Manual and the Standard Specifications.

The combined streambed material shall have a D_{50} that is within 20 percent of the reference reach D_{50}, unless otherwise approved through the WSDOT Engineer by the WSDOT State Hydraulics Engineer.

2.30.5.3.1 *Streambed Sediment*

The table located in Standard Specifications, Section 9-03.11(1), is replaced with the following:

Streambed Sediment	
Sieve Size	Percent Passing
2 ½″	99-100
2″	85-100
1″	50-82
½″	28-68
No. 40	10-20
No. 200	5-10

All percentages are by weight.

2.30.5.3.2 *Fine Band Material*

The following new Section is added to Section 9-03.11 of the Standard Specifications:

9-03.11(5) Fine Band Material

If the Project requires the use of coarse bands, fine bands shall also be included in accordance with the WSDOT *Hydraulics Manual*. Fine band material shall conform to the following gradation.

Fine Band Material	
Sieve Size	Percent Passing
No. 4	99-100
No. 10	46-86
No. 40	26-40
No. 200	10-20

All percentages are by weight.

2.30.5.3.3 *Streambed Sand*

The following new Section is added to Section 9-03.11 of the Standard Specifications.

9-03.11(6) Streambed Sand

Streambed sand shall conform to the following gradation.

Streambed Sand	
Sieve Size	Percent Passing
½″	99-100
3/8″	90-100
No. 4	90 Max
No. 8	32-67
No. 200	2-7

All percentages are by weight.

2.30.5.4 Large Woody Material

Materials for LWM and LWM anchoring shall follow the guidance in Chapter 10 of the WSDOT *Hydraulics Manual*. The Design Builder shall use native conifers for LWM with branches and limbs intact. Metal components of the LWM anchors shall not be galvanized.

2.30.5.5 Stream Restoration

The Design-Builder shall design stream restoration through any new reaches or reaches disturbed by construction, and shall include, at a minimum, the following details:

- Streambed gravel and scour protection at the fish passable structures.
- Streambed gravel, LWM, and scour protection through the new stream channel sections.
- Horizontal alignment following natural stream radii and meanders following the Mandatory Standards.
- Vertical profile, incorporating complexities including, at a minimum, riffles, pools, and pool-riffles in accordance with the Mandatory Standards.
- Anchors for buoyant features such as LWM and large plantings to address forces that occur in the 100-year recurrent storm event.
- LWM and other habitat features used for stream restoration shall be included in the hydraulic model and the FHD submittal.

The Design-Builder shall use SRH 2D hydraulic modeling software for pre-Project and post-Project condition, including all habitat and stream restoration components.

Hydraulic model results used in the preparation of Draft Preliminary Hydraulic Design Reports are available in Appendix H. The Design-Builder is responsible for the accuracy of content and completeness of all hydraulic model results used in the design and construction of the Project. WSDOT does not warrant the accuracy of the hydraulic models provided in the Draft PHDs or elsewhere in the Request for Proposal. The Design-Builder shall verify the accuracy of the hydraulic models, regardless of the source.

The Design-Builder shall coordinate the design and construction of this Work considering fish windows, temporary erosion control, and plant establishment to minimize potential impacts to flood risk in adjacent properties upstream and downstream of any new reaches or reaches disturbed by construction. Refer to Sections 2.8, *Environmental* and 2.15, *Roadside Restoration,* for additional requirements.

The Design-Builder shall provide As Built survey data, including the stream construction and gradation of the streambed gravel and other materials with the SDE's certification that the As Built condition meets the design plans. The

Design-Builder shall include this documentation as part of the As Built Hydraulic Design Report(s) for Fish Barrier Removal.

2.30.5.5.1 *Habitat Features*

At a minimum, the Design-Builder shall install a number of key LWM pieces that are consistent with the WSDOT *Hydraulics Manual* and the requirements in this Section. Key LWM pieces with root wads attached shall be placed as described in the PHD. Each key piece will have a minimum length of 20 feet, a diameter at breast height of 18 to 24 inches, and a minimum volume of 1.3 cubic yards. Key LWM pieces shall be engineered to be stable at the 100-year discharge design flow event and shall be self-ballasting. Non-key LWM vary in dimensions and may or may not have root wads. Refer to Table 2.30-B for non-key LWM specifics.

The Design-Builder shall host and lead meetings to coordinate the final design layout of LWM with the WSDOT Engineer, WSDOT Headquarters Hydraulics, WSDOT Headquarters Fish Passage Biologist, WDFW, and Tribal representatives.

A minimum number of key LWM pieces listed in Table 2.30-B shall be actively engaged within stream flows so that the LWM functions to create habitat such as pools, low velocity refugia, cover, and capture sediment or grade control.

The Design-Builder shall incorporate channel complexity elements inside the new structure(s). The channel complexity shall be accomplished through the use of habitat features that encourage the formation of pools and help maintain the channel shape. Final LWM and habitat features under and adjacent to structures shall be approved by the WSDOT State Hydraulics Engineer.

2.30.5.5.2 *Channel Design*

The Design-Builder shall design the channel top of bank, stream stabilization features, and woody vegetation in accordance with the Mandatory Standards, this Section, and the Contract. The channel bank shall be stabilized using bioengineering techniques and LWM to ensure that the channel will not erode into private property, WSDOT structures, or Utilities that are in the vicinity.

Channel design shall avoid new armoring with rock. New armoring with rock may require mitigation and the Design-Builder shall be responsible for mitigation as a result of armoring the channel.

2.30.5.5.3 *Site Work*

The Design-Builder shall grade the area between the new fish passable structures, stream channels, and adjacent floodplain areas to prevent fish stranding. This Work shall include a continuous low-flow channel thalweg.

2.30.5.6 Scour Analysis

The Design-Builder shall perform a scour analysis that includes all habitat and stream restoration components in accordance with the Mandatory Standards and this Section. The analysis shall include the risk of Lateral Migration (Structural), potential for long-term degradation, and evaluation of Total Scour (long-term degradation, contraction scour, and local scour). The scour analysis shall include all elements of Total Scour as defined by HEC-18. Use the FHWA Hydraulic Toolbox for calculating various scour components (except long-term degradation). If a scour countermeasure is proposed by the Design-Builder, it shall be designed and constructed in accordance with the most recent version of HEC-23. The Design-Builder shall evaluate all flows up to the scour design flood and scour check flood to determine the deepest depth of scour for each scour component. The Design-Builder shall document the flow that causes the maximum depth of scour for each scour component for the scour design flood and scour check flood. The scour elevation for the structure crossing the water shall be based on Total Scour without scour countermeasures in place but shall include final wood and complexity features. The scour analyses supporting all structures, including walls and the roadway embankment, are considered part of the Specialty Report(s).

The scour analysis shall include, but is not limited to, the following variables and evaluations:

- The Design-Builder shall make a determination of the presence of erodible soils in the streambed, (1) between the stream channel and the proposed scour protection locations and (2) between the stream channel and the proposed structure locations. This can be accomplished through geotechnical bore logs, hand augers, or other approved soil investigation methods. This information is used to help determine the extents of vertical and lateral scour limits.
- The Design-Builder shall perform an evaluation of historical/existing conditions versus expected future conditions with the proposed stream design. Primarily, the analysis shall evaluate what the expected Lateral Migration (Structural) will be in the future, based on how the stream may adjust over the life of the structure. This evaluation shall include the determination of whether the site is aggrading or degrading and how that will change or acclimate in future conditions as the stream develops its natural equilibrium gradient.
- The Design-Builder shall perform an evaluation of the dynamic physical process of stream sinuosity and channel meandering capabilities in consideration of the proposed design. The information from this evaluation is used to predict the stream’s migration pattern based on the proposed design.
- The Design-Builder shall perform an evaluation of the existing and proposed hydraulic models and evaluate the potential effects of the shear stress and velocity of the stream in consideration of the proposed design

and how it relates to the expected future condition of the stream. This information is used to predict the stream's scour and bank erosion potential with the proposed design and assess changes in stream characteristics between existing and proposed conditions.

- The Design-Builder shall locate, design and construct any required scour countermeasures (e.g., rock revetment) or scour protection wall to protect various WSDOT infrastructure components against total scour, including Lateral Migration (Structural). This includes an assessment of where the stream may move laterally (e.g., determining angles of attack) and vertically in relation to the various WSDOT infrastructure components. The Design-Builder shall evaluate and design these measures for the proposed grading portions of the stream as well as upstream and downstream grading connections to the existing stream. All scour countermeasures shall be outside the SFZ.

The Design Builder shall document the scour analysis in the Hydraulics Design Report Template located on the WSDOT website: https://wsdot.wa.gov/engineering-standards/project-management-training/training/hydraulics-hydrology-training.

2.30.6 *Construction Requirements*

2.30.6.1 General

The Design-Builder shall coordinate the design and construction of this Work considering fish windows, temporary erosion control, and plant establishment to minimize potential impacts to flood risk in adjacent properties upstream and downstream of any new reaches or reaches disturbed by construction. Refer to Sections 2.8, *Environmental*, and 2.15, *Roadside Restoration*, for additional requirements.

Notice of the Work shall be given to the WSDOT Engineer 14 Calendar Days prior to each element of Work beginning.

2.30.6.2 Streambed Preconstruction Conference

A streambed preconstruction conference shall be held not less than 5 Calendar Days prior, and not more than 14 Calendar Days prior, to the Design-Builder beginning streambed construction to discuss the goals and methods of streambed construction, which shall include the construction procedures, personnel, and equipment to be used.

Those attending shall include:

1. Design-Builder: The superintendent, on-site supervisor, Quality Assurance (QA), foreman, the Environmental Compliance Lead, the SDE, and any other personnel that will have on-site responsibility for streambed material, LWM, habitat features, and coarse and fine band placement.

2. WSDOT: The WSDOT Engineer, Headquarters Hydraulics, and key inspection personnel.
3. Representatives from interested permitting agencies and Affected Tribes shall be invited by WSDOT.

Notice of the meeting date shall be given to the WSDOT Engineer 14 Calendar Days prior to this meeting taking place.

2.30.6.3 Construction Oversight

The Design-Builder shall coordinate with the WSDOT Engineer for oversight during all temporary stream diversions, fish exclusion and handling, and stream restoration and streambed construction Work. This includes but is not limited to mixing and placement of streambed materials and installation of habitat features (key LWM pieces). The SDE shall be onsite for all streambed construction and restoration work.

Notice of the Work shall be given to the WSDOT Engineer 14 Calendar Days prior to each element of Work beginning.

2.30.6.4 Protection and Restoration of Sensitive Resource Areas

All Design-Builder, Subcontractor, and supplier employees that will perform Work on the Project Site shall have environmental training in accordance with Section 2.8, *Environmental*, and shall be aware that no access or impacts are permitted beyond the high visibility construction fencing.

2.30.6.5 Placing Aggregate in Streambed

Streambed Material shall be placed in the prepared channel excavation to the lines and grades shown on the RFC plans and in such a way as to prevent material segregation. Streambed material shall be placed in lifts no thicker than 12 inches. Streambed material in its final location shall be a well graded mix.

Placement of streambed material shall be constructed to ensure that stream low flow rate of 30 gallons per minute or 95 percent exceedance interval, or as determined through the WSDOT Engineer by the WSDOT State Hydraulics Engineer, is conveyed above each streambed material lift. The Design-Builder shall apply water and 1-inch depth of streambed sand to each lift to facilitate filling the interstitial voids of the streambed materials. The voids are satisfactorily filled when water equivalent to the low flow rate of the stream does not go subsurface and there is no perceivable difference in the low flow rate from upstream of the Project limits to downstream of the Project limits. The Design-Builder shall apply water at the low flow rate to the stream channel for visual acceptance by the WSDOT Engineer. Water shall be free from contaminates, chlorination, and any additive that has a risk to fish and other ecological life.

The entire process of placing all streambed material, all streambed sand, and watering in each layer shall be a Hold Point, with attendance by QA and a representative from WSDOT Hydraulics being mandatory.

The Design-Builder shall minimize the potential for increased turbidity in accordance with State water quality standards and Contract requirements. Any accumulated sediments shall be removed. The stream bypass shall remain in place until flows that are introduced to the new channel section at a rate equal to the existing stream flows comply with State water quality standards at the downstream end of the new channel. If no water is flowing in the creek at the time of the bypass removal, the Design-Builder shall apply water to the stream channel for visual acceptance by the WSDOT Engineer.

Temporary erosion and sediment control measures for stabilizing stream bank and slopes shall be installed prior to reintroducing water into the stream channel.

2.30.6.5.1 *Streambed Test Section*

The Design-Builder shall supply and mix the proposed streambed material into a test section no smaller than low flow channel width, the depth as shown in the plans, and a minimum length of 20 feet or three times the low flow channel width, whichever is larger. The test section shall demonstrate the Design-Builder mixing methods of the streambed material into a uniform mix and placement of streambed sand including the layering and watering in methods as described in this Section. The process of constructing the streambed test section shall be a Hold Point for each crossing, with attendance by QA and a representative from WSDOT Hydraulics being mandatory.

2.30.6.6 Re-watering the Stream Channel

Re-watering the stream channel shall be a Hold Point for each crossing. Prior to re-watering the stream channel, the WSDOT Engineer will meet with QA to conduct final inspection of As Built condition for channel shape, profile, and structure.

2.30.6.7 Abandonment of Existing Culvert Structures

Abandonment or removal of existing culverts shall be in accordance with Divisions 2 and 7 of the Standard Specifications. Any existing pipe or other structure that will be abandoned and will remain under any pavement shall be filled using methods and materials that ensure the pipe or structure is completely filled in a supported, non-void condition, prevent the pipe or structure from being a structural element and shall prevent future erosion of the fill material. The Design-Builder shall include the abandonment details, including any abandon-in-place filling methods and materials, in the Released for Construction (RFC) and As Built documents.

2.30.6.8 Streamflow Mean Recurrence Interval Monitoring and Reporting

For each fish passage in the contract, the Design-Builder shall develop and implement a discreet Streamflow MRI Monitoring Plan for use during the fish passage Warranty period(s). The plan shall:

1. Meet the standard of care in the field of professional hydraulic engineering.
2. Calculate the theoretical 25-year streamflow MRI in cubic feet per second (CFS). Provide a detailed explanation of the means and methods used to calculate the theoretical 25-year streamflow MRI. Identify sources of data and calculations.
3. Determine actual streamflow MRI (in years and CFS) of each fish passage, on an hourly basis, for the duration of the fish passage Warranty. Provide a detailed explanation of the means and methods that will be used to measure and document stage and streamflow. Streamflow measurement procedures shall follow Washington Department of Ecology Standard Operating Procedure EAP056, Version 1.3 Publication No. 18-03-203 (March 2018) available at https://apps.ecology.wa.gov/publications/SummaryPages/1803203.html, or approved equal.
4. The plan shall identify stage and flow measuring equipment to be used and how data will be gathered and stored. Provide a detailed explanation of how the field data will be converted and used to determine the actual streamflow MRI in years and CFS.
5. The plan shall provide that the Design-Builder submit a monthly report as described below.

The Design-Builder shall submit the Streamflow MRI Monitoring Plan as a Type 2 Working Drawing to the WSDOT Engineer for Review and Comment at least 60 Calendar Days prior to the first Fish Passage Operationally Complete Date. The Design-Builder shall:

1. Implement the approved plan prior to each Fish Passage Operationally Complete Date, respectively.
2. Implement the approved plan throughout the duration of each fish passage Warranty period.

Once per month for every calendar month during which a fish passage Warranty is in effect, the Design-Builder shall submit a report showing, for each fish passage on the Project that is in fish passage Warranty during that month, for every hour in that month, the hourly streamflow in CFS and the hourly streamflow MRI in years. Each monthly report shall be submitted not later than 28 Calendar Days after the end of the month that is the subject of the report. The report shall present the data in a manner that enables the reader to easily discern. The report shall include:

- The contract number

- The name of the stream and the WDFW's Fish Passage and Diversion Screening Inventory (FPDSI) database identification number.
- The year, month, date, hour, actual hourly CFS and hourly streamflow MRI.
- The year, month, date, hour and actual streamflow MRI for each and every time the actual streamflow MRI exceeds the theoretical 25-year streamflow MRI.

The format of the report shall be modified as required by the WSDOT State Hydraulics Engineer to meet the above requirements. When requested by the WSDOT State Hydraulics Engineer, the Design-Builder shall supplement a report with source data and calculations.

The report shall be emailed to the WSDOT Engineer and copied to heilmaj@wsdot.wa.gov with the subject line containing "Streamflow MRI," the contract number, month, and year the report addresses.

2.30.7 *Submittals*

All submittals shall be in electronic format. All pages of all submittals shall be in searchable PDF format. In addition to the searchable PDF format, submittals that include hidden information not visible in PDF format (such as calculations in the cells of a spreadsheet or drawing) shall be submitted in their original format (such as Word, Excel, InRoads) to facilitate WSDOT's full review and understanding of the basis and assumptions for calculations and other output.

2.30.7.1 Design Plans

The Design-Builder shall prepare stream plan sheets for the Project in accordance with Section 2.28, *Quality Management Plan,* and the WSDOT *Plans Preparation Manual.* The stream plan sheets at a minimum shall have a plan, profile, cross section(s) through crossing structure, upstream cross section(s) and downstream cross section(s) that provide enough information to layout and construct the details of the Work including elevation information.

2.30.7.2 Design Calculations

The Design-Builder shall complete all calculations necessary for the design of the Work and include these calculations in the applicable Specialty Report(s). The Design-Builder shall prepare calculations in accordance with the Mandatory Standards to support the design shown in the plans and details.

The Specialty Report(s) shall describe the approach taken and the order of the calculations, including sections on the methodologies used (appropriateness and accuracy requirements), design decisions made, and resultant summaries. The calculations shall include electronic copies of the input and output from the supporting computer programs, spreadsheets, hand calculations, exhibits, and sketches. At a minimum, the calculations shall also include the following items:

2.30.7.2.1 *Design Calculations*

- Word and PDF file
- Excel files for figures in text
  - Long Profile and Long Term Degradation
  - Pebble counts and sediment mobility calculations
  - Reference reach XS comparison figure
  - Others
- GIS Data
  - Field visit data including bankfull width, pebble count and reference reach locations
  - Basin boundary
- Appendix Files
  - LWM calculator
  - Sediment size and mobility
  - Manning's n roughness
  - Excel files for model results at cross sections and profiles
  - Scour calculations FHWA Toolbox Report and .hyd files
  - Scour countermeasure calculations FHWA Toolbox Report and .hyd files
- Field Visit Photos (including ones not included in the PHD)
- Hydrology
  - MGSFlood Model if used
  - Any other hydrology models
- Hydraulic Model
  - SRH-2D Model
    - All Input and Output files.
    - Remove extraneous or working files/simulations. Coverages and simulations should be clearly named.
    - Coverages used for Results reporting including observation lines and 1D Centerline and XS.
- Special Design Features – The Design-Builder shall include a brief narrative of design decisions or revisions, electronic files from design calculations, and the reasons for them
- Design decision summaries
- Technical Specifications necessary for construction
- Drainage maps showing the fish passage structures and any other illustrations necessary to support and clarify the design calculations. Electronic design drawings and maps, when printed, shall be on 11- by 17-inch pages

- Channel section design
- Streambed material sizing
- Scour analysis
- Scour analysis for streambed gravel sizing around LWM structures, if applicable
- LWM buoyancy and anchoring calculations, if applicable

2.30.7.3 Specialty Reports

The Design-Builder shall submit all Specialty Reports: the PHD, Draft FHD, FHD, As Built FHD, and Flood Risk Assessment Technical Memorandum, No-Rise or Floodplain Analysis for Special Flood Hazard areas, when required. These shall be developed and completed by the Design-Builder following the *Hydraulic Design Report Template* (Appendix H). The Design-Builder shall include all elements of the design, and shall validate, refine, and detail the documentation to demonstrate that the design meets the requirements of this Section, complies with the Injunction and the WSDOT *Hydraulics Manual*, and fulfills the Project's permits (Appendix P) and Commitments List (Appendix C). Each stream shall have a separate Specialty Report. The Design-Builder shall allow 14 Calendar days for the WSDOT Engineer's Review and Comment for each Specialty Report listed in this Section.

2.30.7.3.1 *Preliminary Hydraulic Design Report*

For each fish passage being replaced, the Design-Builder shall submit a PHD to WSDOT for Review and Comment. After WSDOT's comments are addressed by the Design-Builder, WSDOT will submit the PHD to the Tribe(s) and WDFW for Review and Comment. The Design-Builder shall address the comments of the Tribe(s) and WDFW.

Draft PHDs for the fish passages in this Contract are found in Appendix H. These Draft PHDs are Reference Documents and shall not be construed to provide Contract requirements or guarantees beyond the extent to which they are explicitly referenced to do so in the Technical Requirements (TRs).

2.30.7.3.2 *Draft Final Hydraulic Design Report(s)*

For each fish passage structure including the Sammamish River bridge crossing, the Design-Builder shall submit a Draft FHD with the conceptual Stream Design Plans including all conceptual wall layouts to support the WSDOT Engineer's Review and Comment of the stream design drawings for the Project. The Draft FHD shall follow the template provided in Appendix H and shall include habitat features and Total Scour. The Draft FHD shall clearly document the results of the site assessment and Lateral Migration (Structural) analysis as defined the in this Section. Comment resolution of the WSDOT Engineer's review of the Draft FHD and model results shall be complete prior to the submittal of the JARPA (or equivalent application).

2.30.7.3.3 *Final Hydraulic Design Report(s)*

The Design-Builder shall assemble the FHD to reflect the final RFC hydraulic design. The FHD shall bear the Professional Engineering stamp and signature of the SDE.

2.30.7.3.4 *As Built Hydraulic Design Report(s)*

The Design-Builder shall submit an As Built Hydraulic Design Report(s) to document any changes to the design that deviate from the FHD. The Design-Builder shall provide As Built ground survey data, including the stream construction cross section and thalweg alignment and profile, and gradation of the streambed gravel and other materials with the SDE's certification that the As Built condition meets the design plans. The Design-Builder shall include this documentation as part of the As Built Hydraulic Design Report(s) for Fish Barrier Removal.

2.30.7.3.5 *Flood Risk Analysis Technical Memorandum*

For all fish passage projects with earthwork activity within a FEMA Special Flood Hazard Area, a No-Rise or Floodplain analysis shall be performed and documented in showing changes in floodplain elevations and the locations where the Project creates a changed condition in the hydraulics of features that convey the 100-year floodwaters.

2.30.7.4 Vacant

This Section intentionally omitted.

2.30.7.5 Design Revisions During Construction

Calculations for revisions made during construction shall be incorporated into the As Built Hydraulic Design Report when construction is complete.

When new plan sheets or revised sheets are required as part of a construction revision, the revisions shall be made in accordance with Section 2.28, *Quality Management Plan*, and are subject to WSDOT Review and Comment.

2.30.7.6 List of Submittals

At a minimum, Project submittals shall include the following for each fish passage:

- A PHD for any crossing that does not use the WSDOT-provided Draft Preliminary Hydraulic Design Report. This report shall include all sections and appendices that were completed in the WSDOT-provided Draft PHD (Appendix H). Each stream shall have a separate report.
    - Draft hydraulic model submitted for review with the Preliminary Design Submittal

- Hydraulics calculations submitted with the corresponding Stream Design Plans
- Draft Final Hydraulic Design Report(s)
- Final Hydraulic Design Report(s)
- As Built Final Hydraulic Design Report(s)
- Flood Risk Analysis Technical Memorandum
- No-Rise or Floodplain Analysis for Special Flood Hazard Areas
- Streamflow MRI Monitoring Plan
- Monthly Streamflow Monitoring Reports
- The Design-Builder fish passable structure inspection reports and documentation of any repairs during the Warranty period

2.30.8 *Fish Passage Warranty and Monitoring Streamflow MRI*

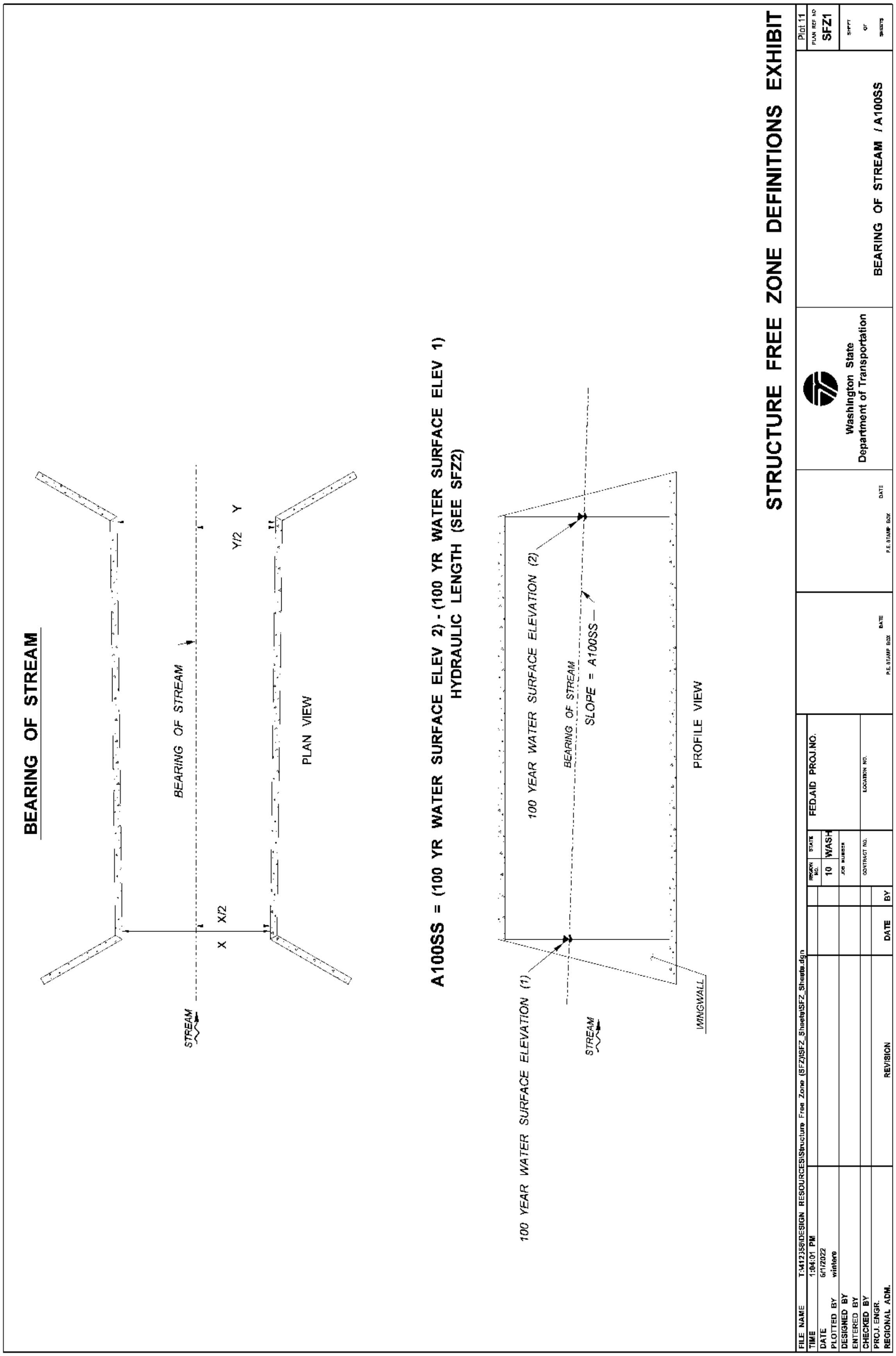
For warranties regarding fish passages, see *General Provisions* 1-05.16.

2.30.9 *Fish Passage Indemnity*

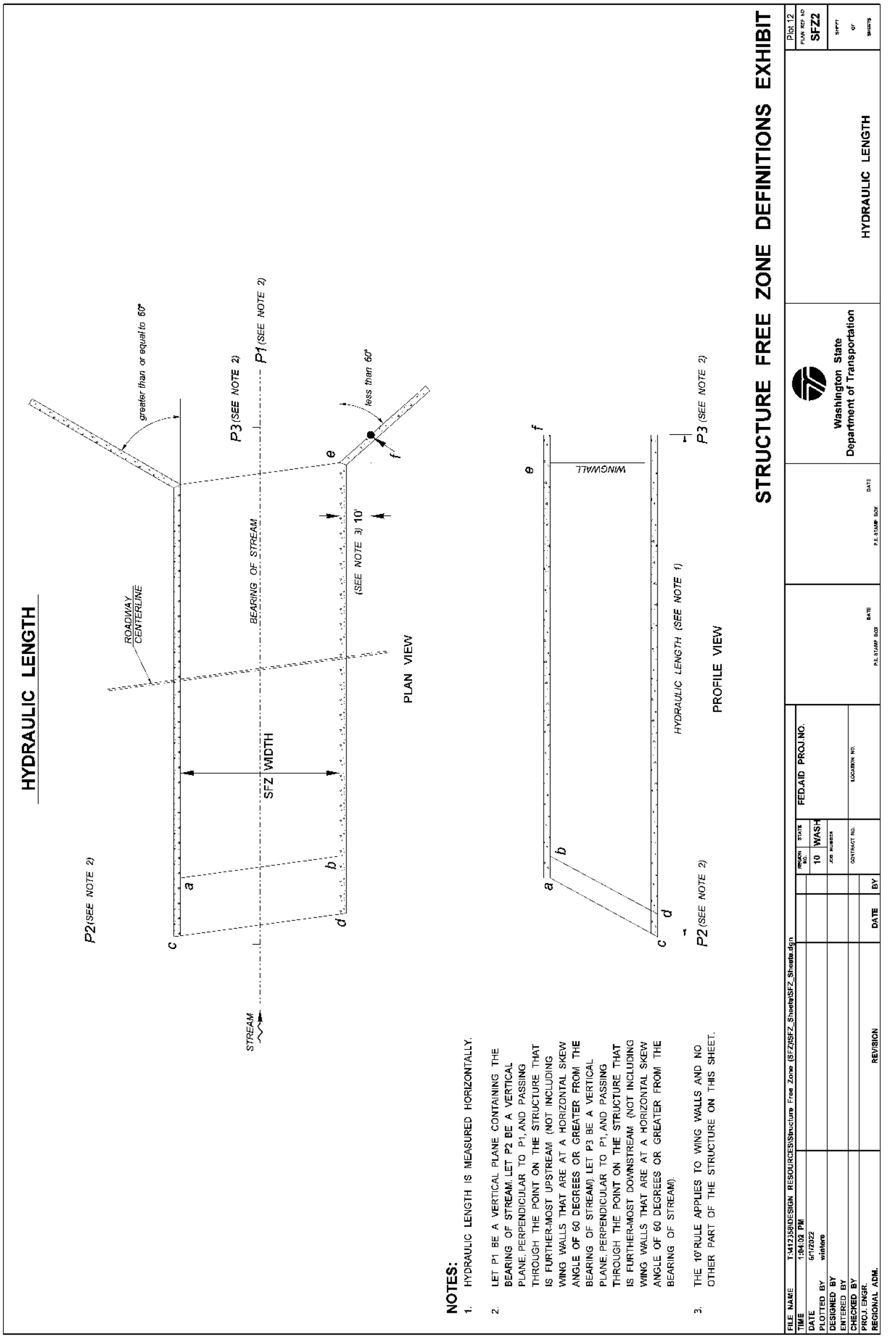
For indemnities regarding fish passages, see *General Provisions* 1-07.14.

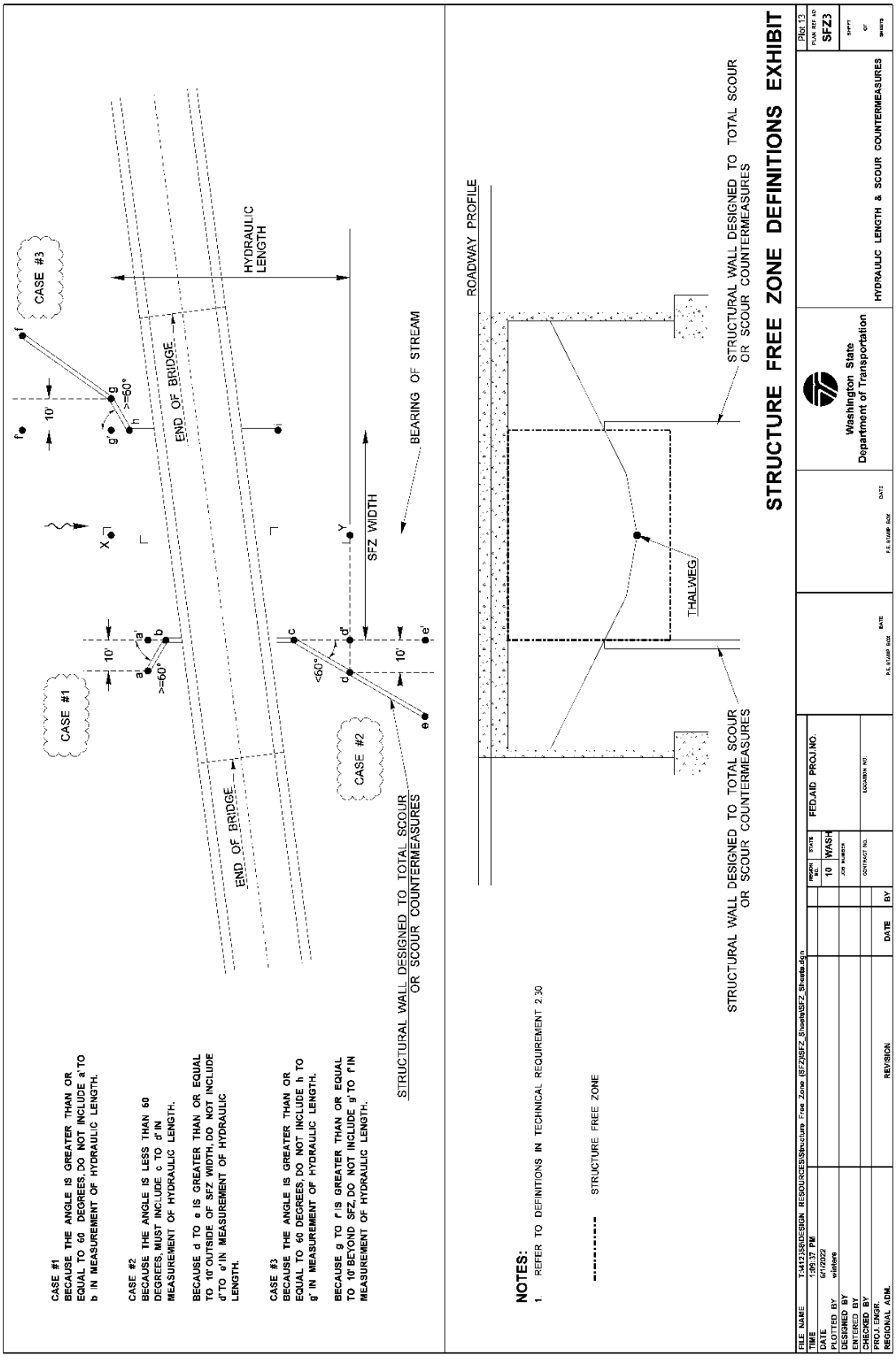
2.30.10 *SFZ Drawings*

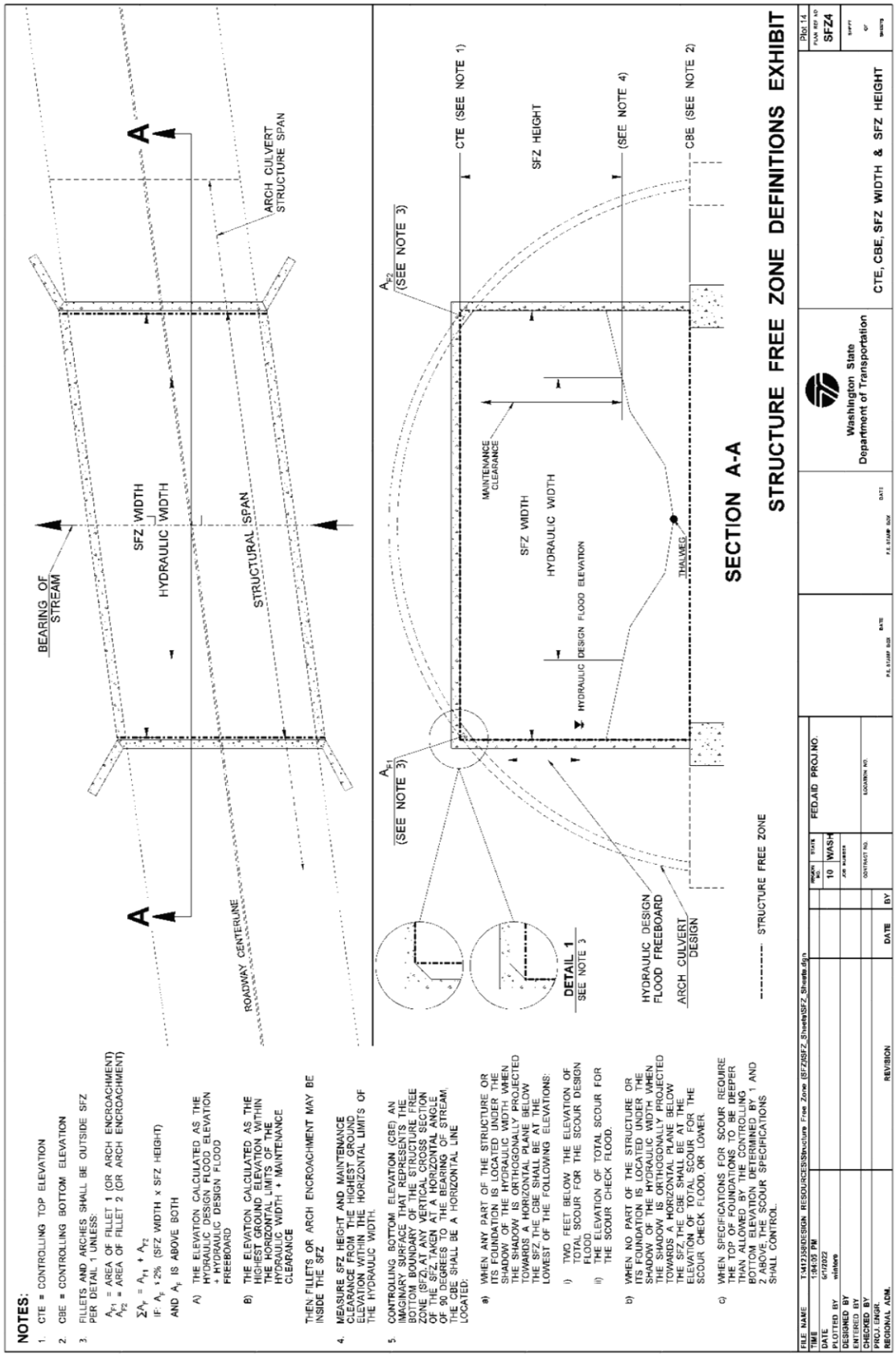
See SFZ Drawings on following pages.


BEARING OF STREAM
BEARING OF STREAM
PLAN VIEW
STREAM
X
X/2
Y/2
Y
A100SS = (100 YR WATER SURFACE ELEV 2) - (100 YR WATER SURFACE ELEV 1)
HYDRAULIC LENGTH (SEE SFZ2)
100 YEAR WATER SURFACE ELEVATION (2)
100 YEAR WATER SURFACE ELEVATION (1)
BEARING OF STREAM
SLOPE = A100SS
STREAM
WINGWALL
PROFILE VIEW
STRUCTURE FREE ZONE DEFINITIONS EXHIBIT
Washington State
Department of Transportation
BEARING OF STREAM / A100SS
Plot 11
SFZ1
FED.AID PROJ.NO.
10
WASH
REVISION
DATE
BY
FILE NAME
TIME 1:04:01 PM
DATE 6/1/2022
PLOTTED BY wintere
DESIGNED BY
ENTERED BY
CHECKED BY
PROJ. ENGR.
REGIONAL ADM.

1


HYDRAULIC LENGTH
P2 (SEE NOTE 2)
P3 (SEE NOTE 2)
P1 (SEE NOTE 2)
greater than or equal to 60°
less than 60°
ROADWAY CENTERLINE
BEARING OF STREAM
STREAM
SFZ WIDTH
(SEE NOTE 3) 10'
a
b
c
d
e
f
PLAN VIEW
WINGWALL
HYDRAULIC LENGTH (SEE NOTE 1)
PROFILE VIEW
NOTES:
1. HYDRAULIC LENGTH IS MEASURED HORIZONTALLY.
2. LET P1 BE A VERTICAL PLANE CONTAINING THE BEARING OF STREAM. LET P2 BE A VERTICAL PLANE, PERPENDICULAR TO P1, AND PASSING THROUGH THE POINT ON THE STRUCTURE THAT IS FURTHER-MOST UPSTREAM (NOT INCLUDING WING WALLS THAT ARE AT A HORIZONTAL SKEW ANGLE OF 60 DEGREES OR GREATER FROM THE BEARING OF STREAM). LET P3 BE A VERTICAL PLANE, PERPENDICULAR TO P1, AND PASSING THROUGH THE POINT ON THE STRUCTURE THAT IS FURTHER-MOST DOWNSTREAM (NOT INCLUDING WING WALLS THAT ARE AT A HORIZONTAL SKEW ANGLE OF 60 DEGREES OR GREATER FROM THE BEARING OF STREAM).
3. THE 10' RULE APPLIES TO WING WALLS AND NO OTHER PART OF THE STRUCTURE ON THIS SHEET.
STRUCTURE FREE ZONE DEFINITIONS EXHIBIT
Washington State Department of Transportation
HYDRAULIC LENGTH
Plot 12
SFZ2
FED.AID PROJ.NO.
10 WASH
REVISION
DATE BY


CASE #1
BECAUSE THE ANGLE IS GREATER THAN OR EQUAL TO 60 DEGREES, DO NOT INCLUDE a' TO b' IN MEASUREMENT OF HYDRAULIC LENGTH.
CASE #2
BECAUSE THE ANGLE IS LESS THAN 60 DEGREES, MUST INCLUDE c TO d' IN MEASUREMENT OF HYDRAULIC LENGTH.
BECAUSE d TO e IS GREATER THAN OR EQUAL TO 10' OUTSIDE OF SFZ WIDTH, DO NOT INCLUDE d' TO e' IN MEASUREMENT OF HYDRAULIC LENGTH.
CASE #3
BECAUSE THE ANGLE IS GREATER THAN OR EQUAL TO 60 DEGREES, DO NOT INCLUDE h TO g' IN MEASUREMENT OF HYDRAULIC LENGTH.
BECAUSE g TO f' IS GREATER THAN OR EQUAL TO 10' BEYOND SFZ, DO NOT INCLUDE g' TO f' IN MEASUREMENT OF HYDRAULIC LENGTH.
STRUCTURAL WALL DESIGNED TO TOTAL SCOUR OR SCOUR COUNTERMEASURES
END OF BRIDGE
HYDRAULIC LENGTH
SFZ WIDTH
BEARING OF STREAM
ROADWAY PROFILE
THALWEG
STRUCTURAL WALL DESIGNED TO TOTAL SCOUR OR SCOUR COUNTERMEASURES
NOTES:
1. REFER TO DEFINITIONS IN TECHNICAL REQUIREMENT 2.30
STRUCTURE FREE ZONE
STRUCTURE FREE ZONE DEFINITIONS EXHIBIT
Washington State Department of Transportation
HYDRAULIC LENGTH & SCOUR COUNTERMEASURES
SFZ3
FED.AID PROJ.NO.


NOTES:
1. CTE = CONTROLLING TOP ELEVATION
2. CBE = CONTROLLING BOTTOM ELEVATION
3. FILLETS AND ARCHES SHALL BE OUTSIDE SFZ PER DETAIL 1 UNLESS:
A_{F1} = AREA OF FILLET 1 (OR ARCH ENCROACHMENT)
A_{F2} = AREA OF FILLET 2 (OR ARCH ENCROACHMENT)
$\sum A_F = A_{F1} + A_{F2}$
IF: $A_F \geq 2\%$ (SFZ WIDTH x SFZ HEIGHT)
AND A_F IS ABOVE BOTH
A) THE ELEVATION CALCULATED AS THE HYDRAULIC DESIGN FLOOD ELEVATION + HYDRAULIC DESIGN FLOOD FREEBOARD
B) THE ELEVATION CALCULATED AS THE HIGHEST GROUND ELEVATION WITHIN THE HORIZONTAL LIMITS OF THE HYDRAULIC WIDTH + MAINTENANCE CLEARANCE
THEN FILLETS OR ARCH ENCROACHMENT MAY BE INSIDE THE SFZ
4. MEASURE SFZ HEIGHT AND MAINTENANCE CLEARANCE FROM THE HIGHEST GROUND ELEVATION WITHIN THE HORIZONTAL LIMITS OF THE HYDRAULIC WIDTH.
5. CONTROLLING BOTTOM ELEVATION (CBE) AN IMAGINARY SURFACE THAT REPRESENTS THE BOTTOM BOUNDARY OF THE STRUCTURE FREE ZONE (SFZ) AT ANY VERTICAL CROSS SECTION OF THE SFZ, TAKEN AT A HORIZONTAL ANGLE OF 90 DEGREES TO THE BEARING OF STREAM. THE CBE SHALL BE A HORIZONTAL LINE LOCATED:
a) WHEN ANY PART OF THE STRUCTURE OR ITS FOUNDATION IS LOCATED UNDER THE SHADOW OF THE HYDRAULIC WIDTH WHEN THE SHADOW IS ORTHOGONALLY PROJECTED TOWARDS A HORIZONTAL PLANE BELOW THE SFZ THE CBE SHALL BE AT THE LOWEST OF THE FOLLOWING ELEVATIONS:
i) TWO FEET BELOW THE ELEVATION OF TOTAL SCOUR FOR THE SCOUR DESIGN FLOOD.
ii) THE ELEVATION OF TOTAL SCOUR FOR THE SCOUR CHECK FLOOD.
b) WHEN NO PART OF THE STRUCTURE OR ITS FOUNDATION IS LOCATED UNDER THE SHADOW OF THE HYDRAULIC WIDTH WHEN THE SHADOW IS ORTHOGONALLY PROJECTED TOWARDS A HORIZONTAL PLANE BELOW THE SFZ THE CBE SHALL BE AT THE ELEVATION OF TOTAL SCOUR FOR THE SCOUR CHECK FLOOD, OR LOWER.
c) WHEN SPECIFICATIONS FOR SCOUR REQUIRE THE TOP OF FOUNDATIONS TO BE DEEPER THAN ALLOWED BY THE CONTROLLING BOTTOM ELEVATION DETERMINED BY 1 AND 2 ABOVE, THE SCOUR SPECIFICATIONS SHALL CONTROL.
BEARING OF STREAM
SFZ WIDTH
HYDRAULIC WIDTH
STRUCTURAL SPAN
ROADWAY CENTERLINE
ARCH CULVERT STRUCTURE SPAN
A
A
A_{F1} (SEE NOTE 3)
A_{F2} (SEE NOTE 3)
DETAIL 1 SEE NOTE 3
HYDRAULIC DESIGN FLOOD FREEBOARD
ARCH CULVERT DESIGN
STRUCTURE FREE ZONE
SECTION A-A
MAINTENANCE CLEARANCE
SFZ WIDTH
HYDRAULIC WIDTH
HYDRAULIC DESIGN FLOOD ELEVATION
THALWEG
CTE (SEE NOTE 1)
SFZ HEIGHT
(SEE NOTE 4)
CBE (SEE NOTE 2)
STRUCTURE FREE ZONE DEFINITIONS EXHIBIT
Washington State Department of Transportation
CTE, CBE, SFZ WIDTH & SFZ HEIGHT
SFZ4
FILE NAME: T:\417\3\BRIDGE\RESOURCES\Structure Free Zone (SFZ)\SFZ_Sheets.dgn
TIME: 1:34:33 PM
DATE: 6/7/2022
PLOTTED BY: wistone
DESIGNED BY
ENTERED BY
CHECKED BY
PROJ. ENGR.
REGIONAL ADM.
REVISION
DATE
BY
PROJECT NO.
10
STATE
WASH
FED.AID PROJ.NO.
JOB NUMBER
CONTRACT NO.
EQUATION NO.
P.E. STAMP SIGN
DATE
P.E. STAMP SIGN
DATE
Plot: 14
FOR REF ID

1 **End of Section**