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**APPLICABILITY FOR  
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Project teams shall refer to their executed project contracts for applicable document versions/revisions.

**SECTION 32 72 00****STREAM MITIGATION****NOTE TO DESIGNER:**

IN GENERAL, STREAM RESTORATION DESIGN IS A COMPLEX ENDEAVOR THAT REQUIRES INPUT FROM BIOLOGISTS, GEOMORPHOLOGISTS, HYDROLOGISTS, AND HYDRAULIC ENGINEERS. ITALICIZED [TEXT] PROVIDES INSTRUCTIONS TO THE DESIGNER TO INCLUDE LANGUAGE ON SPECIFIC TOPICS WHEN APPLICABLE. THE INSTRUCTIONS ARE TO BE DELETED WHEN THE SPECIFICATION IS FINALIZED. THIS GUIDANCE SPECIFICATION CAN SERVE AS A STARTING POINT FOR PREPARING SPECIFICATIONS FOR STREAM PROJECTS; HOWEVER, USE OF THIS GUIDANCE SPECIFICATION IS NOT A SUBSTITUTE FOR APPROPRIATE INVOLVEMENT BY DESIGN PROFESSIONALS, WITH WORK COMPLETED UNDER THE SUPERVISION OF A QUALIFIED PROFESSIONAL ENGINEER.

**DESIGNER TO DELETE TEXT ABOVE FOR FINAL SECTION**

**PART 1 - GENERAL**

## 1.01 SUMMARY

- A. Section Includes *[NOTE TO DESIGNER. EXAMPLE TEXT IS BELOW. UPDATE TO BE PROJECT SPECIFIC. PLANTING REQUIREMENTS ARE INCLUDED IN 32 71 00]*:
1. Work in the following:
    - a. Creek 1: STA XXX to YYY.
    - b. Creek 2: STA RRR to QQQ.
    - c. Additional streams found within the project limits during construction will be added by Change Order.
  2. Work includes installing and operating temporary stream bypass systems and installing and operating cofferdam systems.
  3. Work includes fish exclusion and de-fishing areas where natural flows will be reduced.
  4. Work includes channel excavation and grading, and furnishing and installing streambed sediments and aggregates, and habitat features.
  5. Work includes furnishing and installing large wood and large wood structures.
  6. Work includes furnishing and installing materials for bioengineering bank stabilization and riparian revegetation.

## 1.02 REFERENCES

- A. This Section incorporates by reference the latest revisions or the dated references (as noted) of the following documents:
1. Federal:
    - a. United States Fish and Wildlife Service (USFWS):

- 1) USFWS Washington Fish and Wildlife Office, "Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards". June 19, 2012.

2. State:

a. Revised Code of Washington (RCW):

- 1) RCW 77.55 – Construction Projects in State Waters.
- 2) RCW 77.57.010 – Fish guards required on diversion devices.
- 3) RCW 77.57.070 – Diversion of water.

b. Washington Administrative Code (WAC):

- 1) WAC 220-660-130 – Stream bank protection and shoreline stabilization.
- 2) WAC 220-660-190 – Water Crossing Structures.
- 3) WAC 220-660-210 – Channel Relocation and Realignment.
- 4) WAC 220-660-220 – Large woody material (LWM) placement, repositioning and removal in freshwater areas.

c. Washington State Department of Transportation (WSDOT):

- 1) WSDOT Standard Specifications for Road, Bridge, and Municipal Construction, 2024 Edition, or as amended.
- 2) WSDOT General Special Provisions, November 2023 update, or as amended.
- 3) WSDOT Fish Exclusion Protocols and Standards, September 2016, or as amended.
- 4) WSDOT Hydraulics Manual, May 2023.

d. Washington Department of Fish and Wildlife (WDFW):

- 1) Water Crossing Design Guidelines 2013.

3. Local:

- a. King County Ordinance 16851 - Procedures for Considering Public Safety When Placing Large Wood in King County Rivers.

B. Definitions:

1. Authority Having Jurisdiction: (Define).
2. Cofferdam: a cofferdam is a temporary structure that provides a barrier between the flowing water in the stream and the work area, to allow construction work to be completed in a relatively dry condition, often with the assistance of dewatering within the limits of the cofferdam.
3. DBH: diameter at breast height.
4. In-Stream Work: Any work waterward of the ordinary high-water mark (OHWM).

5. Log or Large Wood: Logs that are depicted individually on the drawings.
6. Log with Root Wad or Large Wood with Root Wad: Logs with root wads that are depicted individually on the drawings.
7. Large Wood Structures (LWS): Structures composed of multiple pieces of large wood and/or large wood with root wads, and possible other elements such as log anchors and piles, wood pile anchors, or mechanical anchors, or earth fill.
8. Slash: Wood material referred to generally on the drawings but not individually depicted on the Drawings. Slash may consist of trees and major tree branches obtained from trees and woody material cleared from the project site or may be imported native material.
9. Streambed material: The material forming the stream channel bottom and sides, commonly a mix of sand, gravel, and possibly also cobbles and boulders, and potentially other materials placed above the subgrade in the stream channel. Streambed material must be rounded river rock of natural origin (not crushed or angular).
10. Subgrade: The limits of channel construction prior to placing streambed material.

### 1.03 COORDINATION

- A. Schedule: At a minimum, include the following activities and Critical Inspections on the project schedule for work: plans and submittals, sampling dates, material testing, temporary stream bypass systems, cofferdams, de-fishing, salvage and stockpiling of streambed material, channel grading, streambed material placement, installation of each type of habitat feature, surveys, re-watering, For sites with multiple areas with differing schedules, the Contractor's schedule must indicate these activities for each work area.
- B. Stream Preconstruction Conference:
  1. A stream preconstruction conference must be held at least 5 working days prior to the Contractor beginning streambed construction to discuss the goals and methods of streambed construction which must include the construction procedures, personnel, and equipment to be used.
  2. The following person must attend the streambed preconstruction conference:
    - a. (representing the Contractor) The superintendent, on site supervisor, foreman, the Construction Site Environmental Management Supervisor and any other personnel who will have on-site responsibility for stream construction, including all persons listed in Article 1.05, herein.
    - b. (representing Sound Transit) The Project Engineer and key inspection personnel, and wetland mitigation manager or designee.
- C. Fish Biologist Observance:
  1. The Contractor must utilize Fish Biologist to direct water management and fish salvage. No In-Stream Work must commence prior to water management and fish exclusion installation as directed by Fish Biologist.
  2. The Contractor must notify the Fish Biologist at least 2 weeks in advance of the time such direction is required for the following work shown on the Contract Drawings:
    - a. During installation of fish exclusion and fish salvage.

- b. During installation of water management systems (including cofferdams and bypass pipes or structures) and bypass structures.
  - c. During dewatering of work areas.
  - d. During removal of bypass structures.
  - e. During removal of water management systems.
  - f. During reintroduction of in-water flows and fish to In-Water Work area.
- D. Stream Restoration Engineer Observance:
- 1. The Contractor must utilize Stream Restoration Engineer to direct Streambed Substrate placement, LWM Structure construction, and grading of channel and floodplain as shown on the Contract Drawings.
  - 2. The Contractor must notify the Stream Restoration Engineer at least 2 weeks in advance of the time such direction is required for the following work shown on the Contract Drawings:
    - a. During preliminary grading, soil preparation, and earthwork.
    - b. When rough grading has been completed in the mainstem channel and floodplain.
    - c. Prior to and during installation of Small and Medium Streambed Materials.
    - d. When LWM Habitat Structures are staged/marked for installation and before installation occurs.
    - e. During installation of LWM Habitat Structures and Anchor Boulder Systems. During reintroduction of in-water flows to In-Water Work area
  - 3. The Contractor must notify Stream Restoration Engineer within 24 hours of a 1 inch or greater precipitation event to confirm water management and In-Stream Work is still in accordance with the Contract Drawings
- E. Critical Inspections: Contractor must provide notice for each Critical Inspection listed below: Sound Transit must approve each item, and the Contractor must not proceed with the work without receiving approval: *[NOTE TO DESIGNER: UPDATE AS NECESSARY BASED ON PROJECT SPECIFICS]*.
- 1. After survey as detailed in Article 3.01, herein this specification.
  - 2. When representative samples of each type of streambed materials are available for inspection at the processing plant. Production processing of the material must not begin until each material is approved by the Resident Engineer in writing.
  - 3. Before salvage of any streambed sediment for reuse.
  - 4. Following installation of temporary stream bypass system or cofferdams, but before use, and fish isolation
  - 5. Before placement of any stockpiled salvaged streambed material.
  - 6. When the first two of any habitat features are staged/marked for installation, but before installation occurs.
  - 7. Installation of each Large Wood structures:

- a. Type A.
- b. Type C.
- c. Type F.

8. Delivery of first streambed sediment to site.

F. Final Inspection and Acceptance:

- 1. Final inspection will be conducted at least one week prior to the end of the in-water work window. Submit notice to the Resident Engineer requesting final inspection at least 7 days prior to the anticipated date.

1.04 SUBMITTALS

A. Submit the following:

- 1. Stream Construction Plan: For each stream segment to be constructed, prepare a Stream Construction Work Plan. The Stream Construction Work Plan must describe the overall construction approach, sequencing, and schedule for the work. Critical Inspections must be identified in the construction work plan schedule. Sound Transit may add Critical Inspections at the Resident Engineer's discretion. For each bypass, cofferdam, or dewatering system, include a plan view drawing section showing stream existing conditions, any proposed stream blockages, locations of temporary facilities and equipment, locations of pumps, power supplies (e.g., meter drops, generators, fuel tanks), hose/pipe alignments including protection at road crossings, and discharges locations and structures.

- a. For each stream segment as shown on the Contract Drawings requiring Temporary Stream Bypass, prepare a Temporary Stream Bypass Plan (refer to WSDOT Standard Specifications 8-31). The Temporary Stream Bypass Plan must be designed and stamped by a professional engineer. The plan must describe the design concept, methods and materials proposed by the Contractor to temporarily bypass stream flows through or around the work area. The plan must identify permit requirements and design criteria, inlet and discharge locations, inlet equipment including fish screens and removal methods for species exclusion methods and species removal methods. The plan must describe methods for monitoring weather to anticipate changes in stream flows, monitor gauging station data, and action levels and contingency measures to be implemented in the event of expected high flows. If pumps are proposed, the Contractor must provide a capacity analysis demonstrating that the overall bypass system has the capacity to meet the performance standards required. The plan must identify pump energy sources and fuels and describe contingency measures and response times in the event of equipment failure. For the following sites, the Temporary Stream Bypass Plans must be prepared and stamped by a Professional Engineer having professional liability insurance meeting Contract Document requirements.

1) Stream XXXX: STA XXXX for construction of YYYY.

2) Stream XXXX: STA XXXX for construction of YYYY.

- b. For each work area requiring a cofferdam, prepare a Cofferdam Plan (refer to WSDOT Standard Specifications 8-31). The Cofferdam Plan must be designed and stamped by a professional engineer. The plan must describe the design concept, methods and materials proposed by the Contractor for cofferdams and associated dewatering. The plan must identify permit

requirements and design criteria, discharge locations and applicable water quality discharge limits, dewatering system inlet equipment including fish screens and removal methods for species exclusion methods and species removal methods. The plan must describe methods for monitoring weather to anticipate changes in stream flows, monitor gauging station data, and action levels and contingency measures to be implemented in the event of expected high flows. For the following sites, the Cofferdam Plans must be prepared and stamped by a Professional Engineer having professional liability insurance meeting Contract Document requirements.

- 1) Stream XXXX: STA XXXX for construction of YYYY.
  - 2) Stream XXXX: STA XXXX for construction of YYYY.
- c. For each cofferdam and other sites requiring water removal to complete the work, prepare a Dewatering Plan that describes the dewatering approach, methods and materials, equipment and power sources, estimated water removal rate (gallons per minute), duration of dewatering, permits for water disposal, any proposed water treatment, and proposed contingency measures and response times in event of equipment failure (refer to WSDOT Standard Specifications 8-31). The Dewatering Plan must be designed and stamped by a professional engineer. For the following sites, the dewatering plans must be prepared and stamped by a Professional Engineer having professional liability insurance meeting Contract Document requirements. .
- 1) Stream XXXX: STA XXXX for construction of YYYY.
  - 2) Stream XXXX: STA XXXX for construction of YYYY.
- d. If stream channel is used as a sediment pond during construction, prepare plan for managing sediment.
- e. For each work area requiring a temporary stream crossing, prepare a Temporary Access Plan: The plan must describe means and materials for the temporary stream crossing including how fish passage will be maintained. The plan must follow project permit requirements and design criteria, areas and volumes of disturbance below ordinary high water, and restoration methods when the temporary crossing is removed.
- f. The Contractor must provide submittals showing the required gradation for each Streambed Material and explaining how the material is to be batched including mix ratios of component materials. The submittal must also indicate the gradation of the “as-batched” material based on gradation tests and stone counts of the actual material to be supplied and indicate any differences between the test results and the specification.
2. As-built Drawing:
- a. The Contractor must prepare and submit As-built Drawings for the Contract sites. The drawings must be plan view at the same scale as the Contract Landscape Drawings. As-built drawings must be based on survey of the constructed work.
  - b. Survey must be completed by Professional Land Surveyor (PLS). Survey must be performed taking shots at 50 feet on-center (OC) along the channel thalweg, around all perimeters, and on a rectangular grid of a minimum of 50 feet OC each way, plus tops and toes of channel banks and tops and toes of floodplain banks, including any side channels,

swales, off-channel areas, installed large wood, and other habitat features. For small or very sinuous streams, provide additional survey shots of stream alignment to obtain accurate depiction of stream channel alignment.

- c. The Drawings must illustrate surveyed topography to the nearest foot for channels sloped at 0.4 percent or greater and to the nearest 6 inches for channels sloped less than 0.4 percent.
  - d. Submit As-built Drawings with overall project As-built Drawings, except submit As-Built Drawings for the channel sections that are designated mitigation sites as listed below within 30 days of completion of channel constructed (defined for this paragraph only as the date of re-watering of the channel):
    - 1) Name Creek: STA XXX to STA YYY.
    - 2) Water Creek: STA XX to YY.
3. Product Data and Certifications:
- a. Log anchor materials.
  - b. Sources of Large Wood, Large Wood with Root Wads, and slash. Include species, bole length, DBH, and root wad length (if applicable) of each log.
  - c. Gradation test data for Streambed Material mixes. For each final Streambed Material mix, complete gradation testing of mix components and overall mix. Complete 1 test initially and 1 additional test per each 5000 tons supplied. Where gradation testing can utilize standard WSDOT sieve tests, utilize appropriate WSDOT test methods. Where gradation testing is not feasible due to oversized stones, sieve material through a 2-inch sieve, then count stones and calculate the gradation from the stone counts. For stones up to 4 inches in diameter, the Contractor must utilize a commercial gravelometer with openings labelled in inches (or metric if inches is not available), and physically pick up stones from a single area of the stockpile selected at random after digging into the pile to obtain a representative zone of material not affected by surface segregation. For stones up to 12 inches in diameter the Contractor must fabricate a "cobbleometer" by cutting square holes in a sheet of  $\frac{3}{4}$  inch plywood (the holes must have dimensions consistent with the material gradation specification) and must physically pick up stones from a single area of the stockpile selected at random after digging into the pile to obtain a representative zone of material not affected by surface segregation. Stones larger than 12 inches diameter must be measured by the each using calipers to determine length, width, and height and the three measurements of each stone averaged to determine the stone diameter. For each component ingredient in the overall gradation and for the mixed material, count stones as follows for each gradation test:
    - 1) 2 to 4 inches: 200 stones.
    - 2) 4 to 12 inches: 100 stones.
    - 3) Greater than 12 inches: 40 stones.



## 1.05 QUALITY ASSURANCE

- A. Contractor's Qualifications to Construct Stream Restoration: Installer must be a specialist in restoring, enhancing, or creating natural streams, with documented experience in constructing natural streams of comparable size, scope, and quality, in-stream habitat large woody debris.
- B. (LWD) installation, in-stream water management, and fish exclusion and removal. A minimum of three (3) successful projects of similar type and size must be presented with references. Installer must also have experience working in or adjacent to open water.
- C. Supervision: *[NOTE TO DESIGNER: UPDATE BASED ON PROJECTS REQUIREMENTS]* The Contractor must provide the services of:
1. Fish Biologist: a biologist familiar with all aspects of the Hydraulic Project Approval (HPA), water management, and fish exclusion with a minimum of 5 years of professional biological experience or as approved by the Owner. Fish biologist is to be retained by Contractor:
    - a. The Contractor must utilize Fish Biologist to direct water management and fish salvage. No In-Stream Work must commence prior to water management and fish exclusion installation as directed by Fish Biologist.
    - b. The Contractor must notify the Fish Biologist at least 2 weeks in advance of the time such direction is required for the following work shown on the Contract Drawings:
      - 1) During installation of fish exclusion and fish salvage.
      - 2) During installation of water management systems (including cofferdams and bypass pipes or structures) and bypass structures.
      - 3) During dewatering of work areas.
      - 4) During removal of bypass structures.
      - 5) During removal of water management systems.
      - 6) During reintroduction of in-water flows and fish to In-Water Work area.
  2. Stream Restoration Engineer (Designer): an engineer familiar with materials and methods for restoring and enhancing stream channels of comparable habitat and size, with demonstrated experience for instream habitat LWM installation, water management, and fish exclusion with a minimum of 5 years of professional stream restoration engineering experience or as approved by the Owner:
    - a. The Contractor must utilize Stream Restoration Engineer to direct Streambed Substrate placement, LWM Structure construction, and grading of channel and floodplain as shown on the Contract Drawings.
    - b. The Contractor must notify the Stream Restoration Engineer at least 2 weeks in advance of the time such direction is required for the following work shown on the Contract Drawings:
      - 1) During preliminary grading, soil preparation, and earthwork.
      - 2) When rough grading has been completed in the mainstem channel and floodplain.

- 3) Prior to and during installation of Small and Medium Streambed Materials.
- 4) When LWM Habitat Structures are staged/marked for installation and before installation occurs.
- 5) During installation of LWM Habitat Structures and Anchor Boulder Systems. During reintroduction of in-water flows to In-Water Work area.

c. The Contractor must notify Stream Restoration Engineer within 24 hours of a 1 inch or greater precipitation event to confirm water management and In-Stream Work is still in accordance with the Contract Drawings

1.06 DELIVER, STORAGE, AND HANDLING

- A. General Requirements: Refer to product requirements as stated elsewhere in the Contract Documents.
- B. Delivery:
  - 1. Deliver Large Wood materials to the jobsite no less than 3 days prior to installation to provide sufficient time for inspection by Resident Engineer. Large Wood materials will be transported and handled such that root wads remain intact and materials are installed per design locations and sizes per Contract documents.
- C. Handling:
  - 1. Exercise care in handling, loading, unloading, and storing of Large Wood materials. Large Wood materials damaged in any way must be discarded and replaced with undamaged materials at the cost of the Contractor.
- D. Storage:
  - 1. Protect packaged materials from deterioration during storage.

1.07 PROJECT CONDITIONS

- A. STREAM FLOW: The Contractor must make its own estimate of stream flows affecting the work. The following creek hydrologies are known and provided for reference. *[NOTE TO DESIGNER: UPDATE EITHER INCLUDE STREAM FLOWS OR SPECIFY A METHOD FOR THE CONTRATOR TO DETERMINE STREAM FLOWS FOR BIDDING PURPOSES]*
  - 1. Creek 1 Hydrology at STA XXX.

Reoccurrence Interval	Q (cfs)
2-year	XXX
5-year	XXX
10-year	XXX
100-year	XXX

2. Creek 2: Hydrology at STA XXX.

Reoccurrence Interval	Q (cfs)
2-year	XXX
5-year	XXX
10-year	XXX
100-year	XXX

B. Geotechnical Conditions including groundwater level information.

**PART 2 - PRODUCTS**

2.01 PERFORMANCE REQUIREMENTS

A. Temporary Stream Diversion: Temporary stream diversion systems must be Contractor designed in accordance with WSDOT Standard Specifications 8-31. Temporary stream diversions must be capable of bypassing the 6-month flood event flow, except systems must be designed to meet the following more stringent Authorities Having Jurisdiction (AHJ) requirements for the creek sections listed below:

1. Creek 1: STA AA to BB, City of XXX Code XXX: 50-year flood event.

B. Cofferdams, if used, must be required to withstand the 6-month flood event flow without being overtopped, except cofferdams must be designed to meet the following more stringent AHJ requirements for the creek sections listed below:

1. Creek 1: STA AA to BB, City of XXX Code XXX: 50-year flood event.

C. Dewatering within cofferdams must be a Contractor designed system sufficient to maintain water at least 1-foot below the active work location. Discharge water quality must comply with permit requirements.

D. Maintain flow downstream of the work area at all times.

E. Stream channel design (plan, profile and section), habitat features, and LWM must conform to the permit requirements.

F. FISH EXCLUSION: *[NOTE TO DESIGNER: CONSIDER DELETING IF PERMITS DEFINE THESE ITEMS AND ALL PERMITS ARE PROVIDED AS ATTACHMENTS TO CONTRACTORS DURING BIDDING, OR IF CONTRACTOR MUST OBTAIN PERMITS FOR DESIGN/BUILD]*

1. Species Exclusion and Removal:

2. All in-stream work must be conducted in accordance with the approved In-water work window specified by the WDFW within the HPA Contract Documents.

3. The construction of the stream channel may be monitored by regulatory agencies. Although regulatory agencies will not communicate directly with the Contractor, they will advise the Stream Restoration Engineer or Fish Biologist when the intent of the plans is not being implemented. The agencies that may be monitoring the work include the WDFW, the Washington State Department of Ecology, and the US Army Corps of Engineers.

4. Protect existing utilities, paving, and other facilities from damage caused by restoration operations in accordance with Section 01 71 30 - Protection and Maintenance of Property and Work.
5. All existing native vegetation must be preserved to the maximum extent feasible. See Section 01 56 39 - Temporary Tree and Plant Protection for tree and sensitive protection plans.
6. Isolation of all In-Stream Work and all aquatic life (including but not limited to fish) exclusion and handling (salvage) must be conducted under the supervision of Fish Biologist and in accordance with the following regulations [*NOTE TO DESIGNER: UPDATE TO BE PROJECT SPECIFIC*]:
7. HPA Provisions
8. WSDOT Fish Exclusion Protocols and Standards.
9. National Marine Fisheries Service (NMFS) Biological Opinion Take Statement.
10. NMFS Electrofishing and Fish Handling Standards.
11. USFWS document referenced in Article 1.2.A.5.a in this specification.
12. The Fish Biologist must comply with the reporting requirements outlined in the HPA and NMFS Biological Opinion.
13. In the event of fish kills observed within the Project Area not associated with fish salvage activities, the protocol and notification requirements designated within HPA provisions must be followed.
14. Any pumping intake or dewatering device used to isolate In-Stream Work must be equipped with a fish screen and velocity diffusion barrier to prevent the passage or entrainment of fish in accordance with RCW 77.57.010 and 77.57.070 and other requirements found within the HPA.
15. To avoid downstream turbidity increases, pumped water must not flow directly back into the stream. BMPs outlined in the HPA and the 401 Water Quality Certification and the Construction Stormwater National Pollutant Discharge Elimination System (NPDES) General Permit must be followed regarding water management.

## 2.02 LARGE WOOD

- A. Each log must have been felled or logged no more than one year prior [*NOTE TO DESIGNER: MAY ADD ABILITY TO USE OLD WOOD BUT CONSIDER LIFE SPAN AND APPLICATION. OLDER LOGS MAY BE CONSIDERED WHERE STRUCTURAL INTEGRITY IS NOT CRITICAL TO DESIGN*]. Each log must meet the following requirements:
  1. Each log must be a trunk of a native coniferous tree species, with the base cut off above the root wad, with the length as designated in the Plans (measured from the cut ends of the log). Douglas fir (*Pseudotsuga menziesii*) is preferred. Other acceptable species are Pacific silver fir (*Abies amabilis*), yellow cedar/Alaska cedar (*Calotropis's nootkatensis*), Western red cedar (*Thuja plicata*), or ponderosa pine (*Pinus ponderosa*). Hemlock (*Tsuga* sp.) or Hem-Fir (species combination of Western Hemlock and the true firs) must not be used in settings where structural integrity of the large wood is critical to the design (i.e. key pieces in log structures).
  2. Each log must be of a diameter and length as indicated on the Drawings. Logs must have only one trunk. Split trunks are not allowed.

3. Logs must not taper more than 25 percent of the largest diameter for each 20 feet of length.
4. Logs must be structural sound, free of hollows or rot.
5. For logs to be used as (XXX), logs must retain branches and foliage to the maximum extent practicable given hauling constraints. The Contractor must retain smaller branches where they can be tied up to the trunk to allow for hauling; larger branches may be cut but retain the branch stubs as long as possible. Logs must have no more than 25 percent of bark removed or damaged.
6. Logs must be free of soil, rocks, and metal.
7. Logs must contain no invasive species or noxious weeds.
8. Large wood anchorage has been designed for Douglas fir, which is typically the densest conifer species. Therefore, if other species are used, particularly grand fir (*Abies grandis*), white fir (*Abies concolor*), western red cedar (*Thuja plicata*), or white pine (*Pinus monticola*), the contractor must provide 50 percent greater anchorage weight/strength as compared to the specified anchorage to compensate for the less dense wood.

### 2.03 LOG WITH ROOTWAD

- A. Log with root wad must meet the following requirements:
  1. Each log with root wad must meet the requirements for logs, except that the root wad must be retained integral with the log.
  2. The root mass at the flared base of the tree at the former ground level must have a diameter at least 1.2 times the log DBH. The root wad must have at least 10 major root branches and many more smaller root branches that create a well-defined root structure with a diameter at least 2.5 times the log DBH.

### 2.04 LARGE WOOD STRUCTURE:

- A. Each large wood structure must have at least 50 percent Douglas fir logs. The Contractor must use predominantly Douglas Fir in large wood structures, and other allowed species in single log applications.

### 2.05 ANCHORS [NOTE TO DESIGNER: NOT ALL ANCHORS OR ANCHOR COMPONENTS MAY BE NEEDED FOR INSTALLATION OF LARGE WOOD OR WOOD STRUCTURES AT THE SITE, AND ADDITIONAL ANCHOR TYPES MAY BE SPECIFIED. DESIGNER MAY SELECT ANCHOR COMPONENTS FROM LIST BELOW AS NEEDED].

- A. Boulder Anchor:
  1. Boulders used for anchors must be of the size designated in the Contract Drawings and must meet the requirements of WSDOT Standard Specifications Section 9-03.11(3).
- B. Wire Rope:
  1. Wire Rope utilized for connecting the log with root wad to the streambed boulders must be 1/2-inch minimum non-galvanized, multi-strand, flexible wire rope with a minimum working load of 10,000 pounds force. The working load must not exceed the rated tensile strength of the wire rope. Wire rope must meet the requirements of ASTM International (ASTM) A1023.
- C. Wire Rope Clips and Thimbles:
  1. Three non-galvanized, malleable wire rope clips per connection must be used to complete the anchor assembly as designated in the Plans and must meet the

requirements of WSDOT Standard Specifications Section 9-16.4(4). Thimbles must be used wherever the wire rope terminates in a loop and meet the requirements of Federal Specification FFT276b Type III. The minimum working load of all wire rope clips and thimbles must be 10,000 pounds force.

D. U-Shaped Rebar:

1. The U-SHAPED rebar anchor used for the LWM Structures must be No. 6 ( $\frac{3}{4}$ -inch) deformed plain steel reinforcement rebar. *[NOTE TO DESIGNER: IN ESTUARINE ENVIRONMENTS CHANGE REQUIREMENT TO USE STAINLESS STEEL].*

E. Epoxy Adhesive:

1. Epoxy adhesive used to connect u-shaped rebar to boulder anchors must meet the requirements of WSDOT Standard Specifications Section 9-26.

F. Permanent Ground Anchors:

1. The Contractor must select the appropriate manufacturer and model of permanent ground anchor and anchor depth that is stable when subjected to the minimum anchor loads listed in Table 1.
2. Holding capacity must be minimum XXXX pounds per log or log with root wad. Table 1 provides minimum anchor loadings that must be achieved for permanent ground anchors *[NOTE TO DESIGNER: PROVIDING LOADINGS, AND SOILS INFORMATION AND HAVE THE VENDOR SELECT THE RIGHT MODEL OF ANCHOR. ALL LARGE WOOD AND LARGE WOOD STRUCTURES MUST BE DESIGNED BY A PROFESSIONAL ENGINEER].*

3. Table 1. Log Anchor Minimum Anchor Loads (pounds, per anchor)

Large Wood Structure Type	Log Diameter x Length	Log Diameter x Length	Log Diameter x Length
1	Load XXX	Load XXX	Load XXX
2	Load XXX	Load XXX	Load XXX

4. Ground anchor locations are identified on the Contract Drawings.
5. Permanent ground anchors must be connected to large wood with wire rope (with wire clips and thimbles) or may be secured through a hole not to exceed 2 inches in diameter through the log at each anchor location as shown on the Contract Drawings.

2.06 STREAMBED AGGREGATE

- A. Streambed aggregates shall be naturally occurring water rounded aggregates. Aggregates from quarries, ledge rock, and talus slopes are not acceptable for these applications. Material for streambed aggregates shall be free of deleterious material. Deleterious material includes manufactured wood products, organic waste, coal, charcoal, or any other extraneous or objectionable material. At the discretion of the Engineer, the percent of deleterious materials may be determined visually or be tested in accordance with AASHTO T 194 or AASHTO T 267 (refer to WSDOT Standard Specifications 9-03.11)
- B. Excavated native streambed gravel material may be salvaged and reused as Streambed Material if the material conforms to the specifications as demonstrated by contractor completed testing at a frequency of one test to 1,000 cubic yards.

- C. Streambed Materials must meet the requirements listed below: (refer to WSDOT Standard Specifications):
1. Streambed Sand 9-03.11(3).
  2. Streambed Fine Sediment 9-03.11(2).
  3. Streambed Sediment 9-03.11(1).
  4. Streambed Cobbles 9-03.11(4).
  5. Streambed Boulder 9-03.11 (5).
- D. Streambed Material Mixes
1. Mix No. 1 must be a mix of the following aggregates with the associated ratios:
    - a. Streambed Sediment: XX percent, by volume.
    - b. Streambed Cobbles 10 In.: XX percent, by volume.
  2. Streambed Cobbles 12 In.: XX percent, by volume.
    - a. Stream Boulder One Man: XX percent, by volume.
  3. Mix No. 2 must be a mix of the following aggregates with the associated ratios:
    - a. Streambed Sediment: XX percent, by volume.
    - b. Streambed Cobbles 6 In.: XX percent, by volume.
  4. The size gradation of Streambed Material will be verified by the Resident Engineer by visual inspection of the load before it is dumped into place, or if so ordered by the Resident Engineer, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load.
- E. Streambed sanding mix must consist of washed sandy gravel of igneous and metamorphic origin. The material must be free from wood waste and other extraneous and objectionable materials. Streambed sanding mix must meet the specifications as summarized by the sizing distribution:

Sieve Size	Percent Passing by Weight
3/4 -inch	100
No. 4	60 to 90
No. 8	50 to 75
No. 50	40 to 60
No. 200	30 to 50

- F. Streambed Boulders: Streambed Boulders must be hard, sound and durable material, free from seams, cracks, and other defects tending to destroy its resistance to weather. Streambed Boulders must be rounded to sub-angular in shape and the thickness axis must be greater than 60 percent of the length axis. Streambed Boulders must be placed in as shown in the Contract Documents and in selected locations elsewhere as directed by the Resident Engineer. Streambed Boulders must meet the size requirements listed below. Streambed Boulders must be delivered separately to the site for independent verification

of size and quantity. Streambed boulders may be salvaged from the project site where they meet specification and as directed by the Resident Engineer:

Rock Size	Approximate Weight	Approximate Size <sup>Note 1</sup>
One Man	200 to 400 lbs.	12 to 18 inches
Two Man	500 to 800 lbs.	18 to 28 inches
Three Man	900 to 1200 lbs.	28 to 33 inches

**Note 1:** Approximate size can be determined by taking the average dimension of the three axes of the rock – length, width and thickness by use of the following calculation:

$$(\text{Length} + \text{Width} + \text{Thickness}) / 3 = \text{Approximate size}$$

- G. Biodegradable Erosion Control Blanket must meet the requirements of WSDOT Standard Specification 9-14.6(2).

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

##### A. Surveys:

- 1. The Contractor must stake existing stream OHWLs, proposed stream OHWL (if newly created stream), wetland boundaries, jurisdictional buffers (i.e., critical areas), locations for habitat feature placement, and new stream alignments at 100 feet OC. All survey work shall be performed under the direction of a PLS.

#### 3.02 PREPARATION

##### A. Work Area Isolation:

- 1. Where shown on the Drawings or required by permit, work areas shall be isolated from natural water bodies and flows and dewatered so that work can be completed in a dry condition. Comply with approved Temporary Stream Diversion, Cofferdam, and Dewatering Plans. Cofferdams must be Contractor designed:
  - a. Cofferdams must be designed to be stable and protective of the work area at the flow listed in Article 2.01 of this Section.
- 2. The Contractor must dewater areas with cofferdams using Contractor designed dewatering systems.
- 3. The design, installation, and operation of the dewatering system must be the Contractor's responsibility. The selection of dewatering methods and equipment is the Contractor's responsibility, in order to achieve the specified results. If wells or well points are used, comply with WAC 173-160. Coordinate with power utility to provide temporary electrical service or provide generators as required. Generators must be "Whisper Generator" or approved equivalent.
- 4. Before operations begin, the Contractor must have available on-site sufficient pumps, power sources, piping, tanks, and treatment equipment and other material



and equipment to assure that the operation of the dewatering system can be maintained.

5. If, in the opinion of the Engineer, the soils at the bottom of the excavation have become softened or disturbed due to inadequate dewatering measures, the softened or disturbed material must be over excavated to a depth accepted by the Resident Engineer and replaced with approved materials compacted to XXX percent of maximum dry density as determined per ASTM D1557.
6. Prevent erosion at all points of discharge.
7. Maintain dewatering and water management systems in place until cessation is approved by Engineer. Thereafter, remove dewatering and water management equipment from the site. If wells or well points are used, decommission per WAC 173-160.
8. Any pumping or dewatering device used within the in-stream work area must be equipped with a fish screen to prevent the passage of fish in accordance with RCW 77.57.010 and 77.57.070 and other requirements found within the HPA.

B. Fish Removal and In-Stream Work Isolation:

1. For all fish exclusion and removal, the Contractor must follow HPA provisions, United States Army Corps of Engineers (USACE) permit conditions and be completed in accordance with "WSDOT Fish Exclusion Protocols and Standards" referenced in Article 1.02.A.1.c. and in accordance with the USFWS document referenced in Article 1.02.A.4.a.
2. All fish exclusion work will be under the approval of the fish biologist.
3. In the event of any fish kills, the protocol designated within HPA provisions must be followed.

C. Preparation of Subgrades:

1. The Contractor is responsible for conducting a detailed site survey, including spot elevations, of stream boundaries before and after construction.
2. During establishment of the sub-grade for a stream channel, the Work must be performed in accordance with earth moving and dewatering requirements as stated elsewhere in the Contract Documents. The Contractor must maintain all excavations and embankments in a well-drained condition at all times.

### 3.03 INSTALLATION

A. Large Wood Construction:

1. Large Woody Debris and Habitat Features:
  - a. The Contractor must install each log, log with rootwad, or large wood structure at the location and elevation shown in the contract plans. The streambed and bank shall be temporarily excavated to allow placement of large wood. Backfill shall be native material or designed streambed material. Backfill shall be placed in lifts no thicker than 12 inches and shall be compacted to be uniformly dense and unyielding as approved by the Engineer. The Contractor shall exercise care when placing the Woody Material to ensure that the method of installation minimizes disturbance of waterways and prevents sediment or pollutant discharge into water (refer to WSDOT General Special Provisions 8-SA4.GR8).

- B. Anchors: *[NOTE TO DESIGNER: NOT ALL ANCHORS OR ANCHOR COMPONENTS MAY BE NEEDED FOR INSTALLATION OF LARGE WOOD OR WOOD STRUCTURES AT THE SITE, AND ADDITIONAL ANCHOR TYPES MAY BE SPECIFIED. DESIGNER MAY SELECT ANCHOR INSTALLATION INSTRUCTIONS FROM LIST BELOW AS NEEDED].*
1. Boulder Anchor Construction:
    - a. Two (2) 1-inch-diameter holes must be drilled a minimum of 12 inches deep into each boulder anchor. After holes are drilled in the boulder anchors, the holes must be thoroughly cleaned using compressed air to blow out the dust and rock particles. After being cleaned, the holes in the boulder anchors must be filled with epoxy adhesive per the manufacturer's instructions, and the u-shaped rebar inserted as shown in the Plans. Note that the minimum amount of epoxy adhesive to place in each hole is equal to the amount necessary to fill the hole to the top with the u-shaped rebar inserted.
    - b. After epoxy adhesive has cured a minimum of 12 hours, anchor the logs to the boulders as shown in the Plans. All logs to be anchored must be anchored such that there is no slack in the wire rope. Boulders must be installed tight under the log to be anchored so that the boulders limit log movement in horizontally, laterally, and vertically.
    - c. The wire rope must be looped around a thimble, through the U-shaped rebar, then doubled back on itself. The end of the wire rope must be secured using three wire rope clips, with the saddle of the clip placed on the "live" end of the wire rope, as described in Section WSDOT Standard Specification 6-02.3(17)F2 Applying Wire Rope Clips. Upon completion of the tie-off of the wire rope, the anchor boulder must be pressed down into the native soil using the bucket of an excavator or similar to the embedment depths shown in the Plans.
  2. Ground Anchors:
    - a. After installation, each permanent ground anchor must be demonstrated to installed to their rated capacity. The Contractor must complete permanent ground anchor testing using an excavator and load indicating device accurate to within 10 percent.
    - b. Anchors must be stainless-steel.
- C. Finished Grading:
1. Unless otherwise indicated, slope all restoration areas for positive drainage to prevent fish stranding during receding water. Tops, toes, and transitions of all slopes must be rounded to produce a gradual and natural-appearing transition between relatively level areas and slopes.
  2. Protect all areas against compaction by construction equipment. Existing and new compacted areas must be eliminated by loosening and aerating the soil with a chisel or ripper shank pulled to just below the depth of compaction, preferably when the soil is dry. Compaction depths should be checked before ripping so as not to needlessly disturb soil. Loosening and aerating must occur parallel with the contours unless the Resident Engineer deems it to be unsafe.
  3. The Contractor is responsible for providing detailed As-built Drawings of restoration areas to provide documentation that the intent of the mitigation plan

has been met. This includes spot elevations, all woody material, and all habitat features.

D. Streambed Material:

1. The size gradation of Streambed Material must be determined by the Resident Engineer by visual inspection of the load before it is dumped into place, or if so ordered by the Resident Engineer, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load. The Contractor must provide labor and equipment to move stones as needed for Resident Engineer measurements.
2. Streambed Materials must be placed in the prepared channel excavation to the lines and grades shown on the Plans. Streambed Materials installation must provide the specified minimum thickness.
3. Prepare streambed subgrade as shown in Drawings and place streambed material on dry subgrade. Do not place streambed material in standing water.
4. Place streambed material in two lifts (dumped in place from minimal height with minimal grading/reworking) to prevent segregation of stone by size.
5. If stream channel is used as a sediment pond during construction, managed sediment in accordance with plan. Use stream channel as sediment pond only prior to installing the second lift of Streambed Material.
6. Place large wood and boulder clusters as integral elements within Streambed Material matrix during or after the first lift of streambed material, not on top of streambed material or in holes excavated in streambed material with small stones packed around the boulders.
7. Placement of Streambed Materials must ensure that low stream flows are conveyed above the finished channel surface. During and after placement of each lift, the Contractor must apply water to facilitate filling the interstitial voids of the Streambed Materials. If subsurface flow is present, the Contractor must apply Streambed Sand or other material containing fines as approved by the Engineer. Comply with re-watering provisions in permits. The voids are satisfactorily filled when water equivalent to the flow rate of the stream does not go subsurface and there is visual acceptance by the Engineer. If water is not present in the stream, the Contractor must apply water to the stream channel for visual acceptance by the Engineer.

3.04 FIELD QUALITY CONTROL

- A. Work will be subject to observance and inspection as described in Article 1.03, in this specification.
- B. Work may be subject to additional observance and inspection as dictated by AHJ and XXX (Permit/Agency).

**END OF SECTION**