FINAL 30 PERCENT DESIGN REPORT
PROJECT AREA 15
TUCANNON RIVER, RIVER MILES 37.15 TO 35.35

Prepared for
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<thead>
<tr>
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<th>Description</th>
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<tr>
<td>BMP</td>
<td>best management practice</td>
</tr>
<tr>
<td>CCD</td>
<td>Columbia Conservation District</td>
</tr>
<tr>
<td>CMP</td>
<td>corrugated metal pipe</td>
</tr>
<tr>
<td>ELJ</td>
<td>engineered log jam</td>
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<tr>
<td>ESA</td>
<td>Endangered Species Act</td>
</tr>
<tr>
<td>GPS</td>
<td>global positioning system</td>
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<tr>
<td>LiDAR</td>
<td>Light Detection and Ranging</td>
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<tr>
<td>LWD</td>
<td>large woody debris</td>
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<tr>
<td>OHWL</td>
<td>ordinary high water line</td>
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<tr>
<td>PA</td>
<td>project area</td>
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<tr>
<td>RM</td>
<td>river mile</td>
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<tr>
<td>SRSRB</td>
<td>Snake River Salmon Recovery Board</td>
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<tr>
<td>TESC</td>
<td>Temporary Erosion and Sediment Control</td>
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<tr>
<td>WDFW</td>
<td>Washington Department of Fish and Wildlife</td>
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1 INTRODUCTION AND PROJECT PURPOSE

Anchor QEA, LLC, was retained by the Snake River Salmon Recovery Board (SRSRB) to develop 30 percent designs for salmonid habitat restoration within Project Area (PA) 15 of the Tucannon River as delineated in the Conceptual Restoration Plan (Anchor QEA 2011a) from approximately river mile (RM) 37.15 to 35.35. The Tucannon River basin is located in Southeast Washington State in Columbia and Garfield counties (Sheet 1). Enhancing and restoring instream habitat in the project area will be accomplished through a variety of treatment actions in the main channel, along the banks, and within the floodplain. These treatments include construction of instream habitat features such as engineered log jams (ELJs), large woody debris (LWD) placements, and modification of existing bank stabilization infrastructure to enhance instream and riparian habitat conditions in the project area and promote natural geomorphic process and watershed recovery. A description of the project site and existing natural processes and habitat conditions is provided, along with the specific physical and biological objectives that the proposed restoration features are expected to achieve. In addition, the project’s contribution to the overall watershed-scale restoration plan is described. Construction considerations and best management practices are also described for the proposed treatment actions to minimize disturbance of existing habitats and species.

The system-wide restoration objective for the Tucannon River is to improve habitat conditions for Endangered Species Act (ESA) listed species for all life history stages. Previous efforts have identified the habitat-limiting factors associated with the decline of ESA-listed populations (CCD 2004; SRSRB 2006). Existing physical, hydrologic, and habitat conditions were synthesized within the geomorphic assessment, as well as a variety of geomorphic parameters. The assessment results are characterized for 10 geomorphic reaches between the river mouth and near RM 50 at Panjab Creek (Anchor QEA 2011b). Reach-scale restoration actions based on this basin-scale assessment were developed at a preliminary level for RM 20 to 50 in the Conceptual Restoration Plan (Anchor QEA 2011a), which identified 28 conceptual project areas organized into a tiered prioritization approach, based upon selected evaluation criteria.
PA-15 was selected as a Tier 1 (highest priority level) project for early implementation by the SRSRB and Columbia Conservation District (CCD). This project will increase instream habitat complexity and promote natural channel processes by strategic placement of LWD, modification or enhancement of existing infrastructure, and excavation to reconnect a former mainstem channel. Collectively, the project elements target retention of mobile wood and sediment, side channel development, and increased connectivity between the river and the adjacent floodplain. An existing tributary, spring channel, and pond will also be enhanced to provide additional quality off-channel instream and riparian habitat; these elements were added to the project during the 30 percent design development. A summary of PA-15 in regards to the four evaluation criteria utilized in project prioritization and tier-level development is provided in Table 1; additional details of the project prioritization and discussion of the evaluation criteria are available in the Conceptual Restoration Plan (Anchor QEA 2011a).

### Table 1
#### PA-15 Evaluation Criteria Rationale

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Rationale</th>
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<tbody>
<tr>
<td>Expected biologic response</td>
<td>In the short term, the LWD placements will provide high-flow refuge, low-flow cover, and additional pools in the project area. In the long term, the project actions are expected to initiate the formation of more complex and diverse habitats for juvenile and adult fish. Increased floodplain connectivity will contribute to the recovery of ecological riparian processes.</td>
</tr>
<tr>
<td>Consistency with natural geomorphic processes</td>
<td>The proposed restoration actions will promote the retention of LWD and sediment and increase floodplain connectivity to initiate the development of a complex channel network through project area. These actions will contribute to the recovery of natural processes in the project area.</td>
</tr>
<tr>
<td>Benefit-to-cost ratio</td>
<td>The project is expected to have a moderate benefit and a low relative cost. The restoration treatments should provide some immediate benefit from the placement of LWD structures and increased side channel connectivity in the left floodplain; the desired geomorphic response will likely take place on a longer time line that will provide increased benefits as complexity develops in the project area.</td>
</tr>
<tr>
<td>Reach priority</td>
<td>The project area is located in Reach 8, which is a Priority 1 reach.</td>
</tr>
</tbody>
</table>

Source: Anchor QEA 2011b
2 PROJECT AREA DESCRIPTION

The project area is located within a portion of the river valley that is primarily owned by the Washington Department of Fish and Wildlife (WDFW), with approximately 900 linear feet that are privately owned near the upper end of the site. The valley area adjacent to the low-lying floodplain contains a private residence, and open space in the publicly owned parcels. An abandoned homestead is located within the lower WDFW site. Plan views of existing features can be seen in Sheets 2 through 5.

The natural historic (pre-settlement) channel condition of the Tucannon River is a dynamic, anabranching channel across the floodplain with multiple split flow paths and active erosion that establish diverse hydraulic conditions throughout the low-lying floodplain and maintains habitat. The channel and floodplain are at times naturally confined by alluvial fans or bedrock along the valley walls. The present condition of the channel in the project area is primarily a single-thread and plane-bed channel form with low sinuosity and limited split flow and off-channel habitat. Within some local areas of the project reach, there is evidence of active channel migration, riparian recruitment, and other habitat features that are valuable for salmonid habitat. However, confining infrastructure is also present that contributes to adverse hydraulic conditions and local incision. These features confine the channel and the accessible floodplain corridor, limiting natural processes such as channel migration, temporary sediment storage, and side channel development that would otherwise naturally sustain habitat features. In addition, spoil piles in the floodplain indicate previous management activities associated with straightening and deepening of the channel.

Russell Springs, a spring-fed channel, is located within the east portion of the floodplain that contains cool, flowing water that is heavily used by juvenile fish. An existing pond is located on the private property east of the channel near Station 37+00. The pond is spring-fed and drains into a channel that coalesces with the Russell Springs channel east of Station 27+00. An ephemeral tributary is located within the west floodplain, a majority of which is diverted to a ditch that is no longer in use since WDFW purchased the property. WDFW currently accesses the property from the west side of the river to treat the area for noxious weeds.
The project area and the conceptual project design are described herein as two subareas. The following sections provide a detailed description of existing physical conditions in each subarea.

2.1 Subarea 1, Stations 42+50 to 20+00

Key observations: The main channel contains little hydraulic complexity, has poor to moderate connectivity to low-lying portions of the left (west) floodplain; riparian cover and complexity are particularly lacking upstream of RM 37. Local incision and high velocities are present along the face of the existing infrastructure. Existing valuable habitat features include active erosion and riparian tree recruitment of the left bank between Stations 33+50 and 32+00, a channel-spanning log jam at Station 28+50, and high-flow connectivity to the right floodplain between Stations 26+50 and 22+00. Russell Springs also contains a high habitat value but is adversely affected by warm water draining from the private pond. The pond itself has poor water quality during the summer months.

The river channel in Subarea 1 is primarily a straight, single-thread channel (Sheets 2 and 3). The channel has likely been straightened and deepened historically, as indicated by its lack of sinuosity and the presence of spoil piles in the floodplain in several locations between Stations 22+00 and 31+00. The channel planform makes two bends at Stations 33+50 and 31+50 (Figure 2-1). In the upper bend, the channel is actively migrating in a downstream direction into the left floodplain. Recruitment of riparian trees and bank erosion were observed in this location. In the lower bend, the outer bank is lined with large, angular armor rocks that are supplemented with rootwad logs and willow plantings. Local incision along the face of the structure is evident in the Light Detection and Ranging (LiDAR) topographic surface and was observed during low-flow site reconnaissance. This is likely a result of high velocities being concentrated along the structure during high-flow events.
Figure 2-1

Two Bends in the Channel at Station 31+50 (foreground) and Station 33+50 (background); 625 cfs at Marengo Gage on April 4, 2012

A 0.4-acre pond is located in the floodplain approximately 350 feet east of Station 37+00 adjacent to a private residence. The pond is fed by a subsurface spring and has an outlet channel that connects to another spring-fed channel referred to as Russell Springs, located immediately to the east of the pond outlet. The pond was likely constructed several decades ago in a naturally marshy location with an ample groundwater supply, similar to the cattail-dominated wetlands south of the pond. The outlet is controlled by a berm and simple spillway outlet structure that releases water downstream into a channel that is primarily vegetated with cattails. Approximately 350 feet downstream, the channel becomes more defined. A 10-foot buffer on either side of the channel is vegetated with shrubs and deciduous trees, some of which have been planted during previous restoration efforts. The pond is relatively shallow and has filled in with sediment over time. Little overhang from adjacent vegetation exists; hence, the water temperature is warm, particularly in the summer months, which degrades the water quality. The temperature in the channel was measured as 14 °C in April 2012, as opposed to the Russell Springs channel, which was measured as 12 °C.
Water quality of Russell Springs is degraded where the warmer water of the pond outlet channel converges with the cooler spring flow.

Downstream of Station 30+00, the channel is straight for approximately 1,500 linear feet to the end of Subarea 1 (Figure 2-2). A channel-spanning log jam located at the downstream end of the armored bank at Station 28+50 created an approximately 5- to 6-foot drop in water surface elevation at the time of field observation in April 2012. This feature was also observed in July 2011 and has since retained additional LWD. The log jam currently creates a pinch-point in the channel planform; streambed spoils in the left floodplain contribute to the narrow channel at this location. Downstream of the log jam, the channel is plane-bed and lacks hydraulic complexity. The left floodplain contains multiple former channel paths; the two primary channels are between Stations 32+00 and 26+00, and Stations 25+00 and 21+00. These channels are both within the low-lying floodplain, except for the upstream end of the lower channel which is disconnected by a higher section of the floodplain (Figure 2-3). The downstream ends of these channels appear to be backwatered during seasonal high flows.
Figure 2-2
The Straight Section of the Channel between Stations 28+00 and 20+00, Looking Downstream; 120 cfs at Marengo Gage on July 20, 2011

Figure 2-3
Low-lying Former Channel Paths through the Left Floodplain (Bottom Half of Image); Pink Outline Indicates the Approximate Elevation of the 5-year Flood Elevation
2.2 Subarea 2, Stations 20+00 to 0+00

Key observations: The main channel contains low to moderate hydraulic complexity and moderate floodplain connectivity; small side-channel areas are present during seasonal high flows, although overall channel complexity is low. Some ongoing channel migration is occurring between Stations 13+00 and 6+00, but infrastructure limits the channel processes in other portions of the subarea. Active erosion and riparian tree recruitment is occurring on the left bank between Stations 33+50 and 32+00, and a channel-spanning log jam is located at Station 28+50.

The main channel through Subarea 2 consists of a series of seven low-sinuosity meander bends (Sheets 3 and 4; Figure 2-4). The upstream-most bend is armored along the right outer bank by an angular armor rock and rootwad log revetment between Stations 19+50 and 18+00. During low and seasonal high flows, velocities along the face of the structure are relatively high and turbulent (Figure 2-5). Downstream of the structure, the banks do not contain infrastructure and some are actively eroding, as shown in Figure 2-4. The right bank at the downstream end of the subarea is positioned along the edge of the bedrock valley wall. Through the subarea, the channel contains unvegetated gravel bars that split flow during low and seasonal high flows. However, the channel is relatively plane-bed and contains few deep pools or significant off-channel areas. Riparian trees have been recruited to the channel in areas of bank erosion although no significant/stable natural log jams were identified.
Figure 2-4
A Relative Elevation Map of Subarea 2 with Relevant Existing Features
The Main Channel Looking Downstream at the Engineered Bank Structure near Station 19+00; 625 cfs at Marengo Gage on April 4, 2012.

A constructed side channel flows around the upstream end of the bank structure between Stations 19+50 and 15+00. The upstream-most approximately 100 feet of the side channel is lined with armored rock. Approximately 350 feet from the side channel entrance, the channel flows through a corrugated steel pipe culvert beneath an access road; this crossing also contains armored rock (quarry spalls) adjacent to the culvert opening. Russell Springs flows along the east side of the low-lying floodplain, through two culverts at access road crossings, and enters the main river at Station 10+50. An ELJ is located at the mouth of the side channel along the right bank that provides cover and willows have been planted along the lower 450 feet of the spring channel to provide additional cover. During seasonal high flows, a small side channel from the main river flows across a gravel bar and adjacent to the ELJ (Figure 2-6).
Figure 2-6
Flow across a Gravel Bar During Seasonal High Flows, from the ELJ at Station 10+50; Main Channel is in Background; 625 cfs at Marengo Gage on April 4, 2012

Floodplain connectivity is moderate through the subarea. Small sections of side channel are present during seasonal high flows although significant off-channel areas are limited. Downstream of Station 12+00, a majority of the floodplain area is higher than the 5-year floodplain elevation and the low-lying floodplain corridor is relatively narrow (Figure 2-4). A push-up levee constructed of spoils is located in the left floodplain between Stations 5+00 and 2+00 that contributes to floodplain confinement.

2.3 Subarea 3, West Floodplain

Key observations: The tributary entering the south end of the west floodplain is currently diverted to an irrigation ditch that is no longer in use. The existing ditch and tributary currently provide minimal habitat value.

The west floodplain in Subarea 1 contains a vegetated lower-lying floodplain with a higher cleared floodplain and alluvial fan area that was formerly used for grazing. Portions of the higher-elevation area contain sediment deposits and channel scars from the 1996 flood event.
An un-named tributary enters the floodplain approximately 670 feet northwest of Station 34+50. A majority of the tributary is immediately diverted to the southeast into straight ditches that are oriented northwest-southeast across the cleared area. These ditches have not been in use since WDFW purchased the property for habitat restoration and preservation. According to local stakeholders, the tributary does not have a surface water connection with the river; water typically spills out into the floodplain and evaporates before entering the river.
3 PROPOSED RESTORATION DESIGN

The proposed restoration actions are described within each subarea, including the physical description and construction details, as well as brief summaries of the expected biological and physical benefits. Detailed descriptions of the general benefits of restoration actions on both a local and watershed-scale, including how these actions address habitat limiting factors are provided in several existing documents. For additional information, see Section 5 of the Geomorphic Assessment (Anchor QEA 2011b) and Section 3 of the Conceptual Restoration Plan (Anchor QEA 2011a). Appendix A describes the general physical and biological benefits and objectives of each of the proposed LWD and ELJ types.

The proposed restoration design is shown in Sheets 7 through 10. Design details for LWD, ELJs, and other typical restoration details are shown in Sheets 11 through 21. For the purposes of describing the site-specific benefits of the design elements, the proposed features are described within the respective subareas. However, the proposed design is intended to function collectively throughout the overall project area in order to achieve a reach-scale geomorphic response and optimum biological benefit in the long term.

3.1 Subarea 1, Stations 42+50 to 20+00

The primary objectives for salmonid habitat restoration within Subarea 1 are to establish hydraulic diversity, provide cover, protect existing valuable habitat in Russell Springs, and promote floodplain connectivity. The proposed restoration actions within this subarea are shown in Sheets 7 and 8 and include the following actions:

- Various LWD and ELJ placements in the plane-bed portion of the main channel between Stations 42+00 and 34+00.
- Construction of three ELJs at the head of a former channel pathway through the low-lying floodplain (near Station 31+00).
- Construction of four side channel roughness LWD features in the existing high-flow side channel area between Stations 26+00 and 22+00.
- Minor side channel excavation in the left floodplain near Station 26+00 to reconnect a former mainstem channel path.
- Placement of ELJs within the outlets of two floodplain overflow channel paths.
• Increasing the depth of the existing pond, improving the outlet, and planting around its perimeter.

Within the main channel between Stations 42+00 and 34+00, a variety of LWD features and ELJs are proposed within the main channel. A bar apex ELJ that is proposed at the upstream end of this section near Station 41+00 at the head of a former mainstem channel path in the east floodplain. In the short term, these structures are primarily intended to establish hydraulic diversity by initiating scour pool development and bedload sediment sorting and deposition. These structures will be placed on top of the channel bed and ballasted with streambed materials or large rock that may be sourced from off site. During high flows, the structures are intended to promote split flow through the low-lying former mainstem channel path in the long term. The bar apex ELJ would act as a hard point to promote split flow and channel development at this location. Several LWD placements (single-log roughness features and toe habitat features) on the right bank are proposed to further promote hydraulic diversity in the main channel and to create cover and complexity along the bank.

Near Station 31+00, two channel grade ELJs and one bar apex ELJ are proposed near existing armor rock and LWD revetment. The channel grade ELJs would be placed on the channel bed in front of the structure and would not require any modifications to the existing structure. The bar apex ELJ is proposed at Station 34+00 along the left bank at the upstream end of a low-lying former channel path through the left floodplain. In the short term, the ELJs will dissipate high velocities that occur along the face of the armored bank during high flows and will create hydraulic refuge and diversity in the channel. The bar apex ELJ will promote split flow through the left floodplain during flood events (likely at a 5-year recurrence interval or greater). In the long term, the three ELJs will work collectively to retain sediment and wood in this locally incised section of the channel to promote bed aggradation and increased connectivity through the left floodplain. With subsequent flood events, it is expected that the proportion of flow entering the floodplain channel to the left of the bar apex ELJ will increase and become more frequent, eventually leading to a more established anastomosing channel pattern long term.
Along the left bank and floodplain between Stations 26+00 and 20+00, a bar apex ELJ is proposed near Station 26+00 in addition to a minor channel excavation to remove an approximately 140-linear-foot portion of the floodplain that appears to contain historic spoil piles at the surface. These actions will reconnect a low-lying former channel path at more frequent flood events. The proposed excavation will emulate the existing low-lying channel with an approximately 10-foot bottom width and 2H: 1V side slopes up to existing floodplain grade (Sheet 15). The elevation of the channel bottom will be at approximately the 2-year flood water surface elevation and tied into the existing slope of the floodplain channel. Two wood entrapment ELJs are also proposed at the downstream end of floodplain flow paths. In the near term, the ELJs will provide structure and cover throughout the flow regime and will provide hydraulic refuge during high flows. Connectivity of the reconnected channel is expected to occur at 2-year and greater flows, increasing in frequency over time, eventually leading to split flow development through the left floodplain. With subsequent high flows, it is possible that the river may establish seasonal or perennial split flow though this channel.

Along the right bank, a variety of ELJs and LWD placements are proposed to create hydraulic diversity in the main channel. These structures are located such that high flows directed at the right bank exiting the left floodplain channel would be dissipated, minimizing the potential for channel migration into the existing spring channel in the short term. The spoil piles on the right floodplain adjacent to the proposed structures near Station 24+00 will be left in place and LWD placements will be positioned along the toe of the spoils to aid in minimizing channel migration into Russell Springs. The side channel roughness LWD features will additionally retain mobile debris and provide cover during seasonal high flows. Over the long term, future evolution of the main channel could potentially erode the spoil piles and capture the spring channel. The LWD placements are primarily habitat features that will promote wood and sediment retention and project high flows away from the spoil piles. They are not designed to prevent erosion should the river migrate into the area.

3.2 **Subarea 2, Stations 20+00 to 0+00**

The primary habitat restoration objectives in Subarea 2 are to establish hydraulic diversity, reduce channel confinement, provide cover, and protect existing valuable habitat in Russell
Springs. The proposed restoration actions within the subarea are shown in Sheets 8 and 9 and include the following:

- Removal of existing armor rock and rootwad logs as needed to place a bar apex ELJ at the upstream end of the existing side channel near Station 20+00
- Culvert and armor rock removal in the existing constructed side channel
- Placement of channel barb ELJs along the outer bank of the constructed side channel
- Various LWD and ELJ placements in the mainstem between Station 26+00 and Station 0+00
- Removal of an existing spoil pile berm in the left floodplain
- Placement of a channel-spanning ELJ at the downstream end of the site

Along the right bank of the main channel near Station 19+00, the existing armor rock and LWD revetment will remain in place. However, the armor rock lining the bed and banks of the constructed side channel and portions of the existing revetment along the main channel will be removed and re-used on site as ballast for LWD and ELJ structures. A bar apex ELJ is proposed at the head of the forested island between the constructed side channel and the main channel, which will require partial removal of the existing revetment. It is expected that over time these actions will promote a greater proportion of flow within the side channel. Therefore, the existing corrugated steel culvert and associated rock at culvert crossings should be removed to minimize damage to the culvert and prevent adverse effects of flow constriction in the side channel during high flows. Two channel barb ELJs and a second bar apex ELJ are also proposed to promote desirable evolution of the side channel. The channel barb ELJs will be placed along the outer right bank to protect the existing spring channel, which has high biological benefit to juvenile salmonids and other species (Hoverson 2012). The bar apex ELJ near Station 15+00 is proposed to maintain the downstream surface water connection. The three ELJs will also have immediate benefits by providing cover and complexity in the perennial side channel. The small existing rock and LWD placement at Station 15+00 may be demolished and the material used as ballast or incorporated into other habitat features.

A series of sediment retention LWD features is proposed along the left bank across from the upstream end of the existing structure between Stations 19+00 and 16+50. Between Stations 11+00 and 0+00, several additional LWD placements and ELJs are also proposed throughout
the main channel. A channel grade ELJ near station 10+00 will be placed in the mainstem, downstream of the existing log jam at the outlet of the spring channel. A bar apex ELJ is proposed near Station 8+00 at an existing gravel bar, and a channel spanning ELJ is proposed at the downstream end of the site. At the downstream end of the site, a channel-spanning ELJ is proposed. The structures will create hydraulic diversity in the short term. In the long term, the LWD will collectively promote aggradation of the bed, continued development of channel migration into the left floodplain, increased channel sinuosity, and other desired effects such as recruitment of riparian trees. In addition, the channel spanning ELJ is designed to retain mobile wood that may not have been retained by upstream LWD. Placement of the structure will minimize the volume of mobile LWD transported to the reach downstream, which contains several private residences.

The final restoration action proposed in Subarea 2 is to remove an existing spoil pile between Stations 5+00 and 2+50 in the left floodplain. The feature will be graded to the adjacent floodplain elevation and the materials used for backfill or distributed through the floodplain. The spoil pile is primarily unvegetated, therefore grading is not expected to have any adverse impacts to the riparian corridor. The actions will reduce local confinement of the mainstem during flood flows.

### 3.3 Subarea 3, West Floodplain

The habitat restoration objectives in Subarea 3 are to re-allocate the tributary flow towards the creation and maintenance of wetland and riparian habitat. The proposed restoration actions are shown on Sheet 10 and include the following:

- Reconnection of a tributary in the west floodplain by excavating a new channel alignment through the floodplain and abandoning the existing ditch
- Planting a vegetative buffer adjacent to the realigned channel where it flows through the cleared area of the floodplain

The tributary in the west floodplain will be realigned through a sinuous channel located primarily through existing flow pathways in the cleared floodplain and into the riparian area near Station 20+00 of the main channel. The proposed cross-sectional channel dimensions are a maximum 2-foot channel bottom width with 2H: 1V side slopes up to the existing
grade. This portion of the realignment is located through existing low-lying areas to minimize the channel grade. The dimensions may be modified on site according to local topographic conditions. An approximately 15-foot buffer of willow, cottonwood, shrub, or other plantings as appropriate are proposed along the margins of the realigned channel between Stations 19+25 and 13+25, which is an existing cleared area. At Station 11+30 of the realigned channel, the tributary will then drop into the lower-lying floodplain and enter the mainstem river near Station 12+50. Within this lower section, no excavation is proposed except the removal of an approximately 50-foot section of floodplain near Station 7+50 (of the realigned channel). Local depressions and raised areas through this part of the realignment will promote the development of ponds that will be ideal for establishing valuable beaver habitat. It is expected that beavers will influence the morphology of the channel over time.
4 CONSTRUCTION ACTIONS

Construction of this restoration project is expected to occur in summer 2013. Dewatering procedures, best management practices (BMPs), and strategic construction sequencing will be specified and provided to the contractor to minimize disturbance to existing habitat to the extent practicable.

4.1 Construction Sequencing

The following is a general outline of the construction sequencing for the project. Potential access roads and staging areas are shown in Sheet 6. The sequencing is based on prior experience with similar projects and serves as recommendations. Final construction sequencing and methods is ultimately up to the contractor.

- Temporary Erosion and Sediment Control (TESC) measures shall be completed as outlined in the TESC plan before mobilizing or moving equipment
- Staging areas and access routes shall be laid out in a manner that minimizes disturbed area
- Access to the site shall be from Tucannon Road on the right bank of the Tucannon River
- The left bank of the river shall be accessed by a temporary crossing of the channel to place LWD and to re-grade the push-up levee
- Care of water plan shall be implemented before any instream work begins
- All excavated materials being stockpiled for later use shall be staged above the ordinary high water line (OHWL)
- All equipment shall be stored above the OHWL
- Armor rock and levee structures shall be modified and stockpiled before ELJs are constructed, as specified
- Excavation for ELJs shall be to the design depth of the structure
- LWD and ELJs placed at the bank shall be done in a manner that minimizes disturbance of the bank
- Structures located furthest from access routes shall be constructed first, backing equipment out as structures are constructed
- As construction is completed, access routes shall be restored to pre-project condition
4.2 Mobilization and Project Area Preparation

Mobilization and project area preparation includes transporting equipment to the area, clearing for construction access and staging, and installing silt fencing and other project-specific BMPs. Any trees and brush cleared for access and staging will be side cast and used during decommissioning of the project area or integrated into other project components. Construction fencing will be placed along the perimeter of the staging areas and access roads to protect adjacent areas from disturbance.

4.2.1 Temporary Access

Temporary access roads may be constructed to access the project area from the east side of the river. Proposed access routes and staging areas are displayed in Sheet 6. In addition, temporary channel crossings may be installed to access bar/island components of the project and features along the west bank. Temporary crossings should be conducted as specified in the project plans to minimize channel disturbance. Site access may require some clearing of immature deciduous trees and shrubs. Any trees and brush cleared during this process will be stockpiled in the project area and used to decommission the access routes or integrated into other project components. Unvegetated gravel bars that are exposed during the construction window will be used as access routes between project area locations to minimize riparian impacts. For this reason, these areas may also be used as staging areas.

4.2.2 Weed Control/Prevention

To minimize the establishment and colonization of weeds and invasive plant species in the project area, several preventative measures can be implemented:

Pre-construction

- A survey for invasive/weed species should be conducted in the entire project area and upstream of all contributing waters prior to construction, planting, or soil-disturbing activities
- Invasive/weed species that are found should be documented on a map or noted by global positioning system (GPS) coordinates for annual inspection
- Invasive/weed species should be removed during or before flowering to prevent the spreading of target species seeds
• In removal areas, soil disturbance should be minimized by cutting the invasive/weed at the stem
• Removed invasive/weed species should be collected and taken away from the project area

**During Construction**

• The root systems of woody invasive/weed species should be removed if in the footprint of the designated soil-disturbance area
• Disturbed soils should be stabilized and covered with a seed-free mulch or anti-erosion material once final grade is established
• Established corridors of travel by construction and support vehicles should be minimized to prevent disturbance of soil and carrying invasive species/weeds into the project area
• All staged or delivered materials (rock, soil, mulch, plants, and LWD) should be inspected upon arrival to minimize the introduction of invasive seed sources and plant material

**Post-construction**

• All disturbed soils, including soil at planting areas should be protected with seed-free mulch or compost to suppress invasive/weed species and to retain moisture
• Revisit pre-construction invasive/weed species survey areas to look for regeneration and suppression (document findings)
• If plantings require irrigation, use a localized drip system instead of a broadcast system to minimize benefit to invasive/weed seed sources
• Establish an annual or biannual monitoring plan to identify and address the problem of invasive/weed species

4.3  **General Earthwork**

Earthwork involves excavation, hauling, and backfilling of native materials, including streambed materials. Earthwork associated with a majority of the LWD and ELJ placements will likely be in coarse gravel/cobble material with a variable sand and organic fraction.
Earthwork associated with spoil pile removal and gravel augmentation will likely be in gravel/cobble material with an unknown quantity of small- to medium-sized boulders.

Generally, a majority of the excavation may be efficiently accomplished using a tracked excavator with an appropriately sized bucket. A bucket with a clamp would be advantageous for working with larger sized material, including boulders. Material hauling within the project area may be accomplished with a dump truck (standard or articulating depending on the condition of the haul route) or a front-end loader. Generally, a majority of backfill could be efficiently accomplished using a tracked excavator.

### 4.4 Earthwork for Tributary Reconnexion

The realigned tributary channel will be excavated in the position and to the grades shown in the plan set. The final alignment of the channel may be modified on site under the direction of the supervising engineer or authorized representative. Trees and shrubs may be removed in order to excavate the channel; however, it is preferable that the channel alignment is modified such that mature riparian trees or other desirable vegetation is avoided. Any vegetation removed may be re-used on site by distributing on the floodplain or incorporating into structures. The excavated material may be distributed within the floodplain or used as structure backfill.

### 4.5 Large Woody Debris

This activity involves placing LWD of various types throughout the project area. Once the placement locations have been surveyed and, if required, field-adjusted by the engineer, placement would begin at the location farthest from the staging area and progressively work toward the staging area. Installation of LWD could be accomplished by using an excavator with a bucket equipped with a clamp (or a grapple) for log placement and a skidder (or similar machine) to ferry materials to the placement site. Before construction begins, all necessary material would be staged in an area on the floodplain or gravel bar adjacent to each LWD location so that the materials are within reach of the excavator once it is in a position to build the LWD. Some LWD types will require excavation for installation. If excavation extends below the water table, turbid water will be generated. Any dewatering required for installation of the LWD will be carried out in accordance with the best management...
practices for water control (Section 4.9.2). Each LWD placement will be completed before the start of construction of another unless enough equipment is present to work concurrently.

4.6 Engineered Log Jams

This activity involves construction of various types of ELJs throughout the project area. Final locations for the ELJs will be determined by the engineer in the field following the objectives described previously in this document. All necessary material will be staged in an area on the floodplain or gravel bar adjacent to each ELJ location before construction of each structure such that the materials are in reach of the excavator once it is in a position to build the ELJ. ELJs will be founded at the specified elevation to minimize undermining from scour after completion. Construction will involve excavation of the footprint of the structure and subsequently backfilling the structure with the material excavated for the footprint. All materials excavated for the placement of the ELJ will be used for backfill. No off-site disposal or redistribution of excavated materials is expected. Once the initial logs are placed at the necessary elevation, the structure can be constructed rapidly. Each ELJ will be completed before construction begins for another ELJ, unless enough equipment is present to work concurrently. Construction of ELJs could be accomplished by using an excavator with a bucket equipped with a clamp (or a grapple) for the log placement and a skidder (or similar machine) to ferry materials to the placement site. Because the ELJs will be constructed below the water table, turbid water will be generated. Any dewatering required for installation of the ELJs will be carried out in accordance with the best management practices for water control (Section 4.9.2). The contractor shall be responsible for dewatering the excavations and pumping water to a location suitable for natural infiltration and approved by the engineer and in compliance with any permits and regulations.

4.7 Culvert Removal

This activity involves the removal of a culvert under an un-paved earth access road. Removal will require the excavation and disposal of a corrugated metal pipe (CMP) culvert and removal of associated angular rock armoring the road prism. Angular rock removed should be re-used in other components of this project as appropriate.
4.8  Project Area Decommissioning

The contractor will break down any equipment and clean any remaining areas that need decommissioning. Water and sediment control structures will be left in place until all construction activities within the river have been completed and any temporary surface erosion control measures are in place. Once construction is complete, these components will be broken down and removed by hand, and the rest of the project area will be decommissioned before leaving the project area. Any temporary access routes and staging areas will be regraded to blend into the adjacent topography and revegetated with a native seed mix to minimize erosion of materials disturbed during construction.

4.9  Best Management Practices

4.9.1  Surface Erosion Control

Surface erosion control during construction is an important turbidity control measure for the project. Removal of vegetation may temporarily leave areas exposed and vulnerable to erosion before re-establishment of vegetation. Silt fencing around the perimeter of areas where vegetation is removed is recommended to capture sediment and delineate the construction disturbance limits. During project area decommissioning, straw mulch should be placed to minimize erosion of materials as vegetation is established. Silt fencing should be removed by hand once temporary surface erosion control measures are in place or vegetation is established in the disturbed areas.

4.9.2  Water Control

Water control during construction is the most critical turbidity control measure for the project. Installation of many project components will require excavation below the water table, and turbid water will be generated. The following section provides a brief description of the recommended water control procedures for project features requiring significant water control. However, the contractor will be responsible for developing the final water control plan. Additionally, the contractor will be responsible for dewatering the excavations as required for constructability and pumping water to a location suitable for natural infiltration as approved by the engineer. The contractor will provide sufficient equipment to accommodate changes to the water control plan required by project area conditions during construction as directed by the engineer.
4.9.2.1 Large Woody Debris and Engineered Log Jam Construction

Many of the LWD assemblies and ELJs will be placed in the active channel (or in areas with a surface water connection to the active channel during construction). For these locations, any required excavation will be conducted within temporary gravel berms, silt curtains, or other temporary flow separation method to minimize the dispersion of turbid water into the active channel. For structures in or near the main channel, water entering the excavation will be of a significant volume. We recommend pumps (of sufficient size and quantity) to partially dewater the excavation. Water would be pumped from the excavation area into an infiltration area. The infiltration area should be located on the floodplain to minimize the potential for overland flow back into the river and to prevent damage to sensitive habitat (wetlands and alcoves). Infiltration rates into the floodplain will be significant and we expect that only a minimum amount of turbid water pumped onto the floodplain will not be infiltrated. If the infiltration capacity is exceeded, overland flow will be routed over existing vegetation to encourage suspended sediment deposition before flowing back to the river.

For LWD assemblies and ELJs placed in the active channel that do not require a significant quantity of excavation, turbidity control is not expected to be a significant issue. For structures not requiring excavation dewatering of the feature, location is also not anticipated to be required.

4.9.3 Refueling Practices and Spill Prevention and Countermeasures

The following best management practices will be implemented for spill prevention during refueling:

- Each piece of machinery will be checked daily for leaks and any repairs will be done before work in or near water
- All vehicle staging, cleaning, maintenance, refueling, and fuel storage will take place above the OHWL in an approved staging area that is 150 feet or more from any waterbody in accordance with local, state, and federal regulations and permit conditions
- A driver/operator must be present and maintain constant observation/monitoring of the fuel transfer at all times
• A driver/operator must be trained in spill prevention, cleanup measures, and emergency procedures
• All employees must be made aware of the significant liability associated with fuel spills
• Spill containment and countermeasures must be maintained at all locations where refueling occurs; materials include non-water absorbents capable of absorbing 15 gallons of diesel fuel and drip pans
• All machinery and equipment working in or near waterbodies will maintain non-water absorbents capable of absorbing 15 gallons of diesel fuel and drip pans
• If a power generator is used during construction, the generator should be placed out of the river channel within a spill containment unit
5 LIMITATIONS

We have prepared this report for use by SRSRB for use in conceptual design development and to provide pertinent design detail to inform the project permitting process. Further development of the conceptual designs described in this document will require additional evaluation and design. The figures included in this report were not developed for use in construction or contract bidding. Conditions within the project reach may change both spatially and with time, and additional scientific data may become available. Significant changes in reach conditions or the available information may require re-evaluation. Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted scientific and engineering practices for restoration design at the time this report was prepared.
6 REFERENCES


APPENDIX A
WOOD PLACEMENT AND STRUCTURE DESIGNS
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A.1 LARGE WOODY DEBRIS

A.1.1 Functions and Benefits
Large woody debris (LWD) creates instream complexity that provides cover, hydraulic refuge, and holding areas for instream species. LWD also promotes retention of additional woody debris, spawning gravels, and fine sediment, and promotes the development of channel networks by splitting or re-directing flow. Installing LWD is often necessary to achieve desired habitat objectives, recognizing that it may take decades of watershed-scale restoration measures or natural recovery to re-establish natural (pre-settlement) replenishment rates. In the long term, the added channel and bank roughness created by wood structures retains additional mobile wood and sediment, thereby further diversifying hydraulic and bedform complexity, and contributing to increased floodplain connectivity, channel planform diversity, and functionality of natural geomorphic processes over time.

Habitat benefits provided by LWD in streams include:

- Scour pools that provide holding and cover
- Hydraulic diversity that promotes water quality
- Velocity shelters in the lee of the LWD that create holding and resting areas for fish during a range of discharge conditions
- Retention and distribution of spawning-sized sediment
- Maintenance of a complex channel system (e.g., side channels, alcoves) that sustains diverse hydraulic conditions throughout the hydrologic regime

A.1.2 Types of Features and Placements
There are several types of LWD features that may be installed in the channel bed, bank, or elsewhere in the active channel or floodplain to create beneficial fish habitat and desired geomorphic effects. Each type has varying levels of engineering and construction effort and a range in magnitude of physical and biological benefit. Each type is identified by its functional name. The types of LWD proposed for the project area are:

- Single log roughness LWD (Sheet 11)
- Toe habitat LWD placed along the banks of the main channel (Sheet 12)
- Sediment retention LWD placed on gravel bars in the main channel or side channels
A.1.2.1 Single Log Roughness Large Woody Debris

The proposed single log roughness features are single logs with rootwads placed in small channels, with the bole placed either perpendicular or parallel to flow and the rootwad exposed in the channel (Sheet 11). For the parallel orientation, the log may be secured to mechanical soil anchors driven into the bed or log anchors buried into the bed. For the perpendicular orientation, the rootwad log may be secured to healthy standing trees or the bole of the log may be buried into the bank to provide stability. For both orientations, a limited amount of synthetic fiber or steel wire rope, strategically designed to limit visibility, can be used to secure the rootwad log to the anchors are trees.

Specific habitat benefits of single log roughness features include:

- Providing low-flow cover and structure for juvenile fish
- Providing high-flow refuge locations for juvenile fish in flow stagnation areas and in void spaces

A.1.2.2 Toe Habitat Large Woody Debris

The toe habitat features consist of two logs with rootwads oriented in an L-shape and placed along the channel bank, with one log parallel to the bank and one log perpendicular to the bank placed over the parallel log (Sheet 12). These features add roughness along the channel banks. The rootwads protrude into the channel to interact with low flows and help create a small localized scour pool. These features are sufficiently spaced along the channel bank that they will not limit the natural channel migration process. Over time, if the channel migrates over the features, the logs will collect additional woody debris and continue to provide juvenile fish habitat benefits. The log perpendicular to the bank may be secured to mechanical soil anchors with synthetic fiber or steel wire rope to provide stability. Alternatively, the bole of the log may be keyed into the bank to provide stability. The log parallel to the bank is pinned under the perpendicular log and held in place behind the rootwad.
Specific habitat benefits of toe habitat features include:

- Providing low-flow cover and structure for juvenile fish
- Promoting development of a small localized scour pool that provides hydraulic diversity at low flow
- Providing high-flow refuge locations for juvenile fish in flow stagnation areas and in void spaces

**A.1.2.3 Sediment Retention Features**

The sediment retention features consist of three logs with rootwads laid out in a Z shape (Sheet 13). Typically, these features are placed atop a gravel bar, with the rootwads facing toward the channel to interact with low flow. Stability is achieved by securing the four corners of the placement to buried rootwad log piles. Alternatively, mechanical soil anchors driven into the bed may be used in place of buried rootwad log piles. In locations where bedrock may be near the surface or the channel is located adjacent to the bedrock valley wall, the sediment retention features may be placed on the channel bed and large boulders may be used as ballast. A limited amount of synthetic fiber or steel wire rope, strategically designed to limit visibility, is used to secure the logs together and to the piles, mechanical soil anchors, or rock ballast.

Specific habitat benefits of sediment retention features include:

- Providing low-flow cover and structure for juvenile fish
- Promoting sorting and temporary storage of sediment in the lee of the feature to provide habitat diversity and a medium for riparian vegetation growth over the longer term
- Providing high-flow refuge locations for juvenile fish in flow stagnation areas and in void spaces

**A.1.2.4 Side Channel Roughness Features**

The side channel roughness feature consists of two log piles and logs with rootwads weaved between them (Sheet 14). These features are typically placed within an existing side channel
adjacent to the outer bank where they will interact with seasonal high flows and rack mobile debris. When placed in series, the structures may deflect energy away from the bank during flood flows; however, this is not the primary objective of the structure. Stability is achieved by burying piles to below the expected scour depth and securing the top cross log to the piles with a limited amount of wire or natural fiber rope.

Specific habitat benefits of side channel roughness features include:

- Providing cover and structure for juvenile fish during seasonal high-flow conditions
- Promoting retention of additional debris
- Add hydraulic diversity to side channels
A.2 ENGINEERED LOG JAMS

A.2.1 Function

Engineered log jams (ELJs) are wood structures that can be placed in the main channel of a river. The primary function of these log jam structures is to create pools and provide cover and refuge while accumulating additional woody debris and promoting gravel sorting and retention. ELJs may also promote the development of multiple flow paths and side channels. ELJs are typically placed along the bank or mid-channel with the bottom of the structure near the anticipated scour depth and the top built to the approximate height of the design water surface elevation. A large portion of the structure is backfilled with streambed materials for stability, and a gravel bar deposit may be placed in the lee of the structure to emulate the natural sediment deposit that would occur in the lee of this type of structure.

A.2.2 Benefits

ELJs create diverse hydraulic conditions that provide resting areas in close proximity to complex cover. Fish conserve energy when holding in the flow stagnation areas up- and downstream of the structure. ELJs also contain a substantial amount of void space within the logs and root masses, providing considerable area for fish refuge. During high flows, the rootwads interact with hydraulic forces from the river and scour large, deep pools that provide holding areas for adults, while the void space within the face of the structure is used by juveniles. In addition, these structures are able to retain mobile wood debris, providing greater complexity and refuge habitat. Because of the hydraulic conditions and hard points created by ELJs, they may also be used as “deflectors” to influence flow direction to promote channel expansion or activation of side channels.

On a reach scale, ELJs can influence gravel scour and deposition, creating localized pool-riffle sequences in otherwise straight, confined plane-bed channel segments. Collectively, the addition of ELJs to a channel can result in a significant increase in hydraulic complexity and a more diverse channel profile throughout a reach. Sediment storage and deposition adjacent to the ELJs can create gravel bars in the active channel, allowing for colonization of riparian vegetation and eventually the development of forested islands. The overall roughening of the active channel and deposition on the riverbed promotes rehabilitation of natural processes by increasing floodplain connectivity and promoting channel migration.
A.2.3 Types

There are several types of ELJ structures that may be constructed in the project area to create beneficial fish habitat and desired geomorphic effects. Each type has varying levels of engineering and construction effort and a range in magnitude of physical and biological benefit. Each type is identified by its functional name and the type letter used in the design Drawings. The types of ELJs proposed for the project area are:

- Wood entrapment ELJ constructed in side channels and along banks (Sheet 15)
- Channel barb ELJ constructed at the outlet of side channels and along the banks of the main channel (Sheet 16)
- Bar apex ELJ constructed at the head of an island or mid-channel bar (Sheet 17)
- Channel grade ELJ constructed within the active channel and set on the existing channel bed (Sheet 18)
- Channel spanning ELJ constructed across the active channel (Sheet 19)

Each structure type provides essentially the same habitat functions but creates different hydraulic conditions and varying levels of benefits.

A.2.3.1 Wood Entrapment Engineered Log Jams

The wood entrapment ELJ (Sheet 15) consists of 5 piles and key members with rootwads placed strategically along the front and sides of the structure. Stability is achieved by burying piles below the expected scour depth and securing the top logs to the piles with a limited amount of wire or natural fiber rope. The rootwad logs are placed within the structure to distribute the load of the secured top logs across the lower layers. During low-flow conditions, water will flow through the voids of the porous structure, creating cover and hydraulic diversity. During seasonal high flows, the wood entrapment ELJ will add hydraulic diversity but will generally be overtopped and create little hydraulic impact during flood flows. The structure is designed to retain additional woody debris that will accumulate on and within the structure over time, increasing the hydraulic influence of the ELJ over time.
A.2.3.2 Channel Barb Engineered Log Jam

The channel barb ELJs (Sheet 16) are constructed of multiple logs with rootwads configured strategically with rootwads exposed along the front and sides of the structure. The logs are secured together with a limited amount of wire rope or chain at the corners and the structure is backfilled with rock materials to provide ballast for stability; the rock backfill does not interface with the channel. Typically, the logs placed parallel to flow are the largest in diameter and rootwad size, providing more exposed rootwad area to the approach flow. The logs perpendicular to flow may be smaller in diameter; the rootwads of these logs will provide hydraulic roughness along the face of the bank. The hydraulic complexity along the rootwads and within the voids of the structure is highly used by juvenile fish. When a channel barb ELJ is placed along the bank, a scour pool is typically maintained in front of and along one side the structure at the rootwads. The scour pool may be excavated at the time of construction if desired. The hydraulic conditions created by the ELJ create low-velocity stagnation zones upstream and downstream as flow is redirected around the structure. Additionally this structure type helps to maintain the integrity of the bank in the near term when placed along the outside bend of a channel. The structures may be placed in a series to create a more continuous flow deflection effect along the bank. The open spaces between logs on the sides and top of the structure, in addition to the potential sediment deposit in the lee, provide areas for vegetation to become established (i.e., live stakes or natural growth), supporting long-term riparian vegetation development.

A.2.3.3 Bar Apex Engineered Log Jams

The bar apex ELJs are constructed of multiple logs with rootwads configured strategically with rootwads exposed along the front and sides of the structure (Sheet 17). The logs are secured together with a limited amount of synthetic fiber or steel wire rope at the corners and the structure is backfilled with streambed material, which is not exposed to the river. Typically, the logs placed parallel to flow are the largest in diameter and rootwad size, providing more exposed rootwad area to the approach flow. The logs perpendicular to flow may be smaller in diameter. When a bar apex ELJ is placed mid-channel, a scour pool is typically maintained around the structure. The scour pool provides a deep holding area at the upstream end that tails out along the sides. The scour pool may be excavated at the time of construction if desired. The hydraulic conditions created by the ELJ create low-velocity
stagnation zones upstream and downstream as flow is redirected around the structure. Because the channel adjusts to the structure by forming the scour pool and depositing sediment in the lee, this type of ELJ is often placed in rivers with ample bedload and in areas of the channel where sediment sorting is likely to occur. Bar apex ELJs may be placed near the upstream end of existing flood flow paths to promote development of a side channel, or they may be placed mid-channel on gravel bars to promote development of split flow, thereby increasing channel complexity.

A.2.3.4 Channel Grade Engineered Log Jams

The channel grade ELJs (Sheet 18) are constructed of multiple logs with rootwads configured similarly to a bar apex ELJ (Sheet 17). However, the channel grade ELJ has two major differences: 1) the ELJ is placed at the grade of the existing channel bed and 2) the logs parallel to the flow extend beyond the backfilled portion of the structure, creating a pocket for additional woody debris accumulation over time. As in the bar apex ELJ, the logs are secured together at the corners with a limited amount of synthetic fiber or steel wire rope and the enclosed portion of the structure is backfilled with streambed material. To provide the required ratio of ballast to wood volume the logs placed perpendicular to the flow are positioned to retain the sediment backfill while the center of the enclosed portion of the structure remains open. This configuration is required to prevent the logs placed parallel to the flow from leveraging the structure out of place.

Because the channel grade ELJ is placed at the grade of the existing channel bed, this type of ELJ is placed in portions of the river with larger than average bed material where a deep scour pool is not anticipated; however, when a channel grade ELJ is placed mid-channel, a small scour pool is still typically maintained around the structure. The scour pool provides a holding area at the upstream end that tails out along the sides. The scour pool may also be excavated at the time of construction if desired. The hydraulic conditions created by the ELJ create low-velocity stagnation zones upstream and downstream as flow is redirected around the structure. Channel grade ELJs may be placed close together to roughen the active channel and promote deposition on the riverbed rehabilitating natural processes and reducing channel incision.
A.2.3.5 Channel Spanning Engineered Log Jams

The channel spanning ELJs (Sheet 19) are constructed of multiple logs with rootwads laid out across the active channel and the adjacent gravel bars or low floodplain. The logs are secured together using synthetic fiber or steel wire rope, strategically designed to limit visibility. The structure is secured to large boulders to resist movement under hydraulic forces. The structure will retain mobile wood and sediment thereby helping to reverse the incision process and promote increased floodplain connectivity and overbank flow path development. It is likely that these structures will accumulate additional woody debris that adds to the overall height and complexity of the structure, further promoting local floodplain connectivity. Low flows will pass through the voids in the structure while high flows will pass over the top and around the edges of the structure. The structure will be placed on the existing channel grade and will be flexible to conform to changes in bed or bank topography.
PLAN SHEETS