To: Shelly Badger and Stephanie Ray, City of Yelm
Julie Rector and Peter Brooks, City of Lacey
Laura Keehan and Andy Haub, City of Olympia

From: Confluence Environmental Company and Natural Systems Design

Date: February 13, 2015

Re: Deschutes River Habitat Restoration Project 60% Basis of Design Memo

Enclosure: Attachment 1: Deschutes River Habitat Restoration Project Groundwater Hydrology Analysis Memo

---

1.0 INTRODUCTION AND PURPOSE

This Basis of Design Memorandum has been prepared by Confluence Environmental Company and Natural Systems Design, herein referred to as the Confluence Team, in support of the Deschutes River Habitat Restoration Project (Project) located on the former Smith Ranch at 16224 Vail Road SE in Yelm, Washington. The project is being undertaken as part of a mitigation portfolio for water rights approvals for the three-city applications by the Cities of Olympia, Yelm, and Lacey (Cities). This memorandum describes the design considerations applied in developing the 60% design package.

The Project will restore habitat on an approximately 185-acre parcel as part of a multi-faceted mitigation portfolio for water rights approvals issued by the Washington Department of Ecology (Ecology). The acquisition of the property and the restoration included in this Project are elements of the mitigation portfolio. The Cities committed to the following restoration actions at the former Smith Ranch as part of their mitigation portfolio:

- Re-establish wetland around the smaller springs
- Reshape existing channel from main spring
- Construct large wood revetment structure along one of the eroding reaches along mainstem Deschutes River
- Replant high-density 50-foot-wide riparian buffer and install buffer fence along mainstem Deschutes River
- Replant low-density riparian buffer between 50 and 200 feet from mainstem Deschutes River

The Confluence Team is designing the wetland, main spring channel, and large wood revetment. The South Puget Sound Salmon Enhancement Group (SPSSEG) has been contracted separately by the Cities to design the planting plans for the wetland, the riparian zone along the mainstem, as well as the riparian zone along the reshaped main spring channel.

2.0 PROJECT DESIGN GOALS AND KEY ASSUMPTIONS

The primary design goal is to fulfill the Cities' mitigation commitments to Ecology specific to the former Smith Ranch restoration site. Specific project design goals and the key assumptions that have informed the design are listed below for each restoration element. A specific site design goal that applies to the entire Project is that the Project will not result in excess soil that would require off-site disposal.

A key assumption that applies to the entire Project is that grading activities across the entire Project will not result in uplands being created in more than 0.5 acres of delineated wetlands for the entire project area. This threshold is related to a U.S. Army Corps of Engineers (Corps) Nationwide Permit (NWP) permitting requirement.

The Cities have entered into an agreement with Mr. Smith that 15 full size trees with rootwads will be harvested from the Smith Ranch site. The design of the restoration activities assume that the trees will be at least 60 feet in length and 10 inches diameter at breast height when harvested. These trees will be used as Large Woody Debris (LWD) structures in the Lake Lawrence outlet channel (outlet channel), spring channel, and/or riverbank stabilization design.

Wetland Design

The design goals for the wetland rehabilitation area are:

- Re-establish or rehabilitate 21.7 acres of wetlands along the Lake Lawrence outlet channel (outlet channel)
- Partially fill side drainage ditches and grade surrounding areas to promote wetland hydrology
- Raise groundwater levels in the proposed wetland area through installation of hydraulic control structure in the outlet channel (roughened channel section)
- Maintain fish passage for juvenile salmon throughout the outlet channel, including past the hydraulic control structure
- Improve base flows and reduce peak flows in outlet channel
- Establish 25-foot vegetated riparian buffer

Assumptions associated with this design are:

- Groundwater data collected from January to July 1, 2014 did not represent a typical water year for the site based on precipitation data analyzed for December 2013 to July 1, 2014.
- Filling side ditches will result in a rise of shallow groundwater that will contribute to establishing wetland hydrology in the proposed wetland area. The amount of rise has not been modeled.
- Outlet channel winter/spring design flow through wetland area is 25 cubic feet per second (cfs) based on observations made during December 2013 field visit and adjusted to account for the lower than normal precipitation that occurred in December 2013 (see Attachment 1 for summary of precipitation analysis).

- The roadbed material to be removed and salvaged from the road crossing the wetland rehabilitation area will provide appropriate and adequate material for the structure of the roughened channel feature that is proposed. Appropriate cobble/gravel mix material will need to be imported for the surface of this structure that will form the new streambed.
- The roadbed from the road crossing the wetland restoration area will not need to be over-excavated to provide appropriate surface for wetland plantings.
- Fill volumes are assumed to be 150% of excavated volumes in order to calculate cut/fill balance for the site.

Spring Channel Design

The design goals for the spring channel are:

- Increase and improve the available aquatic habitat in the channel
  - Restore self-sustaining channel appropriate for low flow volume of spring water source
  - Ensure sustaining flow of cool, spring water to outlet channel
  - Establish template for channel within banks of dense root mass and cover vegetation
  - Include large woody material for overhead cover and instream complexity for juvenile salmonid benefit
  - Include excavated pools
- Establish emergent marsh fringe and riparian vegetation
- Establish 25-foot vegetated riparian buffer on each bank

Assumptions associated with this design are:

- Any fill placed within the existing ditches will not exceed the elevation of the adjacent overbank.
- Flow observed in the channel in December 2013 represented a typical discharge for the spring. No low flow observations have been made to date.

Riverbank Stabilization Design

The design goals for the riverbank stabilization work are:

- Stabilize the most rapidly eroding bank within the project area
- Increase engagement of complex wood within low summer flow up to bankfull
- Increase refuge habitat by enhancing current low-velocity pool and overhead cover

Assumptions associated with this design are:

- Bank stabilization does not extend more than 350 feet of bank length.
- Structure will be supported and ballasted minimizing or avoiding the use of added rock.

- Construction of large wood cribwall does not exceed an average of one cubic yard per running foot of material placed below the ordinary high water mark. This threshold is related to a Corps NWP permitting requirement.

Riparian Buffer along Deschutes River

Design goals and assumptions for the riparian buffer enhancement along the Deschutes River is addressed in a separate report titled Deschutes River Ranch Riparian Restoration Planting Plan (SPSSEG 2014). The 50 foot buffer area has already received approval from the Cities and was planted in the fall of 2014. The 50-200 foot buffer is currently under review for approval. This area is noted in the 60% design drawing set and costs for the 50-200 foot buffer are included for future budgeting purposes.

3.0 SITE CHARACTERIZATION DATA AND ANALYSIS

This section describes the data collected on the site and the analysis conducted to inform each design element.

The City of Lacey conducted a topographic survey of the project site in November 2010, which provided the primary topographic data for all elements in the design. Additional site characterization activities for this project involved the following:

- A topographic survey conducted by the Confluence Team in January and March 2014 to supplement the information available from the City of Lacey's survey
- A comprehensive site reconnaissance visit by the Confluence Team and SPSSEG on December 11, 2013
- Groundwater monitoring within the wetland rehabilitation area conducted from January to July 1, 2014

Wetland

Information on existing wetland conditions was collected by SPSSEG as part of the wetland delineation for the site. The final wetland delineation report is dated November 2014 and was reviewed as part of the 60% design (SPSSEG 2014). The delineation shows that a majority of the proposed wetland area currently functions as an impaired wetland. The wetland has been impacted by installation of drainage ditches, drain tiles, soil tilling, compaction from livestock, and vegetation manipulation. The boundaries of the delineated wetland are shown in the 60% design drawing set.

The groundwater hydrology investigation involved installation of 9 piezometers throughout the proposed wetland rehabilitation portion of the project. The data collected, analysis, and recommendations are discussed in the Deschutes River Habitat Restoration Project Groundwater Hydrology Analysis memo dated August 7, 2014 (see Attachment 1). Attachment 1 is an updated memo based on comments received from the Cities and SPSSEG in August 2014. The groundwater analysis concluded that the site should be able to support the proposed 21.7 acres of wetland re-establishment and rehabilitation with minimal grading.

Roughened Channel - A locally steep (no more than 3% gradient) roughened channel reach will be installed in the outlet channel to raise water levels (i.e., function as a hydraulic grade control) just downstream of the wetland rehabilitation area. The roughened channel section was designed based on an estimated typical discharge (Q) of 25 cfs for the winter/spring season. This estimate was based on field observations made during the December 2013 field visit (Figure 1), survey information provided by the Cities, and comparison to Washington Department of Fish and Wildlife (WDFW) design flows discussed below. This flow does not represent a bankfull condition in the channel.

Figure 1: Outlet channel culvert to be removed within wetland rehabilitation area. Photo taken December 11, 2013.

The reach slope downstream of the roughened channel apex was designed at a 3% slope (S) to allow for fish passage through the roughened channel section. The slope upstream of the roughened channel apex was designed at a 5:1 negative slope dropping down upstream to meet existing channel bed. Upstream of the structure the channel slope was determined based on City provided topographic survey to be 0.5%. At this time it is assumed that the surface of the roughened channel will be constructed of cobble and gravel mix with largest cobbles up to 12 inch maximum diameter. Based on these design criteria, a Manning's roughness coefficient (n) of 0.06 was used for this section of the channel. The wetted area (A) and hydraulic radius (Rh) were determined based on Manning's Equation using the design flow of 25 cfs:

$Q = (1.49/n)*A*R_h^{2/3}*S^{1/2}$

The location of the apex of the roughened channel section was determined based on the designed downstream slope, the new spring channel connection location, and designed thalweg elevation at this connection point.

As part of the 60% design effort the flow of the outlet channel was further investigated. The outlet channel is not a gauged stream system. Flows for ungauged systems can be estimated using StreamStats. StreamStats is an on-line program supported by the U.S. Geological Survey (USGS) that provides stream flow statistics and drainage-basin characteristics (USGS 2014). Unfortunately, this system did not support analysis of the outlet channel's drainage-basin. USGS also provides Regional Hydraulic Geometry Curves to estimate stream flow for the West Cascades and Puget Lowlands. These curves do not accurately represent the Lake Lawrence drainage basin due to the large storage capacity of Lake Lawrence and the large number of springs that are located within the system. The team opted to use a design flow based on the fish passage design flow analysis contained in WDFW's 2013 Water Crossing Design Guidelines, Appendix G (Barnard et al. 2013).

The project site is within the Puget Sound Region (Region 2): Lowland streams less than 1,000 feet in elevation. Fish passage design flow for the site is based on regression analysis of high passage flows during the January and May migration periods conducted by WDFW. The flow equations that are recommended for the project site are:

$Q_{fp}=aA^bP^c$

Where:

Q_{fp}= Fish Passage Design Flow
a= constant and is 0.125 in January and 0.001 in May
A= Drainage area in square miles
b= coefficient and is 0.93 in January and 1.09 in May
P= mean annual precipitation in inches
c= constant and is 1.15 in January and 2.07 in May

The Thurston County Watershed Characterization (Thurston County 2011) provided a drainage area estimate for Lake Lawrence and its sub-watersheds. For the Lake Lawrence Outlet Channel the contributing sub-basins total 4.34 square miles. Mean annual precipitation for the site was determined using the Washington Mean Annual Precipitation Map (OSU SCAS 2003). Based on this mapping, the annual precipitation for the site is 45 inches.

Using the WDFW-recommended equation above, the fish passage design flows for the outlet channel range between 3.27 cfs in May to 58 cfs in January. Therefore, the assumed flow of 25 cfs based on December 2013 observations is within this range and will be used as the design flow at this time.

No changes to elevation of the hydraulic control apex are proposed for this design stage. Based on the analysis done for the 60% design, the water surface elevation just upstream of the structure would be 409.5 feet elevation. In order to handle additional flow during high flow events, the existing 411 feet elevation on the banks of the outlet channel have been pulled back to create a floodway area to create extra flow capacity during high flow events.

Setting the elevation of the roughened channel apex at 409.5 feet means that it is positioned well below the elevation of the existing upstream beaver dam and weir at the outlet of Lake Lawrence which are both at 417 feet elevation. The upstream beaver dam and outlet of the lake are 2,500 feet and 3,300 feet upstream, respectively, of the proposed hydraulic control structure. The elevation of the wetland area surrounding the outlet channel ranges from 410 feet to 414 feet. Any flood flows that would rise to the level of the upstream beaver dam would flood out within the 21.7 acres of wetland prior to backing up water within the outlet channel.

Going forward to the 90% design additional details will need to be designed for the hydraulic control structure to further address potential erosion around the structure and the composition of the surface cobble/gravel mixture. Erosion around the structure would involve designing lateral placements of coarse material that would extend out from the channel banks at some regular interval downstream of the structure The material on the surface and downstream side of the structure will also need to be sized to withstand the higher flows.

The Cities have proposed to install a stream gauge system within the outlet channel to monitor flows both at the Lake Lawrence outlet and downstream of the beaver dams. The information from this monitoring effort would also help to inform design flows based on site observations, including summer low flow conditions.

Spring Channel

The base survey was the basis for establishing elevations for the upstream and downstream tie-in points of the restored main spring channel. During the site visit, observations of subtle topographic depressions suggested a relic channel in the adjacent overbank of the current spring channel ditch. To confirm this observation and interpretation, LiDAR from the Puget Sound LiDAR Consortium, recorded in 2011, was obtained for the nearby area and, from this data, a Relative Elevation Map (REM) produced (Figure 2). The REM depicts a relative difference in elevation between the approximate water surface of the spring channel and the adjacent landscape. The REM confirmed the low areas that indicated relic channels in which the spring may have once flowed.

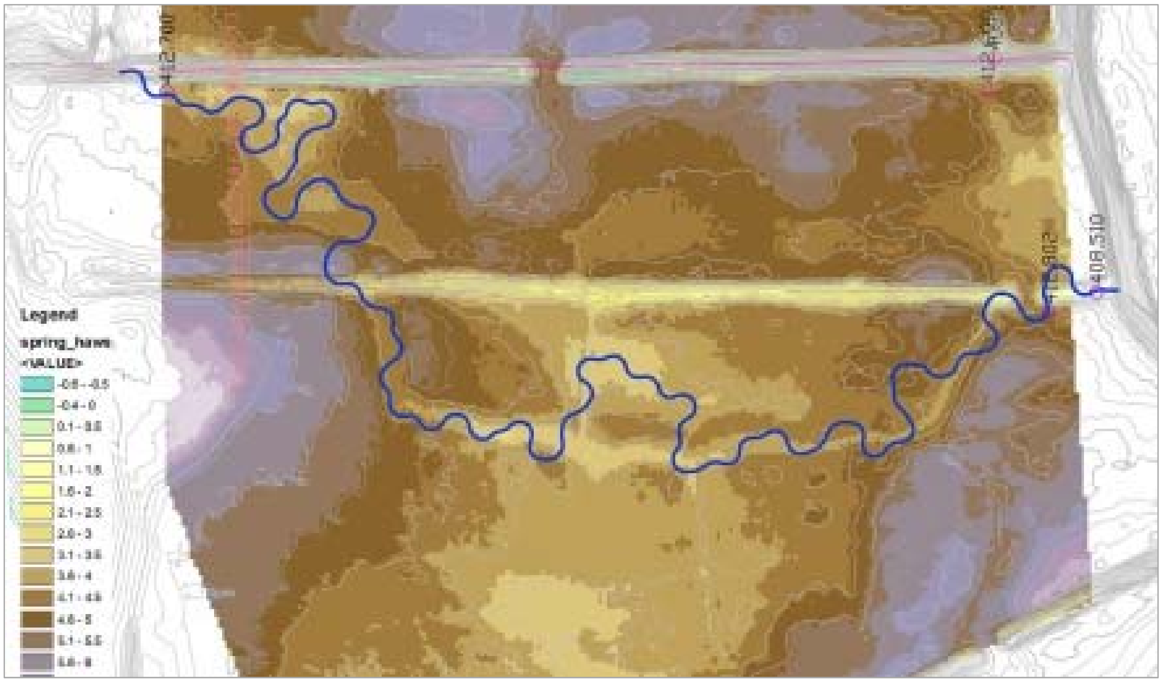

Figure 2: Relative Elevation Map (REM) depicting adjacent overbank elevation relative to water surface elevation of the spring channel. The blue line is the proposed spring channel alignment within the lower elevations.

An estimate of typical discharge was made as a reference for sizing a self-sustaining spring-fed channel. A typical discharge was the reference metric rather than a bankfull discharge because spring-fed channels have little flow variation and exhibit stable flow characteristics. Further, because the site visit occurred in the winter, it is likely that the flow observed was near maximum.

A field assessment of flow velocity and estimated flow area were used to calculate a typical discharge of 2 cfs from the spring (Figure 3). Flow velocity was estimated at a rate of 0.2 feet per second (ft/s) and a water depth of 2 feet. Using survey data, the wetted cross-sectional area was estimated to be 13 square feet (sf) (Figure 4).

(Vel = 0.2 ft/s) * (wetted area = 13 sf) = 2.2 cfs

Figure 3: Spring channel ditch looking downstream with dense bank vegetation.

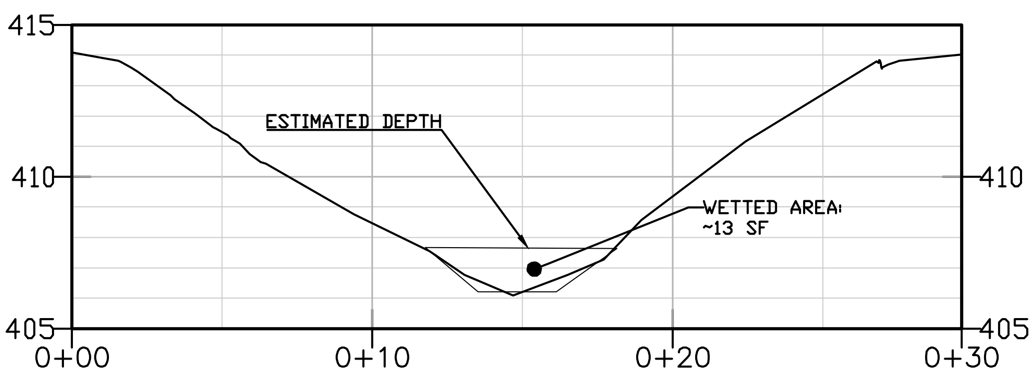

Figure 4: Typical spring channel cross-section with estimated active wet cross-channel area.

Riverbank Stabilization

The Project includes stabilization of a section of eroding riverbank located within the project area on the Deschutes River. A hydraulic analysis of a portion of the Deschutes River was conducted to estimate flow velocity, shear stress, and water surface elevation for a range of flow conditions between the 1.1-year and 100-year recurrence interval. The Hydrologic Engineering Centers River Analysis System (HEC-RAS) model was used to simulate flows and hydraulic conditions.

Design flows include the 100-year recurrence interval flow of 10,822 cfs and the 1.1-year flow of 1,559 cfs. Peak flow values were determined using Log Pearson Type III Distribution analysis of flow records from the USGS Gauge number 12079000 – Deschutes River at Vail Loop Road Crossing near Rainier for the period of record 1952 – 2013. The 100-year flow value provides an estimate of maximum bed and bank shear stress to inform the bank stabilization design. The lower flow value is used to determine the appropriate elevation on the bank to design log placement within the structure that would maximize wood surface area in flows less than bankfull.

The model was configured using 8 river cross sections surveyed by Natural Systems Design in 2014 (Figure 5). Minor adjustments were made to the modeled cross sections based on LiDAR data to incorporate the broader floodplain that extended beyond the bounds of the ground survey.

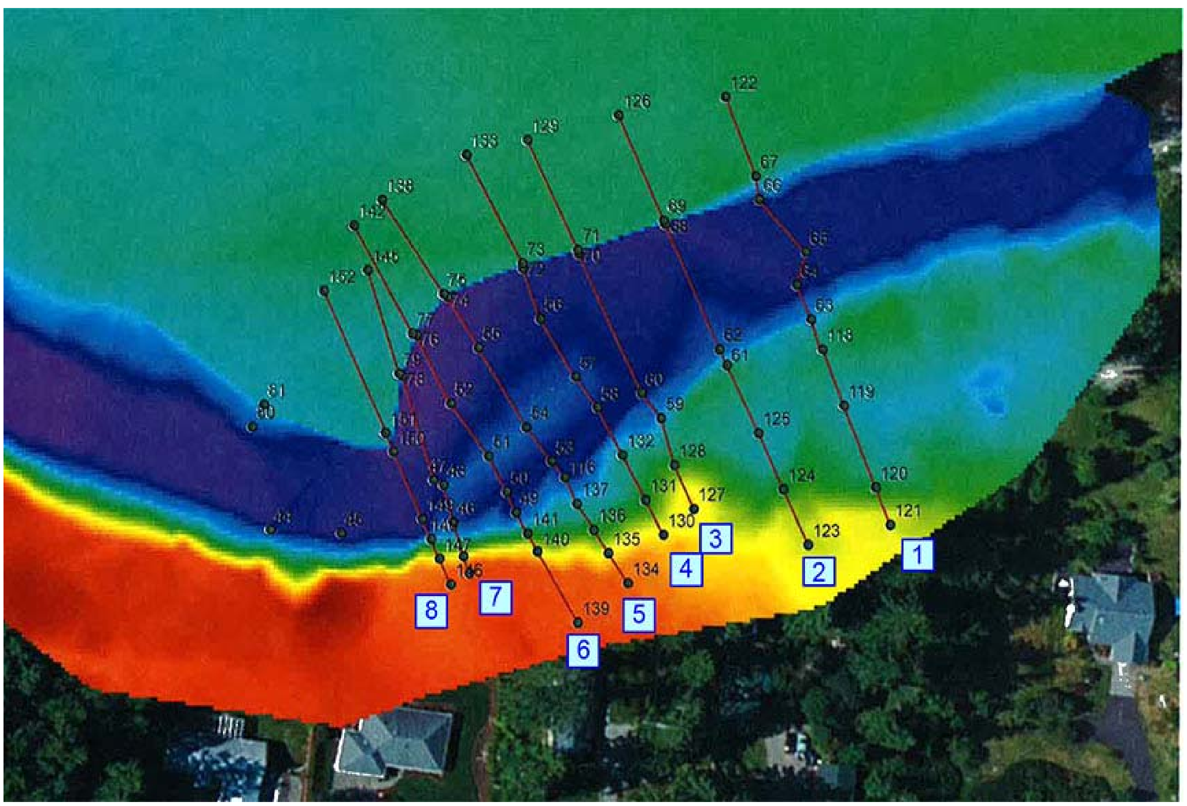

Figure 5: Mainstem Deschutes River Cross-Sections.

Results of the HEC-RAS analysis are summarized in Table 1 showing velocity, maximum depth, shear stress, and water surface elevation for all 8 cross sections corresponding to the 100-year flow and the 1.1-year flow.

Bankfull Width - Bankfull width within the Deschutes was estimated to determine appropriate wood loading of the revetment structure. Water surface elevation results from the 1.1-year flow event were used to determine a typical bankfull width. Undisturbed alluvial channels in western Washington tend to crest their banks at peak flows with a recurrence of 1.1 (Castro and Jackson 2007).

Cross-sections 1 and 2 were selected to estimate a typical bankfull width of 98 feet. These two cross-sections are within the upstream riffle in this model analysis and represent a typical cross-sectional area of hydraulic control for the Deschutes.

Table 1: HEC-RAS Results

100-Year Flow (10,822 cfs)					
Cross-Section #	Average Velocity (ft/s)	Max Channel Depth (ft)	Hydraulic Depth (ft)	Shear (lb/sf)	Water Surf. Elevation
1	5.70	17.10	11.32	0.51	431.10
2	4.84	17.23	10.45	0.38	431.13
3	4.80	17.09	12.86	0.35	431.09
4	4.97	16.76	11.72	0.38	431.06
5	4.08	18.30	11.76	0.26	431.10
6	4.48	17.94	12.88	0.30	431.04
7	5.22	18.12	13.87	0.40	430.92
8	7.71	16.95	12.78	0.90	430.55
1.1-Year Flow (1,559 cfs)					
Cross-Section #	Average Velocity (ft/s)	Max Channel Depth (ft)	Hydraulic Depth (ft)	Shear (lb/sf)	Water Surf. Elevation
1	3.20	8.10	5.06	0.21	422.10
2	2.87	8.18	5.43	0.17	422.08
3	2.24	8.09	5.70	0.10	422.09
4	3.34	7.67	3.58	0.26	421.97
5	2.31	9.19	4.01	0.12	421.99
6	2.27	8.88	4.47	0.11	421.98
7	2.38	9.16	5.47	0.11	421.96
8	4.37	8.11	5.36	0.38	421.71

Scour Depth - The estimated maximum scour depth at a 100-year flow event along the bend of the eroded bank is approximately 3.3 feet using the Maynord Equation defined in the Integrated Streambank Protection Guidelines (Cramer and Bates 2003) (page E-15). This is similar to the existing depth along the outside of the curve along the existing right bank to be stabilized. As such, the existing conditions will be used as an approximate surrogate for the anticipated maximum scour depth along the project area. Piles installed to provide stability for buoyancy and drag forces within the large wood revetment will be driven a minimum of 10 feet below the existing channel depth to ensure a minimum safety factor of 1.5 at the 100-year peak storm flows.

The large wood revetment structure top elevation is set to overtop at the 1.1-year return interval flow, shown in Table 1 as approximately 422.0.

4.0 KEY DECISIONS

This section reviews the key decisions that drive the design of the various elements of the project.

Wetland Area

- Wetland will be designed to support multiple zones of vegetation based on anticipated inundation frequency related to elevation.
- Hydraulic control structure will occur downstream of existing main spring channel. The restored main spring channel will be located downstream of the existing spring channel, and it will drain into the roughened channel hydraulic control structure downstream of its apex.
- The hydraulic control structure must be fish-passable for juvenile salmon in all flows.
- Riparian buffer plantings within the wetland rehabilitation area will consist of a mix of emergent, scrub shrub, and forested vegetation.

Spring Channel

- The pre-disturbance state of the spring was likely either a grassy marsh or a highly sinuous (>2) narrow channel (similar to the Rosgen E5-type channel; Rosgen 1996) through dense root mass of forested wetlands.
- The ditching and dredging of the spring channel has created an entrenched condition that renders the disturbed channel incapable of returning itself to a pre-disturbance condition through geomorphic process.
- The cool water of the spring must be a self-sustaining flow to improve fish habitat and water quality.
- The outlet of the spring at the outlet channel must be fish-passable for juvenile salmon in all flows.

River Stabilization

- Two areas were evaluated for stabilization (Figure 6). Area 2 was selected for stabilization because the eroding bank was determined to be more mobile and actively eroding (estimated bank migration rate of as much as 10 feet per year). This site is also just downstream of a long stretch of mature riparian vegetation. Allowed to continue, erosion could progress toward the back side of this tree-lined segment and undercut the trees in this section. Furthermore, these trees are not large enough to serve as key members to support stabilizing wood jams but are likely to float downstream in higher flows.

Figure 6: Eroded bank areas within project boundaries. Bank erosion was observed to be rapid in bank area 2.

- Bank material is loose gravelly sand with little root mass. Stabilization will require a gentler slope with vegetation and wood pilings to prevent mobilization.
- The stabilizing structure must not engage flow more than ¼ of the current bankfull area to avoid increasing erosion on the opposite bank.

5.0 OVERVIEW OF DESIGN ELEMENTS

This section provides an overview of each of the design elements for the project. Figure 7 (page 14) shows the overall site and the major design elements that are discussed in this section.

Wetland Design

Between January and April in a typical water year the groundwater is anticipated to be at 410.5 feet elevation at the bank of the outlet channel; 411 feet in the areas of P2, P4, P6, and P7 (see Attachment 1 for map of piezometer locations and side channels). For the south side of the outlet channel, groundwater levels will be raised slightly by way of the hydraulic control in the areas near P5 and P9. The filling of Side Ditch 6 (east of P8; See Attachment 1) and the removal of the associated culvert is intended to maintain groundwater levels near ground surface elevation around P8 through the winter.

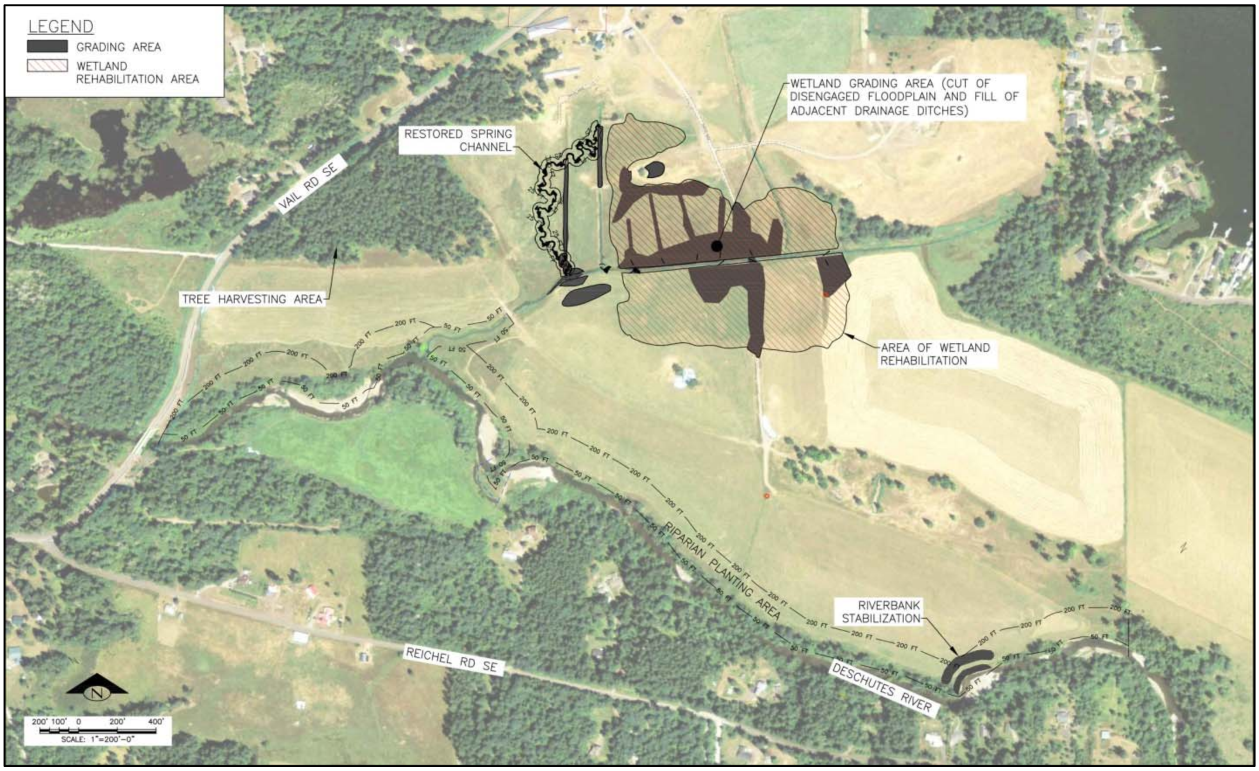

Figure 7: Proposed Restoration Activities

Based on these design elevations the topography from the outlet channel north will be revised so that the soil surface within the area near P2, P4, P6, and P7 is at the 412-foot elevation (see 60% design drawings Sheets 14 through 16). This will place groundwater to within 12 inches of the soil surface in this area. The side ditches will be filled to establish a soil surface approximately at the 412-foot elevation target. The connections of each side ditch with the outlet channel will be widened to increase the amount of off-channel habitat for fish.

Minor grading will occur within the northern portion of the wetland rehabilitation area to ensure surface flow connection with the southern portion of the site and to remove any possible drain tiles that are keeping groundwater artificially low in this area.

The roadway within the wetland rehabilitation area and associated culvert will be removed. It is assumed that the materials from this removal will be used as the base for the hydraulic control structure that is proposed within the outlet channel. The ground surface within the roadbed removal area will then be leveled to match the existing adjacent surface. This roadbed material has not yet been analyzed to determine composition, total volume, or suitability for construction material. The roadbed material and underlying compaction should be analyzed prior to completion of the 90% design package. The culvert crossing within Side Ditch 6 will also be removed to rehabilitate the wetland hydrology in this area.

Based on the analysis conducted for the roughened channel section, the height of the apex will be at 409.5-foot elevation. The apex will be located between the existing outlet of the main spring channel and the newly designed outlet (see 60% design drawings Sheets 14 and 22 for location of proposed roughened channel section). Based on the information collected to date on the outlet channel, it is assumed that this will allow for continuous fish access into the spring channel during low flow conditions. At the design flow of 25 cfs the water depth over the top of the roughened channel apex will be 6 inches. The surface of the roughened channel will consist of a rounded cobble and gravel mix with a maximum diameter of 12 inches. This surface will also allow for fish passage as well as flexible adjustment of the apex height based on flows observed in the channel both at high and low flows.

In order to improve fish habitat within the restored wetland, one or more LWD pieces will be placed within the outlet channel approximately every 200 feet. Wood will also be placed in the mouths of the current side channels. These mouths will be widened and some portion will remain after ditch filling to provide off-channel habitat for salmonids.

The Confluence Team worked with SPSSEG to create the conceptual planting zones shown in Sheets 18 to 20 of the 60% design drawing package. This planting plan provides for a variety of wetland habitats throughout the site. Forested components on the south side of the outlet channel will provide shading to the outlet channel as well as the emergent areas on the north edge. The emergent wet prairie area will take advantage of several spots of existing native emergent vegetation. The list of potential plants for each of these areas is included in the cost estimate. The list will be updated prior to the completion of the 90% design based on feedback from the Cities as well as the permitting agencies reviewing this project for compliance with permit requirements.

Spring Channel Design

A new spring channel will be excavated through the lower elevations to the west of the existing spring channel ditch (i.e., downstream of existing channel). The proposed channel is based on the design metrics list in Table 2.

Table 2: Proposed Spring Channel Design Metrics

Design Metric	Value
Channel sinuosity	2.2
Channel slope	0.22%
Width/depth ratio (typ)	6
Meander belt width	120 feet (max)
Bank angle	Near-vertical

Design Metric	Value
Total channel length	1,786 feet
Channel bankfull width	3 feet
Channel depth	0.5 feet (typical)
Channel wavelength	36' – 48'
Radius of curvature	8' – 11'

The proposed channel is the template of a mature sinuous channel meandering through a forested wetland. The low geomorphic capacity of the spring requires a narrow bank width with 1:1 bank slopes to flow in a self-sustaining channel. The proposed channel alignment was meandered through low areas of the adjacent landscape where the relative elevation map indicated a potential for a pre-disturbance location. The proposed alignment produced a highly sinuous channel with a typical channel grade of 0.2%. The high sinuosity and low gradient within wetland land features further confirmed the characterization of the Rosgen E-5 channel type having high sinuosity in dense root mats of wetland grass and woody species.

The lower 120 feet of the channel steepens to 2.1% as it converges with the proposed hydraulic control structure (roughened channel section) of the outlet channel. To ensure channel stability and fish passage within the steeper grade, bed logs are to be placed, and angled for low flow, within the bed of the channel at 7-ft intervals.

Additional wood, with branches intact, will be place d throughout the shallow portions of the spring to advance woody features that provide cover and refuge. Further, pools will be created in sections under the added wood to provide additional conveyance capacity to support a self-sustaining channel.

The existing ditches will be blocked with fill from both the new channel excavation and from wetland grading. The channel fill will be stabilized with root mass from wetland planting. Areas in the ditches upstream are expected to pond from groundwater seepage.

River Stabilization Design

A timber revetment structure is proposed to stabilize the highly mobile bank in the target bank segment of the Deschutes River to improve water quality by reducing the input of fine sediment into the river. The structure will be secured with driven piles of logs and intermixed with logs. Cut logs will be placed within the piles to provide lateral stability and then backfilled with native soil. Eight whole trees will be removed from another area of the ranch site and used within the structure. These trees will be left intact (full root wad, branches not trimmed) as much as feasible and secured in the structure such that lower branches and the rootwad will engage low flow, provide cover, and sustain the scour pool.

The placement of the structure along the riverbank edge will be placed so the river-ward face of the structure is aligned with the edge of channel surveyed in 2013. This placement will ensure the structure does not cause erosion on the opposite bank. Because the bank is actively retreating, the structure will maintain the bank alignment recorded in 2013.

The revetment structure design is similar to the toe log structure accepted and defined by the Integrated Stream Protection Guidelines, 2003. This technique offers predictable bank stability while ensuring high habitat value having high void space directly in active flow providing low velocity refuge and cover for fish.

The large wood within the structure will be intermixed with soil for ballast, with both wood and soil built from the toe of the bank to bankfull height (approximately elevation 422 feet). Native soil and mulch will predominate the top 12 inches of the structure to create a vegetated floodplain bench. The vegetation will include species appropriate for moist, riparian conditions. From the bench, the back slope will be graded at least 2:1 to existing grade, a slope sufficient to promote survival of fringe species up to the riparian upland.

Wood counts for the revetment structure were compared to the wood loading guidelines by Fox and Bolton (2007) shown in Table 3. The wood piece count exceed these guidelines for a river with the hydraulic capacity of the Deschutes River; however, the revetment structure is built in highly unstable soil requiring more wood material to resist high flows in an entrenched corridor. Furthermore, most of the wood volume is either buried for ballast, or above the active water column, limiting the volume of wood actively engaging river flow. Despite the burial required, the structure presents enough wood volume below bankfull to exceed the median guideline.

Table 3: Proposed Wood Loading for Riverbank Stabilization Structure Compared to Fox and Bolton (2007) Reference Wood Quantities

Stream Parameters		
	(feet)	(m)
Bankfull width	98	29.9
Impacted stream length	350	106.7

Pieces		75th pct	Median	25th pct
Fox and Bolton (2007) Reference Counts		67	55	31
Proposed Count in Design	**112**			
Difference		+45	+57	+81

Volume		75th pct	Median	25th pct
Fox and Bolton (2007) Reference Volume		106	54	30
Proposed Volume of total wood (m^3)	246			
Proposed Volume buried (m^3) [~80%]	172			
Proposed Volume below bankfull (m^3)	**79**			
Difference		-31.7	19.5	44.0

Downstream of the treatment area, a small peninsula of land with mature tree cover juts southward into the channel. It is likely that this piece of land will erode even after installation of the bank structure. The Confluence Team determined that erosive forces on the opposite, southern bank could increase if the proposed bank protection extended farther downstream than shown in the 60% design. Limiting the extent of the bank protection avoids potential impacts on private residential parcels along the south edge of the river.

6.0 PROJECT PERMITTING

The proposed work includes activities within Waters of the State and United States, and so will require submittal of a Joint Aquatic Resource Permit Application (JARPA). The JARPA form is submitted to federal, state, and local agencies and serves as a method of transmitting information for multiple permit applications. Along with figures showing proposed work and potential impacts to wetlands and Waters of the United States, the following attachments would be submitted with the JARPA form:

- Attachment A: Additional Property Owners
- Attachment B: Additional Project Locations
- Attachment C: Contact information for Adjoining Property Owners
- Attachment D: Construction Sequence

Federal

Construction of the large wood revetment to stabilize the banks of the Deschutes River will require a NWP 13 for Bank Stabilization activities from the Corps. In addition to the JARPA discussed above, this permit will require submitting additional information as part of the JARPA package, including:

- Summary of the need for stabilization work, including summary of cause of the erosion and any threats posed to structures, infrastructure, and/or public safety
- Description of current and expected post-project sediment movement and deposition patterns in and near the project area
- Description of current and expected post-project habitat conditions in the project area
- Assessment of the likely impact of the proposed work on upstream, downstream, and cross-stream properties (from nearest upstream bend to the nearest downstream bend of the Deschutes River)
- Description of the type and length of existing bank stabilization within 300 feet up and downstream of the project area
- Demonstration that the proposed project incorporates the least environmentally damaging practicable bank protection methods

Construction of the stream channel, wetland rehabilitation area and hydraulic control structure will require a NWP 27. This NWP will require the submittal of a JARPA with supporting information, including the wetland delineation and grade and fill information.

State

The JARPA form will be submitted to WDFW in order to apply for a Hydrologic Permit Approval (HPA). The JARPA also will be submitted to Ecology for 401 water quality certification. It is anticipated that Individual 401 water quality certification will not be needed. For both the NWP 13 and 27, Ecology has certified these permits subject to conditions. As long as the project meets the listed state conditions, no additional 401 certification would be needed.

A state Construction Stormwater General Permit (CSGP) will also be required for this project. A CSGP is required for any projects that disturb one or more acres of land and that discharge stormwater into surface waters of the state. The stormwater permit requires a separate application to the Ecology. Ecology will be revising and reissuing this general permit in December 2015. Any new information regarding this permit and application process will be incorporated into the 90% design documents.

County

A State Environmental Policy Act (SEPA) Checklist will need to be completed for the project with appropriate attachments, including wetland delineation report, master application, and wetland rehabilitation plan. The SEPA Checklist package also will include the following information:

- County Master Application Form
- Site Plan
- Environmental reports – wetland delineation report, wetland rehabilitation plan, etc.

Additional Thurston County permits, each with their own application forms, will be required for the project, including:

- Construction Permit: Includes engineering plan set.
- Shoreline Permit: The County Shoreline Master Plan is currently being revised, so permit requirements may change.
- Zoning Variance/Special Use Permit: Site is currently zoned Long Term Agriculture.
- Critical Area Review Permit: Activities should be approved under TCC 24.30.170 Wetlands – Enhancement/Restoration.

7.0 RISKS AND RECOMMENDATIONS

This 60% design represents a preliminary design package. As such, certain risks are associated with the proposed design. This section summarizes the risks to design change and overall success of the project, and we provide some recommendations to address these risks.

Construction Sequencing/Timing

Each of the three elements of this project will involve grading and in-water work. The plan is to keep excavated materials on site by filling side ditches and increasing elevations of selected upland areas (e.g., knoll with tree to east of main spring channel). The wetland and spring channel elements would be most efficiently completed if constructed at the same time because some material from the wetland area can be used to fill the existing main spring channel. If the Cities decide not to construct the wetland and spring channel during the same construction effort, then some additional costs can be anticipated for remobilization and rehandling of material that would be stockpiled then moved into the existing spring channel.

An initial cut and fill balance exercise has been done as part of the 60% design effort. At this time no fill will be exported off site and all excess fill areas have been identified in the grading plan sheets within the 60% design drawing set. Fill volumes were calculated to be 150% of the excavated volume because fill areas will not be compacted. Once the Cities can confirm that both the spring channel and wetland work elements will be completed at the same time an additional check of cut and fill balance will need to be conducted to inform the necessary sequencing of excavated material. This information will confirm construction sequencing or if limits to construction timing, like in-water work windows, will require soil to be stockpiled for some period of time.

For this 60% design effort the Cities have requested that there be an assumption in the cost estimating that the river stabilization task be completed separately from the wetland rehabilitation and spring channel construction. Separating these tasks will increase overall costs because of separate site mobilization and erosion control tasks. Prior to completing the 90% design effort and submitting permit applications the Cities will need to determine whether the river stabilization activity will occur at the same time as the other two restoration tasks. If it is to occur separately, then revisions would need to be made to the plans, specifications, and estimates to show this task as separate.

The portion of the road that currently crosses the proposed wetland rehabilitation area will be removed. The timing of this removal in relation to the timing of grading and planting activities associated with the construction of the wetland rehabilitation element will be considered during the next phase of the design process. At this time we propose to use material from the roadbed as base for the roughened channel section in the outlet channel. This roadbed material and depths have not been analyzed to date. The roadbed material and underlying compaction should be analyzed prior to completion of the 90% design package.

Culverts

Three culverts are proposed for removal with this project: (1) in outlet channel at road crossing the proposed wetland area, (2)in main spring channel, and (3) in adjacent ditch to west of main spring channel (see the 60% design drawings Sheets 7 to 9 for location of culverts to be removed). In a separate project for the Squaxin Island Tribe, Natural Systems Design is designing the replacement of the downstream-most culvert in the outlet channel. This downstream culvert removal is not one of the three culverts proposed for removal as part of this Project and would occur at a later date.

Based on field observations in 2014, the downstream outlet channel culvert(s) appear to be at least partially blocked and therefore the water levels observed in the outlet channel between January and

July 2014 appear to be higher than expected for an unimpeded flow condition. The removal of culverts will eliminate this blocking condition and will likely cause the outlet channel water surface elevation to change to a lower elevation. We recommend collecting flow data within the outlet channel prior to the 60% design change to better inform the design of the roughened channel element as well as the effects the removal of the culverts will have on the main spring channel and wetland rehabilitation elements. We also plan to conduct a review of historic data collected by volunteers on the Lake Lawrence lake levels during the next phase of the design. This information will also inform the channel flow analysis.

The effect of the two outlet channel culverts on water surface elevations in the outlet channel and the timing of culvert removal will be further considered during the next phase of the design. The culverts in the main spring channel and adjacent ditch are not anticipated to affect the construction of other elements of the Project.

Wetland Design

A backwater analysis was not conducted as part of this 60% design. A backwater analysis would inform what effects placement of the roughened channel feature will have on the drainage channel that leads from the Smith Ranch Property (Side Ditch 5) as well as ensure that placement of the feature will not affect lake drainage. This analysis could be completed once additional information is gained on the flows within the outlet channel. At this time the Cities have agreed to place stream gauges in the outlet channel to gather water surface and flow information at the Lake Lawrence outlet and downstream of the beaver dams. This information will be used to inform the 90% design effort.

One of the unknowns for the wetland rehabilitation is the possible presence of agricultural drain tiles on the site. One tile was observed by SPSSEG during the wetland delineation activities. There is also water being routed through the culvert that is at the end of Side Ditch 6. It is possible that this culvert is conveying water from drain tiles. Mr. Smith, former property owner, may have knowledge of the location of these drain tiles. We recommend that Mr. Smith be interviewed about possible drain tile presence on the property prior to the 90% design package submittal. Removal and/or disruption of drain tiles would be an essential component of restoring site hydrology to support wetland conditions.

The Cities have also raised questions concerning ditch maintenance activities in the ditches that will remain on the site. This 60% design does not propose to conduct any grading or planting activities within Side Ditch 5, which continues to drain water from the Smith Ranch property located north of the project site. Mr. Smith would have information on how much maintenance was needed to maintain sufficient conveyance within these ditches during the time that he owned the property. This knowledge would inform whether additional grading or other activities would be needed to minimize maintenance activities within the ditch.

The wetlands associated with this project are adjacent to and drain to waters of the U.S. and will therefore need a jurisdictional determination from the Corps as part of the permitting process for this project. SPSSEG has completed their delineation of the site, and that report would be used as part of the permitting submittal package and would be the basis for the Corps' review of their jurisdiction. The ordinary high water mark for the outlet channel has also not been identified. This information will be required for the JARPA application package.

The size, stabilization, and exact placement of LWD within the outlet channel has not been analyzed at this stage of the design. A more thorough analysis, including log buoyancy, will be conducted to inform LWD placement once additional information is gathered on flow and the proposed water surface elevation within the channel after all project elements have been implemented.

Spring Channel Design

- Recommended to measure seasonal flow, including summer low flow, in the spring channel to confirm channel sizing as part of 90% design development.

River Stabilization Design

- Due to floodwater depths within the Deschutes River at the time of field survey, measurement of riffle elevation downstream of the reach to be stabilized could not be obtained. This required an extrapolation of calculated reach slope using adjacent topographic data. This extrapolation adds uncertainty to the predicted water surface elevation of the 100-yr flood event which is countered by additional anchoring of the structure's upper layers, and by bioengineering of the structure's upper slope.

- The Deschutes River has been entrenching for decades, and the lowering of the bed has contributed to higher instream velocities and continued degradation of the bed. The section stabilized by the proposed structure may continue to lower potentially exposing the bottom of the structure. To account for this uncertainty, a deeper depth of piles may be adopted for the large wood revetment structure to ensure a minimum safety factor of as much as 2.0 for scour and drag forces. However, soil conditions are unknown therefore deeper pile depth may require geotechnical investigation to reduce construction risk.

- There is a risk of further lateral degradation of the riverbank, both migrating northward as well as erosion of the downstream end of the treatment reach prior to construction. The structure design must be reviewed to determine adjustments necessary to accommodate actual site conditions at the time of construction.

Beavers

Beavers currently occupy locations along the outlet channel. Two beaver dams are in place: one is located several hundred feet downstream of the lake in the forested area and a smaller second dam is located downstream where the hillside channel joins the outlet channel. Anecdotal reports indicate that prior to the Cities acquiring the land, beavers were occasionally shot by local landowner(s) to prevent impacts to lake levels (flooding shorelines) and vegetation.

The habitat restoration has the potential to result in beavers occupying areas lower in the outlet channel. This could diminish, but not end, the lakeshore flooding concerns of property owners on Lake Lawrence by encouraging the beavers to relocate away from the lake and into the proposed restoration area. However, some level of beaver activity and dam-building in the upper portion of the outlet channel can be anticipated even if they expand their occupation to include the restored areas.

The restored wetland could be positively or negatively impacted by future beaver activity. The primary activities that could affect the restored areas are dam-building and cutting of plant material within restored planting areas. Based on conversations with the Cities after the 30% design review the Confluence Team has decided to add two full-spanning woody material structures in the outlet channel. These two structures are intended to attract beavers to this area by creating a more favorable dam site compared to the areas closer to Lake Lawrence. . Each of the structures will utilize one full tree that will be harvested from the Smith Ranch. The tree will have branches and rootwad that remain in place. The tree will then be cut in half and the two halves will be positioned together to create an X-shaped structure that spans the outlet channel and engages fully with the flow. See Sheet 28 of the 60% design drawing set for a detail of this structure.

The restored wetland will be planted with vegetation appropriate for the designed inundation patterns with different plant species used in different elevation zones. Damming by beavers within the wetland would be expected to increase water surface elevations and change the designed locations for the various wetland plant zones. The increase in water surface elevation would result in more open water area within the wetland. Such a change in vegetation distribution is not necessarily a negative impact, but it would mean the wetland would be functioning and looking differently than designed. From a fish perspective, beaver dams and the ponds they create are excellent habitat for juvenile salmon rearing. It is well documented that beaver ponds provide good off-channel habitat for juvenile coho salmon (e.g., Pollock et al. 2004).

In addition to potentially changing vegetation community distributions in the wetland, increased inundation by a beaver dam in the wetland would increase the size of the wetland. While a larger area supporting wetland functions would be favorable, potential exists for the water surface elevation changes to affect drainage and flooding conditions on the adjacent land still owned by Mr. Smith. A beaver dam in the wetland area is far enough down the outlet channel that it would not be expected to affect lake levels and therefore would not cause flooding concerns for lakeshore property owners.

Overall, the functional and habitat goals of the restored wetland can be achieved whether or not beaver activity occurs in the area. However potential off-site effects of beaver activity in the outlet channel and wetland necessitate a plan to manage future beaver activity on the property. Such a plan will need to be developed with input from WDFW and Thurston County. As it relates to the habitat restoration work being designed, no changes are needed to the two existing beaver dams. When the restoration work is constructed, one or both of the structures could be notched, fitted with a leveler to control ponded water elevations (and effects upstream to lake), or removed. We recognize that for reasons other than the restoration, the Cities may want to address the existing beaver dams sooner.

Depending on the Cities' interest in encouraging beavers to occupy the restored habitats, the design could include the placement of small wood to encourage dam- or lodge-building. The wetland planting design could be adjusted to see how beavers use the area. As described previously, having beavers in the restoration area is not a bad thing, but does lead to some uncertainty about what level of dam building they undertake and how it may affect the planned wetland design. The Cities' approach to how to handle beavers should be considered in reviewing the 60% designs and looking ahead to future design and implementation steps.

8.0 REFERENCES

Barnard, R.J., J. Johnson, P. Brooks, K.M. Bates, B. Heiner, J.P. Klavas, D.C. Ponder, P.D. Smith, and P. D. Powers. 2013. Water Crossings Design Guidelines. Published by Washington State Aquatic Habitat Guidelines Program, Washington State Department of Fish and Wildlife. 297p.

Castro, J. and P.L. Jackson. 2007. Bankfull discharge recurrence intervals and regional hydraulic geometry relationships: patterns in the Pacific Northwest, USA. Journal of the American Water Resources Association. 37(5): 1249-1262.

Cramer, M. and Bates, K.; Editors (2003). Integrated Streambank Protection Guidelines. Published by Washington State Aquatic Habitat Guidelines Program, Washington State Department of Fish and Wildlife, Washington DOT, Washington Department of Ecology, U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service. 625p.

Fox, M., and S. Bolton. 2007. A Regional and Geomorphic Reference for Quantities and Volumes of Instream Wood in Unmanaged Forested Basins of Washington State, North American Journal of Fisheries Management 27: 342-359.

Kuck, Todd D. 2000. Regional Hydraulic Geometry Curves of the South Umpqua Area in Southwestern Oregon. Stream Notes. January 2000. Available at: <http://stream.fs.fed.us/news/streamnt/jan00/jan00_3.htm>

Pollock, M.M., G.R. Pess, T.J. Beechie, and D.R. Montgomery. 2004. The importance of beaver ponds to coho salmon production in the Stillaguamish River basin, Washington, USA. North American Journal of Fisheries Management 24: 749-760.

Rosgen, D. 1996. Applied River Morphology. Printed Media Companies.

South Puget Sound Salmon Enhancement Group (SPSSEG). 2014. Deschutes River Habitat Restoration Project Wetland Delineation Report. Prepared for City of Olympia, City of Lacey, and City of Yelm, Revised 2014.

South Puget Sound Salmon Enhancement Group (SPSSEG). 2014 Deschutes River Ranch Riparian Restoration Planting Plan. Prepared for City of Olympia, City of Lacey, and City of Yelm, September 22, 2014.

Thurston County Resource Stewardship Department and Geodata Center. 2011. Deschutes Watershed Characterization Report.

U.S. Geologic Survey (USGS). 2014. The StreamStats Program. Available at:<http://water.usgs.gov/osw/streamstats/>