Public Safety Management Plan
Countyline Levee Setback Project

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1.0. **Overview**

The Countyline Levee Setback Project is a flood risk-reduction project on the Lower White River that will lower flood elevations for hundreds of residential properties in the city of Pacific and also restore approximately 115 acres of off-channel rearing habitat for Chinook salmon. The project is located on the left (east) bank of the Lower White River between river mile (RM) 5.00 and RM 6.33, corresponding to the Stewart Road SE and the A Street SE bridges, respectively. The project spans the King-Pierce county line and will be constructed in the cities of Pacific and Sumner, as well as in a portion of unincorporated Pierce County. Although the majority of the Countyline project will be constructed on property owned by King County, no portion of the project will be in unincorporated King County. The southern tie-in at the Stewart Road SE Bridge will be constructed within the City of Sumner public right-of-way. The southern 1,100 lineal feet of the setback levee will be constructed on property owned by Pierce County (within unincorporated Pierce County). King County assumes the sole responsibility for the management and maintenance of the engineered and habitat elements of the project.

The Countyline project is one of two levee setback projects within this reach of the Lower White River that will upon completion provide a significant level of increased flood protection for the City of Pacific and surrounding areas for the annual one percent chance flood of 15,532 cfs with the future expected channel condition that accounts for sediment accumulation. The Pacific Right Bank Project is a levee setback project on the opposite bank that will provide a more permanent level of flood protection for the City of Pacific by replacing the existing temporary HESCO flood protection barrier with a setback levee. The Right Bank project is currently in the planning and feasibility phase and is anticipated to be constructed in 2018-2019.

This Plan has been prepared in accordance with the King County Department of Natural Resources and Parks (DNRP) 2013 Procedures for Managing Naturally Occurring Large Wood in King County Rivers (Appendix A). The procedures require the DNRP to prepare a public safety management plan when designing projects that are expected to or are likely to cause wood from onsite or elsewhere in the watershed to accumulate at the project site. This Plan also follows Policy PROJ-11 in the 2006 King County Flood Hazard Management Plan (and incorporated by reference in the 2013 Flood Hazard Management Plan Update and Progress Report) for the monitoring and adaptive management of projects over time to meet permit requirements or improve the effectiveness of projects.

1.1 Purpose

The purpose of this Plan is to characterize existing public safety hazards and risks within the project area, assess the change in these risks as a result of the project, and to describe the procedures for how any new risks will be addressed with adaptive management actions. This Plan establishes a proactive approach to monitoring, maintenance, and modifications of the site over time in order to assure public safety and the success of the project. This Plan also presents a management approach for the coordination of multiple jurisdictions and local agencies and to inform the public of potential changes to river conditions that may affect instream or adjacent land uses. The framework for monitoring and adaptive management in this plan will be updated if it is necessary to address any new public safety

concerns that may arise as site conditions change both before and after project construction and also to reflect any changes in Department policies governing site management.

1.2 Organization of the Plan

This plan is organized to first provide, in Section 2, a background of the geomorphic setting and historical conditions leading up to the existing conditions and to demonstrate how this background information was utilized to develop assumptions for assessing future anticipated conditions both with and without the project. Existing land uses described in Section 3 set up the discussion of existing public safety hazards and risks and how those hazards and risks might change immediately after the project is constructed. Section 4 describes the approach for addressing the identified risks.

2.0. **Background**

The following sections describe the physical setting, history, and future anticipated conditions of the project reach, followed by a detailed description of the Countyline Levee Setback Project and King County procedures for managing large wood that will influence the long-term management strategy for the project site.

2.1 Geomorphic Setting

The project reach is located on the southern edge of the White River alluvial fan, which extends from Auburn in the north to Sumner in the south and to the western edge of the valley. Upon deglaciation of the Puget Lowland approximately 16,000 years ago, embayments of Puget Sound extended up the Kent and Sumner valleys to the mouths of the White and Green rivers near present-day Auburn. A series of lahars (volcanic mudflows) originating from Mount Rainier filled these glacial troughs with sediment. (Collins and Montgomery 2011). The largest lahar (referred to as the 5,600 year-old Osceola mudflow) supplied the sediment that formed the White River alluvial fan. There have been several smaller lahar events adding sediment to the alluvial fan and lengthening the White, Green, and Puyallup rivers by several miles (Zehfuss et al. 2003). It is this prehistoric lengthening of the rivers and the concomitant reduction in valley slope at the former Puget Sound shoreline at Auburn that has set the stage for the present-day hazards related to sediment deposition, channel migration, and flooding within the project reach.

2.2 Historical Conditions

2.2.1 Predevelopment Conditions

At the time of the arrival of early settlers in the 1850s, most of the White River water and sediment exited the White River canyon near RM 8.2 and flowed north, where flow was joined by the present-day Green River near Auburn and the Black and Cedar rivers (including the Lake Washington and Lake Sammamish watersheds) near Renton. From there, the White River became the Duwamish River and discharged into Puget Sound at Elliot Bay. A smaller secondary channel (Stuck River) split from the White River above Auburn and flowed south through the project area to join with the Puyallup River. Lacking the sediment load of the main stem river, the Stuck River within the project reach appears to have eroded several feet into the alluvial fan deposits over approximately the past 1,000 years (i.e., since the last major mudflow event). This recent erosion into the fan is evident by the well-defined top of bank along the eastern edge of the wetland and is documented in photographs from the 1910s and 1920s showing efforts to armor the bank to address recurring channel migration.

The historical Stuck River was so small or its channels so dispersed that surveying its full length continuously (in a process referred to as “meandering”) was not done for the preparation of General Land Office maps of the area during 1867 to 1891 (Collins and Sheikh 2004). By the end of the 1800s, the size of the Stuck River channel and the portion of the White River flow that it conveyed seems to have increased, based on a surveyor who observed Stuck River channel widths of 400 feet to 600 feet

and a quote from Ober (1898) that "from one-fourth to one-third of the total volume of the White River, at low water, passes down the Stuck River. At high water, probably one half goes down Stuck River." Thus, Stuck River conditions during this time period prior to settlement seem to have been transitional as the Stuck River conveyed increasingly more water and sediment.

2.2.2 Early 1900s River Improvements

The first permanent bridge crossing over the White River at the upstream end of the Countyline reach was constructed in 1900 by the Northern Pacific Railroad. Timber bulkheads were constructed parallel to the river on both banks, upstream and downstream of the bridge, to train the river through the narrow bridge opening. The railroad bridge was washed out during a massive flood in November 1906 and replaced in 1907 (along with the addition of a second track) with the current steel truss bridge now owned and operated by the BNSF Railway.

The 1906 flood event and debris jam that formed near Auburn caused the main stem White River to avulse to the Stuck River. The InterCounty River Improvement Agreement (ICRIA) between King and Pierce Counties was executed in 1914 to channelize the Lower White River. One of the first projects funded by the ICRIA was the construction of the Auburn Wall in 1915 to ensure that the avulsion (rapid shift in channel alignment) was permanent and complete. This forced the entire flow of the White River down the path of the former Stuck River. A survey map from 1914 shows that the White River in the project reach was characterized by a braided channel that migrated between the City of Pacific and the eastern edge of the wetland. The unconstrained nature of the new channel was undesirable to farmers in the area and precipitated the construction of levees and revetments to confine the flow and prevent further migration of the channel into farmland.

The timber bulkheads downstream of the railroad bridge required repeated maintenance and were replaced in 1915-1919 on both banks of the river with permanent levees and concrete revetments extending downstream to the vicinity of the present-day Pacific Park. The left bank levee and concrete revetment (Countyline Levee) extended to RM 5.9 and isolated the northern portion of the wetland from the active channel of the White River. A series of short timber bulkheads oriented perpendicular to the river were constructed in the 1920s along the alignment of the present-day Countyline levee for the purpose of deflecting erosive flows away from the agricultural fields east of the wetland.

IRCIA records indicate that a continuous concrete revetment was constructed along the left bank upstream of the Stewart Road Bridge from 1915 to 1919. This concrete revetment extended north along the eastern edge of the wetland to within about 700 feet of the county boundary line. Ground photographs from the 1920s confirm the existence of this concrete revetment and several timber bulkheads constructed across the wetland.

The Lower White River was historically known for the accumulation of substantial volumes of large wood. Wood loading in the early 1900s was so great that the 1906 avulsion of the White River to the Puyallup River was attributed to the formation of a giant logjam at Auburn. Great efforts were carried out under the ICRIA in the early 1900s to manage wood. They included the construction of a 2,000 foot-long drift barrier across the entire river valley at RM 11.8 in 1915 and the seasonal removal of large

wood from the White River downstream of the drift barrier by work crews. Early reports completed under the ICRIA (e.g., Roberts 1920) estimated that the removal of wood from the river reduced flood damages by 50 percent. Roberts (1920) reported that the removal and burning of 100,000 cords of drift wood released a million cubic yards of gravel, sand, and silt from the bars that had reportedly been built up by the accumulations of the drift. Channelization of the river in the early 1900s and gravel removal operations through the mid-1980s helped to reduce wood loading in the project reach. Since the cessation of gravel removal activities, large wood has accumulated on the gravel bars that have formed along the banks and within the channel of the Lower White River.

2.2.3 Mid-1900s Improvements

By the time of the 1936 aerial photograph (only three years following the flood of record), the left bank levee had been extended downstream to the county boundary line. The levee appears to have been constructed from dredge spoils and included rock or timber groins spaced every 40 feet. By the late 1950s, the left bank levee (Potelco Levee) had been extended through Pierce County to high ground at the southern end of the wetland and subsequently armored with riprap between 1959 and 1965 based on the dates of aerial photographs.

The concrete revetment on the right bank isolated portions of the active channel beneath the present-day Pacific City Park and manufactured homes along 3rd Place SE. Filling of these areas with refuse and dredge spoils is evident in the earliest aerial photographs from the 1930s and on through the 1960s.

Aerial photographs show that vegetation that had been allowed to grow on the Countyline levee since the 1930s was cleared beginning in the late 1950s and continuing through the 1970s. By the early-1960s, nearly the entire reach between the A Street and Stewart Road SE bridges had been confined by levees and revetments. This action restricted sediment deposition to within the channel and simplified dredging operations that were performed to maintain flood conveyance. Annual ICRIA reports through the mid-1980s indicate that gravel removal and the placement of rock armoring continued during this period. Dredging operations ceased in the late 1980s due to environmental concerns over impacts to declining populations of native salmonids.

2.2.4 Post-dredging Conditions

Facility maintenance activities declined following the cessation of gravel removal in 1985. Inspection reports filed in the late-1980s and 1990s noted sediment deposition, the establishment of vegetation along the banks, and the gradual loss of rock armoring into the river. Maintenance activities since the 1990s included the mowing of vegetation along the access road adjacent to the Potelco Revetment and on the top of the Countyline Levee. In 2011, Pierce County repaired the culvert outlet and access road at the southern end of the wetland.

2.2.5 Mud Mountain Dam

Flows on the Lower White River are controlled at Mud Mountain Dam, which was completed in 1948 and is located at RM 29.6. Mud Mountain Dam is a single-purpose flood control project operated by the U.S. Army Corps of Engineers (USACE) that is authorized to operate for the primary purpose of reducing

flooding on the Lower Puyallup River. Flood protection for the Lower White River is a secondary benefit. The 2004 Water Control Manual for dam operations limits peak discharges, when feasible, to 12,000 cubic feet per second (cfs) in acknowledgement of the channel capacity of the Lower White River; however, the dam is authorized to release up to 17,600 cfs to efficiently utilize all available reservoir storage space for flood control on the Lower Puyallup River. Prior to dam construction, the flood of record on the Lower White River was 28,000 cfs in 1933. The peak flow on the Lower White River since dam construction was 15,200 cfs in 1986. Based on the record of historical flows from 1946 to 2007, the annual one percent chance flow on the Lower White River is 15,532 cfs (NHC, 2009).

2.2.6 January 2009 Flood Event

Extensive flooding of the City of Pacific occurred on January 9-10, 2009 during an estimated peak flow of 12,400 cfs, which roughly corresponds to a 5-year recurrence flow (i.e. annual 20 percent chance flow). On the right bank, flows overtopped the river bank at Pacific City Park and flowed south, inundating apartment complexes west of the park, numerous residences in the White River Estates neighborhood, and residential and commercial properties along Butte Ave SE. On the left bank, flows spilled out of the southern end of the wetland and flowed south through agricultural fields before overtopping Stewart Road SE. The January 2009 flood event damaged more than 60 homes, closed several businesses, and resulted in approximately $15 million in property damages.

Following the January 2009 flood event, King County constructed temporary flood-control measures consisting of a sandbag berm and HESCO bastions (fabric-lined gabion baskets filled with sand) in October 2009. The HESCOs, provided by the USACE, were installed by King County from high ground at the upstream end of Pacific City Park to the county boundary line behind White River Estates, where they joined a sandbag berm constructed by Pierce County and the USACE on the south side of the King-Pierce county boundary line. On the left bank, property owners constructed a three foot-high dirt berm along the southern end of the wetland in an attempt to contain future overtopping of floodwaters from the wetland into the farm fields. In 2011, a portion of the HESCO barrier in Pacific City Park was repositioned north of the parking lot to facilitate annual maintenance and provide increased flood storage.

2.2.7 2013 Emergency Flood Protection Measures

In October 2013, King County extended the HESCO barrier upstream from the Pacific City Park to the BNSF Railway embankment and added a second tier of HESCOs to low segments of the barrier located on the west and north sides of the park. These emergency measures were implemented based upon results of new hydraulic modeling indicating increased risks of HESCO overtopping due to higher flood levels caused by ongoing sediment deposition in this reach. The 2013 work also repositioned and added new segments of HESCO barriers in the White River Estates neighborhood to improve the level of flood protection. Pierce County added new sandbags to the berm in 2013 (raising it by several inches in some areas) and wrapped it in protective plastic.

2.3 Existing (Pre-construction) Conditions

The lower White River has been the subject of numerous studies completed by King County and the U.S. Geological Survey (USGS) to characterize historical and existing sediment depositional patterns. Monitoring of sediment deposition and associated changes in flood conveyance conducted by King County since 2001 and sediment load measurements conducted by the USGS in 2010 indicate that on average, 22,000 CY of sediment (composed of approximately 70% gravel and 30% sand) is deposited in the existing channel each year between the A Street and Stewart Road SE bridges. This volume includes approximately 75% of the bedload (mostly gravel, with some sand) passing beneath the A Street SE Bridge. Over the past 27 years, since the cessation of dredging operations in the mid-1980s, the White River has aggraded an average of five feet within the project reach, consequently reducing the flood-carrying capacity of the project reach by one-half since this time and by two-thirds since the original 1914 channel design.

Flooding within the project reach is exacerbated by the artificial constriction imposed by the various elements of the Steward Road SE bridge crossing (e.g., road prism and elevated approaches, abutments, and the two in-water piers that collect woody debris). The combination of the backwater from the artificial constriction and the loss of flood conveyance at the bridge crossing due to sediment deposition has resulted in an increased volume of split flow through the floodplain on both banks of the river. The following sections describe the existing conditions on each side of the river in the vicinity of the project reach.

2.3.1 Left Bank

The rock facing placed historically on the waterward face of the Countyline and Potelco facilities is now exposed only intermittently along the levee within the project reach. Some of the rock has likely been eroded into the river channel or has been covered with dredge spoils and sediment deposition. The bank is vegetated with 20 to 30 year-old cottonwood and alder trees and occasional conifers. Because sediment deposition and loss of channel conveyance has been the greatest at the King-Pierce county boundary line, this is the first location where the left bank levee overtops as flow in the White River increases. Based on field observations made by King County personnel in 2012, the left bank levee at the county boundary line (RM 5.55) begins to overtop into the wetland when flows in the White River reach approximately 3,500 cfs, which typically occurs several times each year. Flows circulate clockwise through the wetland and return to the river via a culvert and ford in the access road near RM 5.2. On November 25, 2014, when the peak flow reached 7,380 cfs, floodwaters came to within two feet of overtopping the dirt berm constructed by property owners along the southern end of the wetland. Water overtopping the dirt berm during a greater magnitude flood event would send water down 142nd Avenue E and over Stewart Road SE, through areas of Sumner zoned for light industrial development.

As the flow in the river rises above 3,500 cfs, the length of the existing Countyline levee that overtops near the county boundary line increases. When flows exceed approximately 10,000 cfs (about 500 cfs more than the 2-year recurrence event), the river would begin to overtop low spots on the existing Countyline levee just downstream of the BNSF Railway and flow into the wetland along the railway embankment.

2.3.2 Right Bank

The 1919 concrete revetment is visible along the right bank from the BNSF Railway Bridge to the upstream end of Pacific City Park near RM 5.95. Several concrete panels have been damaged by scour and settlement or have been lifted and separated by tree roots. The toe of the concrete revetment is buried beneath the channel bed. Temporary flood-protection measures on the right bank (i.e., the HESCO barrier and sandbag berm) extend from the BNSF Railway embankment (at the corner of 3rd Ave SE and Skinner Road SE) to the left bank of Government Canal at the county boundary line. The temporary flood barriers do not provide flood protection against backwater flooding up Government Canal for homes located along the canal, nor does the temporary flood barrier provide any flood protection for properties located along Butte Ave SE, southwest of the canal.

2.4 Anticipated Future Conditions without the Project

Based on the results of hydraulic modeling and the projection of historical trends in sediment deposition measured from decades of channel monitoring, the flood risk to the City of Pacific will continue to increase if the project is not constructed. The HESCO barrier and sandbag berm are nearing the end of their functional service life and are only high enough to provide flood protection for up to a 10-year recurrence flood event. Without the project, the channel will continue to fill with sediment and avulse (shift rapidly to a new alignment during a moderate flood event) into the wetland at the county boundary line and follow a flow path along 142nd Avenue E. An avulsion over Stewart Road SE (east of the bridge) during a 10-year (or lesser) flood event is considered imminent in next 10-20 years in the absence of the project. Land use along this potential avulsion path is currently agriculture and commercial uses, but as indicated above, the properties are zoned for light industrial and are undergoing the placement of permitted fill for the construction of warehouses at the time of this writing.

The results of hydraulic modeling of future anticipated channel conditions indicate that flooding of Pacific City Park and areas along portions of the HESCO barrier is likely to occur more frequently in future years. Modeling results also indicate that the upstream end of the existing Countyline Levee near the BNSF railway embankment could begin to be overtopped during a 2-year recurrence flood event and would certainly overtop and breach during a 10- to 100-year event, which would put properties east of the wetland at greater flood and channel migration risk.

2.5 Project Description

The Countyline Levee Setback Project will remove most of the existing levee and construct a new setback levee extending from the BNSF Railway embankment to the Stewart Road SE Bridge approach. The project is designed to provide containment of 15,532 cfs (i.e. 100-year flood) along with more than 3 feet of freeboard on the left bank within the project area by redirecting flows under the Stewart Road Bridge. A semi-continuous log biorevetment along the eastern edge of the wetland and several engineered logjams (ELJs) will deflect erosive flows away from the setback levee and protect off-site areas from future channel migration. The setback area will substantially increase the area available for

flood waters, thereby reducing flood elevations while also providing more area for sediment deposition and slowing the rate of sediment aggradation. The project includes the following design elements:

- Remove most of the existing levee prism and rock revetment between river miles (RM) 5.2 and RM 6.1 to reconnect approximately 115 acres of floodplain habitat to the White River.
- Construct 6,000 lineal feet of a setback levee between the A Street SE/BNSF Railroad Bridge and the Stewart Road SE Bridge.
- Construct 5,780 lineal feet of a log biorevetment (including four embedded bank deflector ELJs along the eastern edge of the wetland.
- Construct four apex ELJs in the wetland. One apex ELJ will be paired with the upstream-most deflector ELJ. The other three apex ELJs will be installed near the upstream wetland inlet to improve habitat by providing hard points for scour, as well as rearing and refuge habitat for fish.
- Plant nearly 18 acres of wetland and upland buffer area.
- Replace a blocked, 18 inch-diameter by 30 foot-long concrete culvert with a constructed channel at the wetland outlet to the White River.
- Install a backwater check valve on the 24-inch culvert draining into the wetland under the BNSF railroad embankment.
- Resurface and biostabilize the upstream 1000 lineal feet of the Countyline levee that will remain and function as a training levee for flows entering the wetland.

2.6 Anticipated Post-construction Conditions

The removal of the existing levee will allow flow to more readily enter the wetland area during the first wet season after construction when discharge first exceeds about 1,500 cfs after project completion and at lower flows thereafter. New channels will form in the reconnected floodplain from sediment deposition, bar erosion, wood recruitment, logjam formation, and the erosion of wetland soils. At higher flows, the results of hydraulic modeling indicate that flow will be split about half between the existing channel and the new channel network that will form in the reconnected floodplain. After several years, blockage of the main channel by sediment deposition and/or logjams is possible and could result in the relocation of the main stem channel alignment and most of the flow through the floodplain area, with the existing channel converted to a smaller side-channel and mosaic of vegetated floodplain and wetland habitats. The anticipated post-construction conditions and associated hazards are described in the following sections.

By virtue of containing the 100-year flood event (15,532 cfs) riverward of the setback levee, the Countyline project will route all of the flow during this event under the Stewart Road SE Bridge, as was most likely the case from the time the bridge was constructed in 1952 up until the cessation of dredging in the 1980s, when channel capacity diminished.

2.7 King County Procedures for Placing Large Wood in Rivers

King County Public Rule LUD 12-1 adopted on March 31, 2010 (Appendix B to this Plan) establishes procedures for the consideration of public safety when placing large wood in King County rivers. The

procedures apply to all King County DNRP projects involving the placement of large wood in King County rivers and streams.

Section V, Part 4 of Appendix A of the Public Rule includes requirements for post-construction monitoring and the adaptive management of projects involving the placement of large wood to assess whether any new actions at the project site are warranted. Such actions may include outreach to advise the public of potential risks posed by placed large wood, placing warning signs at the site, notifying the local jurisdiction that may impose use restrictions, and removing or altering the position of placed wood to further reduce risks.

The Public Rule also includes public use restrictions that may be imposed by the King County Sheriff's Office (KCSO) in unincorporated King County. Such restrictions would not apply to the Countyline project site because it is located outside of unincorporated King County. Under these circumstances, the Public Rule allows the County to coordinate with the appropriate jurisdictions and agencies to provide technical assistance for the development of actions to address public safety concerns. The responsibility and decision to impose use restrictions on recreational use within the project reach would fall on the agencies with jurisdictional authority.

2.8 King County Procedures for Responding to Naturally Occurring Large Wood

The DNRP's 2013 Procedures for Managing Naturally Occurring Large Wood in King County Rivers (Appendix A) apply to locations within unincorporated King County. Because the Countyline reach is located outside of unincorporated King County, the procedure for responding to public safety concerns associated with naturally occurring large wood is to contact the appropriate jurisdiction and, if requested, provide technical support to the local jurisdiction.

3.0. Hazard and Risk Assessment

This section describes the potential hazards present within the project reach and the risks they pose to public safety under both existing conditions without the project and future conditions after the project is constructed. A hazard is defined as an event that could potentially result in and injury or loss. Risk is defined as the combination of the probability of the hazard occurring and the consequence or adverse effects if the hazard occurs.

3.1 Existing Land Uses in Vicinity of Site

The following sections describe the existing land uses and potentially affected infrastructure in the vicinity of the project site.

3.1.1 Levees and Revetments

The existing access road on the Countyline Levee and the Potelco Facility extends from Stewart Road SE to the BNSF Railway Bridge. The only known public use of the access road is informal use for hiking, biking, and fishing. Public access to the levee is via a Pierce County locked gate north of Stewart Road SE. The north end of the levee and access road terminate at the BNSF Railway embankment, and hence there is no legal public access from the north end of the levee.

Public access points to the project reach on the right bank include the intersection of 3rd Ave SE and Skinner Road SE downstream of the BNSF Railway Bridge, Pacific City Park, and the levee access road south of the park. The Countyline project will not alter the existing land uses on the right bank.

3.1.2 Stormwater Facilities

Stormwater from the cities of Pacific and Auburn discharges to the White River on both banks within the project reach. The only stormwater outfall on the left bank of the White River within the project reach is a 24-inch concrete culvert passing through the BNSF Railway embankment approximately 1,700 feet south of the river. The culvert discharges stormwater into the wetland at the northeast corner of the project site. The culvert is owned and maintained by BNSF and seems to have been installed as part of the original railway construction in 1900. The culvert receives water from three stormwater ponds located at the intersection of A Street SE and Lakeland Hills Way SE and from catch basins located along both sides of A Street SE, between Lakeland Hills Way SE and the bridge. Based on the stormwater drainage system map provided by the City of Auburn, the culvert receives runoff from 61 acres of mostly residential land use.

In addition to the culvert, surface water flowing within the ditch between the railway and A Street SE is able to flow under the BNSF railway embankment at an undercrossing located at the boundary line of the two counties. This surface water then flows south and enters a buried pipe draining southerly along the western toe of the railway embankment. The next culvert crossing under the BNSF railway embankment is located approximately 2,000 feet to the south of the county boundary line, near Terrace View Drive SE. This culvert drains into Stewart Creek, which is culverted under Stewart Road SE and then flows into the White River near RM 4.3.

Along the right bank within the project reach, the City of Pacific stormwater system discharges to the White River at six locations. The upstream discharge point penetrates the concrete revetment near RM 6.3, approximately 100 feet downstream of the BNSF Railway Bridge. A backwater check valve is installed in a manhole located upgradient of the outfall to prevent floodwaters from backing up into the neighborhood streets. Two 8-inch culverts draining the two catch basins on 3rd Place SE (a privately maintained road) penetrate the concrete revetment at RM 6.25 and 6.20. These 8-inch pipes do not have check valves installed on them and can allow floodwater to back up into the catch basins and inundate portions of 3rd Place SE.

The stormwater pond and ditch on the west side of Pacific City Park drain under the temporary HESCO barrier and into the left bank wetland south of 4th Avenue SE. A check valve is installed on the end of this culvert. The catch basins in the parking area of the Park View Apartments (located at the east end of 4th Avenue SE) also discharge to the wetland south of 4th Avenue SE. A check valve has been installed on the end of this culvert.

The southern-most stormwater outfall on the right bank within the project site is located east of White River Estates and drains to the stormwater pond located near RM 5.6. The pond then drains into the wetland south of White River Estates. A check valve is installed in the catch basin on White River Drive west of the stormwater pond. The City of Pacific is in the process of designing a bioswale to replace the existing stormwater pond.

Government Canal runs along the east side of the Union Pacific Railroad and drains the Auburn Boeing facility and portions of Pacific and Algona east of the Union Pacific Railroad. The canal flows under Butte Avenue SE through four, 36-inch culverts before flowing southeast behind White River Estates and entering the White River south of the project site, near RM 5.4 in Pierce County. There are no backwater check valves on the canal culverts.

3.1.3 Roads

A Street SE (also known as the East Valley Highway south of the White River) is located east of the BNSF Railway embankment and is a north-south connector between Auburn and Sumner for commuters and commercial traffic. The A Street SE Bridge crossing coincides with the upstream end of the project reach.

Stewart Road SE (also known as 8th Street E) runs east-west and is located at the southern extent of the project reach. The road east of the river is prone to flooding during a 2-year (or less) recurrence flood event, when flows would overtop the southern end of the wetland. Stewart Road SE is a local commercial and commuter corridor between SR 167 to the west, the light industrial businesses in the valley, and the Lakeland Hills residential development (Auburn) and Lake Tapps (City of Bonney Lake) located east of the valley on the plateau.

Butte Avenue SE is located west of the White River and east of the Union Pacific Railroad and is a north-south connector between 1st Avenue SE in Pacific and Steward Road SE. The road provides access to Stewart Road SE for residential properties located in northeastern Pacific and for commercial and industrial businesses located along Butte Ave SE in southern Pacific. Butte Avenue SE crosses

Government Canal approximately 350 feet north of the county boundary line and is prone to flooding south of the canal to Stewart Road SE.

3.1.4 Railroads

Two rail lines oriented north-south run on either side of the project site. The Burlington Northern – Santa Fe (BNSF) Railway is located east of the project site and forms a physical barrier to flooding. The BNSF Railway includes two tracks and provides services for freight, Amtrak, and the Sound Transit commuter trains. A third track is proposed for construction west of the existing tracks to accommodate additional commuter trains. The BNSF Railway is in the process of acquiring land from existing property owners for construction of the future third rail line.

The Union Pacific (UP) Railroad is located west of the project site and also forms a physical barrier to flooding. There are no known culverts under the UP Railroad in the vicinity of the project. The UP Railroad includes one track and serves freight markets.

3.1.5 Bridges

There are three bridges over the White River within the project reach. The A Street SE Bridge, constructed in 1989 and located at the upstream end of the project reach, is owned by the City of Auburn and has one in-water pier that accumulates woody debris. The BNSF Railway Bridge, constructed in 1907 and located approximately 50 feet downstream of the A Street SE Bridge, is a full-spanning, steel truss bridge with concrete abutments on both banks that do not accumulate woody debris. The Stewart Road SE Bridge, constructed in 1952 and located at the downstream end of the project site, is owned by the City of Sumner and has two in-water piers that accumulate woody debris. The bridge is planned for replacement with a wider deck and longer bridge span as part of the Stewart Road widening project. The City of Sumner is currently in the preliminary design stage for the new bridge. The city has estimated a completion date of 2020 depending on the availability of funding for final design and construction.

The City of Sumner owns and maintains several bridges on the Lower White River downstream of the project site. King County staff conducted a reconnaissance of four bridges downstream of the Stewart Road Bridge for the purpose of assessing existing conditions and the potential for large wood accumulations on these structures.

3.1.6 Utilities

Fill for the southern tie-in of the proposed setback levee will be placed over a 4-inch buried natural gas line and beneath two sets of overhead power lines owned by Puget Sound Energy (PSE). An 18-inch water supply line owned by the City of Sumner is located beneath the westbound lanes of Stewart Road SE, which is outside of the project footprint. Both the gas line and the water supply line are attached to the Stewart Road SE Bridge. The gas line is attached to the downstream-facing edge of the bridge deck. The water supply line is suspended between the concrete arches, under the westbound bridge deck. The metal brackets supporting the water supply line hang below portions of the concrete arches between the bridge abutments and bridge piers. A communications line operated by Comcast crosses

over the White River on the PSE power poles and becomes buried east of the first power pole on the left bank of the river. The setback levee will be constructed under the overhead power lines and over the buried utilities.

A buried fiber optic line owned by MCI runs along the west side of the BNSF Railway embankment prism within the BNSF right-of-way where the proposed setback levee will tie in to the embankment. Under an agreement between King County and BNSF, BNSF will cause the relocation of the fiber optic line as part of BNSF's preparation for the construction of a future third rail line. In addition to having the fiber optic line relocated, BNSF will place fill for the future third rail line to elevations a few feet above the finished elevations of the setback levee. Under the agreement, this work by BNSF will occur before the end of 2016, pending permit approvals.

3.1.7 Recreation

Recreational uses on the right bank include the use of sports fields and playground at Pacific City Park, wading on the edge of the gravel bar at the park, and hiking along the levee access road south of the park. Recreational uses on the left bank include hiking along the levee access road. Recreational facilities located upstream of the project site that provide direct access to the river include the White River Trail and Roegner Park on the left bank near RM 7, Game Farm Wilderness Park on the left bank near RM 8.2, and Auburn Game Farm Park on the right bank near RM 8.1.

The scale of difficulty for in-water recreational use of the Lower White River (Buckley to Auburn) was rated by American Whitewater (*a national, non-profit organization advocating for the preservation of whitewater rivers by connecting the interests of human-powered recreational river users with ecological and science-based data*). On a scale with six difficulty classes, the Lower White River (Buckley to Auburn) was rated as a Class II (novice) as defined by the International Scale of River Difficulty:

> *"Straightforward rapids with wide, clear channels which are evident without scouting. Occasional maneuvering may be required, but rocks and medium-sized waves are easily missed by trained paddlers. Swimmers are seldom injured and group assistance, while helpful, is seldom needed."*

The project reach has a lower gradient than the upstream reach rated by American Whitewater.

In-water, recreational use of the White River within the project reach was assessed as part of a county-wide study of river recreational use completed in 2013. (King County 2013). The study collected data on recreational use with a one-day helicopter survey and a field camera mounted on the right bank at Pacific City Park. The camera recorded a still photograph every 10 seconds during daylight hours for 168 days, from July 4, 2013 through September 2, 2013. During this study period, the camera recorded recreational use of the river within the project reach by 30 people on 26 vessels (inner tubes, rafts, and one canoe). The average daily river recreational use within the project reach during the sampling period was less than one percent of the use measured on any other major river in the County during the 2013 King County study.

River recreational use (i.e., swimming, floating, boating, and fishing) on the Lower White River is thought to be low relative to other rivers in the region because of several factors. The Lower White River below Auburn (which includes the project reach) flows through an urban/industrial corridor that might be aesthetically undesirable to most recreational river users. The undeveloped segment of the Lower White River that might be more aesthetically pleasing to recreational users is located upstream of Auburn in the 14-mile canyon segment that has no public take-out points until Auburn and is only accessible from public put-in points located near Enumclaw or Buckley. Additionally the river has high turbidity and cold water temperatures due to its glacial origins on Mount Rainier. The fast and shallow flow resulting from the relatively steep gradient and the coarse substrate of the Lower White River may also discourage casual recreational use of the river. Another possible reason for the relatively low historical recreational use might be related to the daily fluctuations in river levels due to significant flow diversions of up to 2000 cfs from the White River for hydropower generation that occurred up until the early 2000s. Additionally, more experienced boaters prefer to float rivers with a difficulty rating higher than Class II. All of these factors combine to significantly limit the recreational use of the Lower White River within the project reach.

3.1.8 Private Land Use

Private land use in the vicinity of the project ranges from agriculture to heavy industrial. Private properties east of the project site, in Pacific, are zoned open space and are currently used for agricultural purposes. Properties east of the project site in Sumner are zoned light industrial and general commercial and are used for industrial purposes now or are under development (filling and site grading) for such use at a future time.

On the right bank, private land use in Pacific and north of the county boundary line is zoned residential north of the county boundary line and office park and light industrial south of the county boundary line (in Pierce County) and west of Butte Avenue SE. Land east of Butte Avenue SE in Pierce County is located in unincorporated Pierce County and is zoned as Employment Center, which is consistent with office park/industrial use. Most of the land adjacent to the White River in unincorporated Pierce County is used as a Pierce County wetland mitigation site, except for five occupied parcels near the county boundary line. The Manke lumber yard located on the right bank of the river and south of Stewart Road SE in Sumner is zoned heavy industrial. Land south of Stewart Road SE is zoned primarily as light industrial and general commercial.

3.2 Existing Public Safety Hazards

The following sections describe the public safety hazards and risks that exist under both the existing and future anticipated site conditions if the Countyline project is not constructed. Because channel conditions and associated hazards are changing rapidly due to sediment deposition, this assessment also evaluates site conditions that could exist within a planning horizon of a few decades if the project is not constructed. This risk assessment includes an evaluation of the likelihood that the identified hazards will occur, the potential consequences if those hazards do occur, and the resulting risk to public safety and infrastructure. Risk is characterized qualitatively as negligible, low, moderate, high, and very high. A

summary of the hazards and risks for existing and future conditions without the project is presented in Appendix D.

3.2.1 Sediment Deposition

Ongoing sediment deposition since the cessation of dredging in the 1980s and the resulting loss of flood conveyance capacity within the project reach of the White River is the most significant factor contributing to the flooding, avulsion, and channel migration hazards described below. Sediment deposition occurs primarily during large flood events because the rate of sediment transport and deposition in the project reach is nonlinear and increases exponentially with discharge. This means that a doubling of the flow from 7,000 cfs to 14,000 cfs can result in a ten-fold increase in the rate of sediment deposition (i.e., from 1,400 to 13,000 cubic yards per day, respectively) in the project reach. Adding to the cumulative hazard of sediment deposition is the fact that deposition occurring during a single flood event can cause rapid and unpredictable changes in the channel geometry, patterns of wood loading, and the redirection of erosive flows during the event. The consequences and associated risk to public safety due to sediment deposition is addressed below in the relevant sections.

3.2.2 Flooding

Due to the loss of flow conveyance in the channel from ongoing sediment deposition, the likelihood of flooding along the project reach now is greater than it has ever been in the past 100 years since the White River was permanently diverted to the Puyallup River and the conveyance improvements were completed. As discussed previously, the temporary HESCO barrier and sandbag berm along the county boundary line is providing limited flood protection for most properties on the right bank for flows up to approximately the 10-year flood event (i.e. approximately 13,000 cfs). The temporary flood barriers do not provide flood protection to properties located along Government Canal that are at risk of inundation from backwater flooding up the canal originating from the White River.

The results of hydraulic modeling of 2011 channel conditions without the temporary HESCO barriers indicate that the 15,532 cfs (i.e., the annual, one percent-chance flow) occurring today would impact approximately 200 residential properties in the city of Pacific and additional commercially developed properties within Pierce County. Without the flood protection provided by the temporary HESCO barrier or a future permanent right bank levee, flood damages (structures and contents) on the right bank are estimated to be $65 million if the 100-year flood event were to occur today. With the HESCO barrier in place, the level of risk to the right bank properties in King County from flooding is considered low. In 15 years, with continued sediment deposition in the project reach, flood damages to structures and contents from the 100-year flood event is estimated to climb to nearly $150 million if the projects are not constructed by this time. The total damages could be twice this amount following total build-out of the left bank floodplain in Sumner over the next 15 years. Consequently, the risk to public safety and infrastructure from flooding is considered very high.

Hydraulic modeling completed by King County and field observations of high water in February 2012 indicate that flows will overtop the south end of the wetland at approximately 8,000 cfs and allow water to flow down 142nd Avenue E and over Stewart Road SE. Results of hydraulic modeling of the 100-year

flood event indicate that about one-third of the flow (about 5,000 cfs) will split from the main channel and flow through the floodplain along this alignment. This area lies within the City of Sumner and is currently being developed for light industrial use. Permitted fill for the construction of warehouses has been placed in this flow path since development of the hydraulic model. The partial blockage of this flow path by artificial fill will deflect flood flows to the west and increase flooding on commercial and industrial properties located between the river and 142nd Avenue E. The risk to these properties under existing conditions is considered high due to the likelihood of flooding in any given year and the property damage and interruption of business that would result.

South of the project site, the results of hydraulic modeling of existing (2011) conditions completed by King County show that the extent of inundation during the 100-year flood event extends across most of the developed floodplain, from the BNSF Railway embankment to within a block or two of the UP Railroad embankment. Land use in this area includes several commercial properties and the former Sumner Meadows Golf Course (now zoned for light manufacturing) on the left bank and several large warehouses on the left bank. The flood risk to these properties is considered moderate to high under existing conditions, depending on the elevations of building pads relative to the flood elevations and the value of equipment and materials stored on-site below this elevation.

3.2.3 Avulsion

Hydraulic modeling and geomorphic analyses completed in support of the Countyline project have identified two avulsion hazards under existing conditions (Herrera 2014). The probability of either one of these avulsions increases with increasing flood magnitude and with time as the channel continues to fill with sediment.

The first avulsion hazard is located on the left bank at the county boundary line. Here the levee access road is overtopped several times each year when flows exceed approximately 3,500 cfs. Rock placed along both sides of the access road in 2012 by Pierce County has provided some resistance to breaching of the levee; however, the rock could be scoured during a major flood event and allow at least a partial avulsion of the river into the wetland. There are several likely consequences to an avulsion at this location. An avulsion would recruit hundreds of trees to the river and deposit some of this large wood within the project reach, while transporting the remainder downstream. There would likely be a slight increase in the water surface elevation in the wetland, which would initiate overbank flooding on adjacent properties for a lower flow rate than occurs under existing conditions. The outlet channel at the southwest corner of the wetland would widen, which would result in the immediate loss of access to the existing Countyline levee. The return flow from the wetland would be directed through the vegetated bar near RM 5.25. Erosion of this bar would recruit large wood to the river and allow the river to migrate west into the Pierce County wetland on the right bank, thereby recruiting additional large wood.

The second avulsion hazard is located on the left bank at the south end of the wetland. The probability of this hazard occurring would increase if the avulsion at the county boundary line described above occurs first and furthermore if significant quantities of large wood accumulated on the Stewart Road SE Bridge piers. An avulsion at this location would carve a new channel along 142nd Avenue E, erode a

section of Stewart Road SE, and follow the path of least resistance through the ditches recently constructed on both sides of the Six Kilns property (14200 block of Stewart Road SE), before rejoining the main stem of the White River near RM 4.5. The risks to 142nd Avenue E and to Stewart Road SE are discussed in a subsequent section.

3.2.4 Channel Migration

Although most of the banks along the project reach have been armored and have successfully resisted bank erosion over the past century, there are several locations where channel migration is possible under existing conditions and is likely to occur in the short-term if the levee setback projects are not constructed.

There is a possibility of future channel migration on the right bank, both under and upstream of the A Street SE Bridge abutment. Approximately 50 feet of channel migration occurred at this location between 2007 and 2009. This area has since filled with a gravel bar extending to the bridge pier, and the thalweg has shifted to the left side of the channel. Although the likelihood of more bank erosion is low, the risk is considered high because the consequence would be the loss of the bridge. This hazard and risk to the bridge is discussed in greater detail in the section on bridges.

There is a possibility of future channel migration into the left bank levee and access road at the county boundary line, at the same location as the avulsion hazard described above. The consequence of channel migration here is the loss of access to the Countyline levee for maintenance activities or repair actions that might be needed in the future. Channel migration here would likely trigger at least a partial avulsion of the river into the wetland. This would increase the likelihood of channel migration along the eastern edge of the wetland as the river is drawn toward the bank because this area is several feet lower in elevation than the river channel due to historical sediment deposition in the channel. The consequences of channel migrations at these two locations, without an avulsion, could be temporarily addressed with repair work; therefore, the risk to public safety and infrastructure is considered low but repair work may be ongoing as avulsion locations potentially shift over time.

There is a possibility of channel migration into the right bank levee and access road near the county boundary line (RM 5.55) and also into the Pierce County wetland near RM 5.3. The banks at these locations are vegetated with mature deciduous trees but are mostly unarmored. The right bank near RM 5.35 has recently experienced visible erosion and possible migration that has not yet been quantified. The City of Pacific's stormwater pond is located behind the levee. The consequences of the channel migrating through the levee near RM 5.55 would be the loss of access to Pierce County's levee located to the south and the breaching of the containment for the city's stormwater pond. The risk is considered low and is constrained to the near term because the city expects to evaluate options for relocating their stormwater facility, and the White River Estates neighborhood is buffered from the river by a forested wetland.

3.2.5 Large Wood

The Lower White River was historically known for its high wood loading rates and today transports significantly more large wood than most of the rivers in King County. Large wood can pose a hazard to

river recreational users when it is present in the channel and to public infrastructure when it accumulates on bridge piers or deflects erosive flows into banks. Both of these hazards, as they relate to large wood, are addressed in subsequent sections. In order to understand the severity of these hazards for existing conditions on the Lower White River, King County (2010) computed an estimated wood budget for the Countyline project reach for existing and future conditions.

Under existing channel conditions (without an avulsion), the hazard posed to recreational users and to infrastructure by large wood in the Countyline reach is considered low to moderate because most of the wood passes through the confined channel of the White River and does not accumulate, except on bridge piers, gravel bars, and the inlets to side-channels. Known hazards related to large wood within the project reach include wood that has accumulated on the piers of the A Street SE and Steward Road SE bridges, the logjam on the right bank gravel bar alongside Pacific City Park, trees spanning the side-channel on the right bank near RM 5.3, the logjam on the right bank near RM 5.18, and individual pieces of large wood found along the banks throughout the project reach. Large wood is also found on the gravel bars throughout the project reach, but this wood is usually above the water surface during most of the year.

The results of the 2010 wood budget estimated that an average of about 600 cubic meters (about 640 pieces) of large wood are transported through the Countyline project reach each year. The study found that large wood in the Lower White River is recruited to the river by channel migration into the forested floodplain of the unconfined canyon located upstream of Auburn. The 2010 study concluded that an avulsion through the Countyline levee and into the left bank wetland could recruit up to 3,700 cubic meters (1,300 pieces) of large wood from the forested wetland during a single event. An estimated 1,500 cubic meters (680 pieces) of this wood could accumulate within the project reach during the first year after the avulsion, resulting in an initial pulse of approximately 2,800 cubic meters (1,300 pieces) of large wood leaving the project site that year. During the decade following such an event, the study estimates that the project site would function as a wood "sink" by retaining approximately 700 cubic meters (350 pieces) of wood each year, resulting in the volume of large wood leaving the project site declining to approximately 200 cubic meters per year. Some of the wood leaving the project site could be deposited on floodplain properties located along the path of split flow that would follow 142nd Avenue SE and properties south of Stewart Road SE.

The hazards posed to recreational users and infrastructure following an avulsion into the wetland (which is likely during a 10- to 100-year flood event occurring under existing conditions), is considered moderate to high because of the relatively large quantity of large wood potentially accumulating in the project site and leaving the project site. The associated risks to recreational users and infrastructure related to large wood loading under existing conditions are addressed in subsequent sections.

3.3 Assessment of Existing Risks

3.3.1 Levees and Revetments

The results of hydraulic modeling of existing (2011) conditions indicate that the upstream end of the Countyline levee could begin overtopping during a 2-year flood event (approximately 10,000 cfs). At approximately 14,000 cfs (equivalent to a 10-year recurrence event), the upstream 500 feet of the Countyline levee (below the BNSF Railway bridge) would be overtopped by about 6 inches of water. The approximately 6-foot difference in water surface elevation between the river and wetland could initiate erosion on the back side of the levee and lead to a levee breach that would allow the river to (at least) partially avulse into the wetland. Modeling results also indicate that at 14,000 cfs, flows would overtop the entire length of the left bank levee between RM 5.7 (which is 1,000 feet upstream of the county boundary line) and Stewart Road SE at RM 5.0. Breaching of the levee and a partial avulsion could occur along this segment of the left bank levee as well. Given the relatively high probability that the upstream end of the levee could be overtopped in any given year and be breached, the risk to the Countyline levee is considered very high.

The results of hydraulic modeling of existing (2011) conditions along the right bank indicate that the top elevation of the HESCO barrier exceeds the water surface elevation of the 10-year flood event by at least two feet along most of the temporary flood barrier upstream of 4th Avenue SE and roughly corresponds to the water surface elevation of the 10-year flood event downstream of 4th Avenue SE, including the sandbag berm along the county boundary line. The sandbag berm ties into the left bank of Government Canal and provides limited flood protection to homes in the White River Estates neighborhood from backwater flooding up Government Canal. The risk of damage to or failure of the HESCO barrier during a 10-year flood event is considered low. Seepage through the permeable subgrade materials beneath the HESCO barrier and sandbag berm is likely to occur during sustained high flows and could be addressed with temporary pumps operating on the landward side of the HESCO barrier.

Hydraulic uplift forces during a flood event could dislodge one or more of the 100 year-old concrete slabs that are currently cracked and exposed along the right bank between the BNSF Bridge and Pacific City Park. Piping of flow under a slab could also dislodge sections of concrete. The loss of a concrete slab could expose the bank to erosion and undermine the fill supporting the temporary HESCO barrier. The risk of this occurring is considered low because the lower one half of the slabs are buried beneath alluvium, and several sections of concrete slab would need to fail before significant bank erosion could occur.

3.3.2 Stormwater Facilities

Hydraulic modeling of existing (2011) conditions indicates that the water surface elevation of the 100-year flood event would rise to within a few inches below the invert elevation of the BNSF culvert and would not inhibit stormwater flows from the City of Auburn. Modeling of future conditions without the project (assuming continued sediment aggradation) indicates that the water surface elevation of the 100-year flood event would backwater up the culvert and allow floodwaters to flow south in the ditch between the BNSF Railway embankment and A Street SE and then west under the railway at the

undercrossing located at the county boundary line. Flows could overwhelm the capacity of the ditch and inundate portions of A Street SE and the East Valley Highway if the future 100-year flood event on the White River coincided with significant stormwater runoff from the City of Auburn. The risk to Auburn's stormwater system is considered low under existing conditions and moderate under future conditions without the project.

On the right bank, stormwater outfalls in Pacific have been retrofitted with check valves to prevent backwater flooding from the White River. If significant stormwater runoff in the City is expected to coincide with flooding on the White River when the check valves are closed, pumps must be deployed to convey stormwater over the HESCO barrier. The risk to the City of Pacific's stormwater system is considered low under existing conditions because only a small area would be affected. The level of risk depends on the ability of agencies, primarily the National Weather Service in conjunction with the USACE water management staff, to accurately forecast river stage and flow releases from Mud Mountain dam and for the timely deployment of pumps to where they are needed in the City of Pacific.

3.3.3 Roads

There are several consequences of an avulsion occurring on the right bank; the worst in terms of property damage is the temporary loss of the major arterial, Stewart Road SE, until repairs could be made. Damage to the recently improved Stewart Road corridor would disrupt local freight and commuter traffic for months until the White River could be diverted back under the bridge (if at all possible) and the road reconstructed. There is also a risk to public health and safety if the avulsion occurs catastrophically while motorists are on the bridge or road and before businesses could be evacuated and the road closed to traffic. Given the high probability of a partial or full avulsion of the White River occurring at this location during a 10-year flood event and the public safety and economic consequences of this event, the risk is considered very high. There is also a potential for loss of life if motorists attempt to drive across inundated areas, even with road closure barriers in place, and become swept off the road into flood waters.

Local flooding of A Street SE and the East Valley Highway could occur as a result of backwater flooding through the 24-inch culvert under the BNSF Railway. The consequence of this flooding might prompt a temporary road closure that could cause delays for motorists. The risk to the road is considered low because of the low probability of such an event occurring, the short duration of road flooding, and the low probability of damage to the road infrastructure.

Backwater flooding up Government Canal occurs as flows in the White River exceed approximately 10,000 cfs. Backwater up the canal allows floodwaters to begin inundating properties to the south in Pierce County along Butte Avenue SE. Flooding along Butte Avenue SE is worsened by the artificial depression formed by the UP Railroad embankment, Steward Road SE, and dredge spoils in the Butte Pit east of Butte Avenue SE. This artificial depression drains to the river through an 18-inch culvert under Butte Avenue SE and a ditch along the north side of Stewart Road SE. When the capacity of this drain is overwhelmed, water flows over a low point through the south end of the Butte Pit that is about 1 foot lower than the "saddle" in Stewart Road SE and, hence, controls the depth of flooding along Butte Avenue SE. The risk to Butte Avenue SE is considered moderate because, although flooding of the

roadway is expected to occur more frequently, traffic disruptions may only last for a day or two, and (except for local residents and businesses along Butte Avenue SE) there are alternate routes available.

3.3.4 Railroads

A breach at the upstream end of the existing Countyline levee could allow deep and fast flows to become entrained along the northern extent of the BNSF Railway embankment adjacent to the project site. A 25 foot-wide gravel and dirt bench along the west side of the railway embankment would provide limited protection against channel migration into the railway during an initial breaching event. The bench widens to approximately 100 feet at the northern end of the wetland and is oriented such that flows would be deflected away from the railway embankment. These topographic features would buffer the railway from erosive flows that might impinge upon the edge of the wetland along the railway embankment. The risk to the BNSF Railway from this hazard is considered low. In the absence of the project, the risk of a levee breach affecting the BNSF Railway prism increases with time due to sediment aggradation.

The periodic saturation at the toe of the BNSF Railway embankment during major flood events could weaken the steep embankment slope. The risk to the railway is considered low because of the short duration of potential saturation during major flood events on the White River and from urban runoff on the east side of the embankment and because of the buffering effect of the 25-foot bench on the west side of the railway.

Inundation along the toe of the UP Railroad embankment during large flood events is not expected to significantly impact the stability of the slope. The risk to the railroad embankment under existing conditions is considered negligible because of the low relief of the embankment and because portions of the railroad embankment are normally saturated where it has been constructed through wetlands and where it parallels Government Canal.

3.3.5 Bridges

The results of 2D hydraulic modeling of the 100-year flood event (for 2011 channel conditions) completed by King County indicate the freeboard under the A Street SE Bridge is approximately 1.5 feet. The Washington State Department of Transportation minimum design standard for freeboard is 3 feet above the 100-year water surface elevations to account for fluctuations in the river bed elevation and the loss of flow conveyance from the accumulation of debris. Large wood accumulating on the single in-water pier of the A Street SE Bridge typically organizes to form a stable apex log jam in the center of the river channel that induces bed scour around the pier and gravel deposition upstream of the jam. The blockage caused by the gravel bar and wood accumulation reduces the available freeboard under the A Street SE Bridge. The loss of freeboard due to sediment and/or wood accumulations that results in submergence of the bridge deck during a large flood event would initiate pressurized flow, which would cause additional scour around the bridge pier. This condition presents a hazard to the bridge because the center pier and abutments rest on shallow spread footings that are considered scour critical. According to the 1989 bridge construction plans, the top of the spread footing for the pier is 18 feet below the river bed. The top of the footings for the abutments are 3 feet above the elevation of the

river bed and must be protected from channel migration that could undermine the abutments supporting the ends of the bridge and erode the road prism comprising the bridge approach. Although there is no known estimate of the potential scour depth at the A Street SE bridge pier (with wood loading), calculations performed for the proposed apex ELJs calculated an average scour depth of 17 to 19 feet for the unconfined flow conditions within the reconnected floodplain area.

Since about 2002, the thalweg at the A Street SE Bridge has remained fixed to the right side of the channel (north of the center bridge pier), and a gravel bar has formed on the left side of the channel beneath the bridge and extending several hundred feet downstream. During the January 2009 flood event, wood accumulated on the center pier of the A Street SE Bridge, and the channel migrated about 50 feet north through the rock armor protecting the right bank abutment. Woody debris was last removed from the bridge pier in 2009, but new wood had begun to accumulate again by 2011. Although there is currently rock armoring along a 50-foot section of the right bank between the BNSF and A Street SE bridges, the bank is unprotected under the A Street SE Bridge and upstream where the bank erosion occurred in 2009. Due to the condition of the right bank and the shallow abutment footings, the risk to the A Street SE Bridge under existing conditions is considered moderate.

The results of hydraulic modeling indicate the freeboard under the BNSF Bridge is approximately 4.5 feet. The depths of the footings for the BNSF Bridge are not known. Additionally there are no known reports of large wood accumulated on the bridge abutment. The risk to the BNSF Bridge is considered low.

The results of recent 2D hydraulic modeling of the 100-year event indicate the freeboard under the Stewart Road SE Bridge is approximately 1.5 feet as measured from the bottom of the metal brackets supporting the water main, where the main is exposed below the three concrete arches of the bridge. Wood typically accumulates on both of the in-water bridge piers. As in the case of the A Street SE Bridge, large wood accumulating on the piers forms two apex log jams in the river channel that could reduce the available freeboard. An analysis of pier scour at the Stewart Road SE Bridge completed by King County (in Herrera 2014) estimated a scour depth of 6 to 7 feet for the 100-year flow event, without wood loading. Submergence of the bridge deck during a large flood event would initiate pressurized flow, which would cause additional scour around the bridge piers. Woody debris was last removed from the Stewart Road SE Bridge piers in 2013. The natural widening of the left bank side-channel upstream of the bridge later that year recruited wood to the channel that accumulated on the bridge piers and replenished the large wood removed only months earlier. Records obtained from Pierce County indicate that wood was also removed from the bridge piers in 1999 and 1992.

According to the 1952 bridge construction plans, the top of the pile cap for the two piers is 10 feet below the existing river bed. The top of the footings for the abutments are 15 feet above the elevation of the river bed and must be protected from channel migration that could undermine the abutments supporting the ends of the bridge and erode the road prism comprising the bridge approach. The risk to the Stewart Road SE Bridge is considered moderate.

Hydraulic modeling results of future conditions without the project estimate that the 100-year water surface elevation at the Stewart Road SE Bridge will decrease over time because of an increase in split flow through the left bank floodplain due to continued sediment aggradation in the main channel. Flow under the bridge would decrease substantially as a result of an avulsion through the left bank floodplain, which is considered imminent in the next 15 to 20 years due to sediment aggradation if the project is not constructed.

King County staff conducted a reconnaissance of four bridges downstream of the Stewart Road SE Bridge on March 6, 2014 for the purpose of assessing the potential for large wood accumulations on these structures. As-built plans noting the elevations of bridge footings were not reviewed as part of this reconnaissance. Flow measured at the R Street gage at the time of the reconnaissance ranged from 6,000 to 6,100 cfs. The reconnaissance noted conditions at the four bridges spanning the White River within the City of Sumner. The 16th Avenue and 24th Avenue pedestrian bridges are full channel-spanning, steel Pratt truss bridges with piers located on the banks and floodplain. The low chord of the 16th Avenue Bridge was about 10 feet above the water surface, whereas the low chord of the 24th Avenue Bridge was about 15 to 20 feet above the water surface. The Tacoma Avenue Bridge and the 142nd Avenue Bridge are both multi-span, concrete beam bridges. Both bridges are supported by two concrete pile bents located near the toe of each bank and concrete abutments located within the upper portion of each bank. No large wood was observed accumulated on the piles. The channel is incised into the floodplain, so the bridge chords are more than 20 feet above the observed water surface. Because of the abundant freeboard and the positioning of the piers outside of the center of the channel, the risks to the four bridges located downstream of the Countyline project are considered low.

3.3.6 Utilities

The utilities at the greatest risk are located along Stewart Road SE. Split flow passing over Stewart Road SE could erode the road prism and expose buried utilities. The risk to the gas line and water supply line attached to the Stewart Road SE Bridge crossing depends on the structural resiliency of the bridge. Slumping of the bridge deck due to the failure of either abutment or pier could shear the utility lines. The risk to the water supply line is considered greater because it is vulnerable to direct impacts from floating debris, whereas the gas line is mounted on the downstream-facing side of the bridge deck and is protected from direct debris impacts.

The risk to the utilities under the A Street SE Bridge is considered low because they are shielded from flow and debris impacts by the concrete girders. The utilities are at risk of shearing in the event of bridge collapse or if an abutment or pier settles due to bank erosion or scour. The risk to the fiber optic line attached to the BNSF Bridge is considered low.

3.3.7 Recreation

In 2015, King County completed a third-party river recreational safety review and risk assessment for the Countyline project (MIG 2015). The risk assessment (Appendix C) evaluated existing (2015) conditions, future conditions with an avulsion into the wetland if the Countyline project is not constructed, and future conditions after construction based on the 60% design plans (MIG 2015). The assessment

characterized the risk to the types of river users identified in the King County (2014) study (i.e., novice boaters and inner tubers) as low to medium for existing conditions. The MIG (2015) report found that the relative risk to a recreational user on the White River within the project reach depends on their experience, training, and preparation and the type of vessel deployed on the river. The cold water temperatures, swift currents, natural logjams, and downed trees spanning the entire width of side-channels can present a high risk to an inexperienced user floating on an inner tube with no means of maneuvering around such hazardous obstacles. The same conditions may present a low and acceptable level of risk to an experienced kayaker familiar with the natural hazards common on the White River and on many similar rivers found throughout heavily forested floodplains of the Pacific Northwest.

Following an avulsion into the wetland, MIG (2015) found the risk to recreational users would increase substantially (relative to 2015 conditions) due to a significant increase in wood loading, shifting gravel bars and side-channels that could accumulate large wood, porous logjams and strainers that could entrap inexperienced users, poor lines of site through multiple meandering channels, challenging terrain to portage around these hazards, and poor means of access to and from the wetland area for self-rescue or rescue by others.

3.3.8 Private Land Use

The risk of flooding and channel migration to properties located east of the project site increases in the downstream direction. Under existing conditions, properties south of the county boundary line are at a high risk of flooding and channel migration. The properties along both sides of 140th Ave E and along 140th Avenue E south of Stewart Road E (extending to the White River) carry the additional high risk of an avulsion. Under future conditions without the project, the risks to properties east of the project site increase, and the properties at risk expands north to include agricultural lands in Pacific.

The properties on the right bank in Pacific are at a high risk of flooding. The flood risk is greatest in the vicinity of Pacific Park, White River Estates between the park and the county boundary line, and properties south of the county boundary line along Butte Avenue SE. The relative risks to these properties are reduced by the temporary HESCO flood barrier installed along the right bank and the sandbag berm along the southerly edge of White River Estates. The flood risk to these properties is expected to increase without the Countyline project, up until a time when the river avulses through the left bank floodplain, away from the right bank. The Manke lumber yard on the right bank is at risk of flooding under existing conditions due to its low elevation relative to the river. Two-dimensional hydraulic modeling of 2011 channel conditions indicate floodwaters do not overtop Stewart Road SE west of the bridge, and observations during the 2009 flood event placed the high water line near the crown of the road. An analysis of the lidar topography indicates that the floodplain east of Butte Avenue SE is about two feet lower than the crown of Steward Road SE and allows floodwater to drain east back to the river.

3.4 Post-project Hazards

This section describes how the existing hazards and risks might change as a result of the project and the residual risks not addressed by the project. A summary of the post-project hazards and risks and comparison with existing and future conditions without the project is presented in Appendix D.

3.4.1 Sediment Deposition

The risks associated with sediment deposition (primarily the loss of flood conveyance capacity and resulting increase in the potential for channel migration and avulsion) will be reduced because the project will provide additional area for sediment deposition, thereby slowing the rate of sediment aggradation relative to existing conditions. Sediment deposition within the project footprint is expected to result in conditions similar to those described above for an avulsion into the wetland under existing condition, except the effects will be contained within the project footprint by virtue of the new setback levee. The associated risks to recreational users and infrastructure related to post-project sediment deposition are addressed in subsequent sections.

3.4.2 Flooding

The project will significantly reduce the flood risks within the project reach. Properties on the right bank upstream of RM 5.6 will experience an immediate reduction in the water surface elevation of the 100-year flood event by as much as three feet along the temporary HESCO barrier surrounding Pacific City Park. Approximately 85 acres of properties on the left bank north of Stewart Road SE and zoned for light industrial use that would be inundated by the 100-year flood event under existing conditions would be protected from inundation by the setback levee. The project will also reduce flood elevations by up to three feet on the left bank south of Stewart Road.

As a consequence of eliminating the split flow and avulsion hazard through light industrial properties on the left bank floodplain and routing all flood flows under the Stewart Road SE Bridge, the project is expected to result in an initial increase in water surface elevations for the 100-year flood event on the right bank in an area bounded by the UP Railroad, Government Canal in Pacific, and 24th Street E in Sumner. These temporary increases are less than the maximum allowable increase (1 foot) per the regulatory requirements of the local jurisdiction, and they only affect properties that already experience flooding. When compared to future conditions without the project, the change in risk to these properties will not be measurable within a few years after construction because the project will slow the rate of sediment aggradation and result in a comparable flood risk to what would occur if the project is not constructed.

Additionally, the future project proposed by Sumner to replace the Stewart Road SE Bridge and set back the levees downstream of the bridge are expected to lower flood elevations in this reach of the river. The hydraulic modeling completed by King County does not account for the planned bridge replacement or for the permitted fill placed in the floodplain since 2011 that, if included in the model, would yield a smaller relative increase in flood risk to downstream properties resulting from the Countyline project.

3.4.3 Avulsion

The proposed biorevetment, roughening structures, riparian buffer, and setback levee will eliminate the risk of an avulsion on the left bank during the 100-year flood event. This includes the elimination of the potential for the left bank avulsion along 142nd Avenue SE and over Stewart Road SE described above for existing conditions.

3.4.4 Channel Migration

The proposed levee removal and the construction of the biorevetment, roughening structures, riparian buffer, and setback levee will allow the channel to safely migrate into the wetland and will eliminate the risks following the uncontrolled migration of the channel into the wetland. The proposed project elements will not change the likelihood of channel migration into the right bank at the A Street SE Bridge crossing or the current risk to the bridge due to channel migration at this location.

The project will deflect flows away from the south end of the wetland near RM 5.25, with the potential to redirect flows westerly toward the Pierce County wetland on the right bank. The proposed bank roughening log structures and apex logjam proposed on the east side and south end of the wetland are positioned to disperse flows into multiple channels leaving the wetland, thereby reduce the likelihood of channel migration along the right bank that might threaten infrastructure west of the river. Migration of the channel into the right bank at this location would reoccupy the channel location that existed before 2009; therefore, the risk to properties and infrastructure located along the right bank is expected to be unchanged (low) as a result of the project. By virtue of removing the existing left bank levee and allowing flow to enter the wetland, the project will reduce the likelihood of channel migration on the right bank at locations upstream of RM 5.3.

3.4.5 Large Wood

The removal of the existing levee will allow the river to form new channels through the forested wetland and recruit trees to the river. The existing levee will be removed down to an elevation that will allow flows to enter the wetland when discharge first exceeds approximately 1,500 cfs after project completion and at lower flows as new channels entering into the wetland develop. If flows exceed approximately 8,000 to 10,000 cfs during the first flood season, wood loading within the project reach and the delivery of wood downstream of the project could be as high as the quantities described earlier for the avulsion scenario evaluated in the 2010 wood budget. If peak flows on the Lower White River are less than approximately 8,000 cfs for the first few years following construction, then the same quantities of wood loading and delivery downstream would be spread over several years.

The deliberate engineering design and placement of the ELJs and biorevetment will reduce the uncertainty of geomorphic response as compared to the response during an uncontrolled avulsion into the wetland. The architecture and positioning of the proposed ELJs have been designed to trap most of the large wood recruited from the setback area and to allow this wood to accumulate at locations that minimize the influence of their effects on public safety and the surrounding infrastructure. Large wood recruited to the channel is expected to accumulate on the ELJSs and cover the key logs and rootwads exposed on the front of the ELJ structures. Furthermore, the project will eliminate the risk of large

wood depositing on properties south of the wetland. Consequently, the risk to recreational users and infrastructure is expected to be less than the risk that could exist under existing conditions or future conditions if the project is not constructed.

3.5 Assessment of Post-project Risks

3.5.1 Levees and Revetments

The resurfacing and raising of the upstream portion of the existing Countyline levee will provide three feet of freeboard above the 100-year flow event (15,532 cfs) for future conditions considering sediment deposition and significantly reduce the risk of overtopping and failure of this segment of levee. The removal of most of the Countyline levee downstream of the resurfaced segment and the construction of the setback levee will significantly reduce the risks associated with the failure of the existing levee.

The lowering of flood elevations along the right bank resulting from the project will reduce the risk to the temporary HESCO barrier. Because the flood-risk reduction benefits of the project on the right bank do not extend south of the county boundary line, the project will not change the level of risk to the sandbag berm located south of the White River Estates neighborhood.

The project will result in a minor reduction in the likelihood of a failure of one or more of the concrete slabs along the downstream portion of the concrete revetment, where water surface elevations are expected to drop as a result of the project. Consequently, the risk to the concrete revetment is expected to be reduced or not change significantly relative to existing conditions.

3.5.2 Stormwater Facilities

Hydraulic modeling results of the conditions anticipated immediately after construction indicate that the 100-year flood event would inundate a portion of the culvert outlet at the BNSF railway embankment but would not backwater all the way up to the catch basin along A Street SE. The hydraulic head at the inlet would allow all of the flow from the City of Auburn to flow through the check valve and into the White River during a 100-year flood event. Hydraulic modeling results of future, post-construction conditions assuming continued sediment aggradation indicate that the water surface elevation during the future, 100-year flood event could exceed the elevation of the catch basin along A Street SE. A check valve installed at the outlet of the BNSF culvert will prevent backwater flooding from the White River. Under this scenario, some of the flow from the City of Auburn would flow through the check valve (to the White River), and some would flow south down the ditch along A Street SE. This would only occur when a major flood event on the White River coincides with significant stormwater runoff from the City of Auburn. By eliminating backwater flooding through the culvert, the project is expected to reduce the peak flow in the ditch along A Street SE and, hence, reduce the risk to Auburn's stormwater system and stormwater flooding along A Street SE.

Because the project will lower the water surface elevations in most of the City of Pacific, the risk to Pacific's stormwater outfalls as related to backwater effects should decline as a result of the project.

3.5.3 Roads

The project will eliminate the risk of damage and temporary closures to Stewart Road SE caused by flooding or an avulsion through the left bank floodplain. The project will also reduce the risks to A Street SE and the East Valley Highway as related to backwater flow through the BNSF culvert.

The project could result in a temporary increase in the frequency of inundation of Butte Avenue SE immediately after construction. This would increase the risks associated with temporary road closures during major flood events. When compared to future conditions without the project, the change in the risk to Butte Avenue SE is expected to be negligible within a few years because the project will slow the rate of sediment aggradation and the associated increase in flood risk that would occur along Butte Avenue SE if the project is not constructed.

3.5.4 Railroads

The proposed resurfacing of the upstream portion of the Countyline levee will substantially reduce the likelihood of a levee breach and thereby reduce the risk to the BNSF Railway related to this hazard. The risk to the BNSF Railway related to toe saturation will initially increase after construction but after several years will be comparable to the risk under existing conditions because the project will slow the rate of sediment aggradation and progressive rise in water surface elevations during future flood events. Also by 2016, BNSF will place additional material on the westerly portion of the railway embankment as necessary to support construction for the future third line. This additional material will lower the risk of inundation affecting the railway embankment. Similarly, the risk to the UP Railroad embankment may increase initially after construction, but after several years would be comparable to the risk under existing conditions.

3.5.5 Bridges

The project is not expected to result in any changes in the channel configuration, water surface elevation, or wood loading at the A Street SE or BNSF bridges. Consequently, the risk to these bridges is not expected to change as a result of the project.

Hydraulic modeling results of post-project conditions indicate that the project could cause the water surface elevation of the 100-year flood event at the Stewart Road SE Bridge to increase by up to 1 foot, thereby reducing the freeboard to approximately 6 inches. The reduced freeboard could increase the likelihood of woody debris impacting the suspended water supply line and accumulating under the bridge deck. This would increase the likelihood of pressure flow under the bridge and the potential for scour at the bridge crossing that could threaten the shallow footings for the abutments and road approaches. Bed scour during pressure flow would need to exceed 8 feet to match the bed elevation when the bridge was constructed in 1952. Scour is not expected to change the risk to the deep footings for the two in-water piers.

The increased hazard to the Stewart Road SE Bridge resulting from the increased water surface elevation will be mitigated with continued channel monitoring, periodic updates to the hydraulic model, and close

coordination between King County, the City of Sumner, and the appropriate agencies in accordance with the public safety monitoring approach described below in this document.

Because the volume of wood delivered to the Stewart Road SE Bridge crossing and other downstream bridges immediately after project construction is expected to be less than the volume of wood potentially delivered during an uncontrolled levee breach and avulsion into the wetland, the project is expected to reduce the relative risk to downstream bridges due to wood loading.

3.5.6 Utilities

The project would reduce the risk to the utilities along the north side of Stewart Road SE because of the elimination of the avulsion and flood risks at this location. The project could increase the risk to the water supply line beneath the Stewart Road SE Bridge because of the reduction in freeboard and increased potential for direct impacts from debris the first few years after construction. Because the project is expected to trap wood and reduce the quantity of wood delivered to the bridge, the risk to the water supply line could decrease several years after project construction. The project would not increase the risk to the gas line because it would still be protected from direct impacts from debris. The project would not change the risk to the utilities under the A Street SE Bridge or to the MCI fiber optic line attached to the BNSF Bridge.

3.5.7 Recreation

The recreational review of the project (MIG, 2015) found that the project will result in an immediate, but temporary increase in risk to recreational users relative to 2015 conditions. The long-term risk to recreational users will be reduced when compared to the future conditions of an uncontrolled avulsion that is likely to occur if the project is not constructed. The risk is rated to be lower because the areas of wood accumulation and sediment deposition are expected to be more predictable after construction than they would be during an uncontrolled avulsion. The risk would be reduced further by the County implementing mitigation measures through public outreach efforts aimed at communicating the project goals, anticipated channel changes, and the presence of natural and placed large wood..

Boaters passing under the BNSF Railway Bridge as they enter the project reach would have a 1,000-foot line of sight before reaching the newly formed inlet to the reconnected floodplain and wetland area on the left bank. Signs will be posted upstream of the project reach notifying boaters of large wood in the river and options for take-out. The main channel may have partially avulsed into the reconnected floodplain area, may follow the current alignment, or may split the flow between the two alignments. Boaters continuing downstream would be able to scout ahead by exiting onto the Countyline levee (river left) or onto the gravel bar in front of Pacific City Park (river right). If most of the flow has avulsed into the wetland, boaters will likely encounter enlarged gravel bars and accumulations of large wood within a portion of the former main channel in front of Pacific City Park (near RM 6.0).

Upon entering the reconnected floodplain area, boaters would likely encounter shallow flow, with velocities less than 2 feet per second in most areas, split between several channels formed within an area of gravel deposition (splay deposit) and would have a 300-foot line of sight to the three apex ELJs

constructed in the north end of the wetland. The upstream faces of the ELJs and the banks of the new channels would likely be partially covered with large wood recruited from the forested wetland and upstream sources. Approximately 300 feet beyond the last apex ELJ, boaters might float along the biorevetment (also lined with natural accumulations of large wood), where the channel alignment is initially expected to form through most of the reconnected floodplain area. Throughout the remainder of this area, boaters would encounter conditions similar to those described earlier for the avulsion scenario. Those conditions include accumulations of large wood on new gravel bars and along the biorevetment, shifting gravel bars and side-channels, natural logjams with strainers that could entrap inexperienced users, poor lines of site through multiple meandering channels, and poor means of access to the wetland for a rescue or for a user to portage around hazards. At the bank deflector and apex ELJ near RM 5.4 and at the bank deflectors at the south end of the wetland near RM 5.2, boaters would likely encounter more accumulations of large wood before returning back to the main stem of the river.

To mitigate the potential risks to recreational users following construction, MIG (2015) recommended posting signs to alert users of the presence of potential recreation hazards in the project reach and of possible take-out locations upstream of the project site. The signs could be installed on the A Street SE and R Street E bridges and at upstream put-in locations (public parks) where the public has access to the river. Posting of the signs will require coordination with the cities of Auburn and Pacific. The hazards that might be present following construction will require some recreational users to be more vigilant, modify their activities, or avoid entering the reconnected floodplain area if it presents an unacceptable risk. MIG (2015) also recommended that King County monitor the project site for large wood accumulations that may pose a hazard to recreational users and post updated information regarding large wood hazards on the existing County's website of known hazards in King County rivers. Adaptive management measures may also be employed to address such hazards.

Public access for hiking and biking on the access road on the top of the proposed setback levee will be similar to existing conditions. Access from the south will be provided via a gated entrance at the location of the current gate north of Stewart Road SE. No public access will be provided at the northern end of the resurfaced existing levee where it will tie-in to the BNSF Railway embankment due to the significant safety issues related to illegal access of pedestrians crossing railways. Public access will not be provided or maintained to the upstream 1,000 lineal feet of the levee that will remain after project construction.

3.5.8 Private Land Use

The project will reduce the risk of flooding and channel migration threatening the use of private (mostly residential) lands located on the right bank north of the county boundary line and private agricultural and light industrial lands located on the left bank north of Stewart Road SE. Private lands located roughly east of 142nd Avenue E south of Steward Road E (to the Dieringer return) will also experience a reduced risk of flooding.

As indicated in previous sections, the project is expected to result in an initial increase in flood elevations on the right bank in an area bounded by the UP Railroad, Government Canal in Pacific, and

24th Street E in Sumner. These temporary increases are less than the maximum allowable increase (1 foot) per the regulatory requirements of the local jurisdiction, and only affecting properties already experiencing flooding. When compared to future conditions without the project, the change in risk to these properties will not be measurable within a few years after construction because the project will slow the rate of sediment aggradation and result in a comparable flood risk to what would occur if the project is not constructed.

4.0. Monitoring and Adaptive Management Strategy

4.1 Roles and Responsibilities

The Countyline project site spans several jurisdictions and is served by numerous service providers. No part of the project site is located in unincorporated King County; therefore, the King County Sheriff's Office does not have jurisdictional authority to regulate river use, but it is available to provide technical assistance to the local jurisdictions and agencies upon request. The city of Auburn has jurisdictional authority upstream of the BNSF Railway Bridge and is the owner of the A Street Bridge. Below the BNSF-owned bridge, the city of Pacific has jurisdictional authority on both banks of the river and throughout the reconnected floodplain area as far south as the King-Pierce county boundary line. Pierce County has jurisdictional authority on both banks of the river between the county boundary line and the Stewart Road SE Bridge because this area is located in unincorporated Pierce County. The city of Sumner has jurisdictional authority within the reconnected floodplain area east of the existing river channel and within the river downstream of the project site (including and south of the Stewart Road SE Bridge). The city of Sumner is also the owner of the Stewart Road SE Bridge. The roles and responsibilities of the various jurisdictions, agencies, and private organizations are summarized below in Table 1.

Table 1. Public Safety Roles and Responsibilities.

Jurisdiction or Agency	Roles	Responsibilities
King County River and Floodplain Management Section (as the primary service provider to the King County Flood Control District)	Manage the Countyline Project site	Monitor, inspect, and maintain the integrity and function of the Countyline project components. Coordinate with local jurisdictions to address public safety.
King County Flood Control District	Provide funding for capital improvement projects, ongoing site management, and facility maintenance for purposes of flood-risk reduction.	Reduce flood risks to people and property in King County.
King County Office of Emergency Management	King County coordination center for disaster preparedness, response, and recovery.	Coordinate regional services and resources during a disaster or emergency.
King County Sheriff's Office	Provide Expertise in the assessment of risks to river recreational users and swift water rescue.	If requested, provide technical support to local jurisdictions for the assessment of hazards to river recreational users.

U.S. Army Corps of Engineers, Water Management, Reservoir Control Center (RCC)	Operation of Mud Mountain Dam.	Operate Mud Mountain Dam to reduce flood risks on the Lower Puyallup River, while minimizing flood risks on the Lower White River. Coordinate flow releases with USACE Emergency Management
U.S Army Corps of Engineers, Emergency Management (EM)	Field monitoring of conditions on the Lower White River during flood events. Emergency response.	Provide resources and emergency response during flooding. Coordinate field observations with USACE Water Management and the RCC
City of Pacific	Protect public safety and property within the city limits	Maintain interior drainage, stormwater systems, and pumps at outfalls. Authorize evacuations and the closure of the river to recreational users within the city limits. Address risks to city infrastructure and public safety.
City of Auburn	Protect public safety and property within the city limits.	Maintain interior drainage and stormwater systems. Inspect and maintain the A Street SE Bridge (including wood removal). Authorize evacuations and the closure of the river to recreational users within the city limits. Address risks to city infrastructure and public safety.
City of Sumner	Protect public safety and property within the city limits.	Maintain interior drainage and stormwater systems. Inspect and maintain the Stewart Road SE Bridge (including wood removal). Authorize evacuations and the closure of the river to recreational users within the city limits. Address risks to city infrastructure and public safety.
Pierce County Surface Water Management Division	Oversight of flood protection infrastructure in unincorporated Pierce County.	Monitor, inspect, and maintain the Potelco Revetment.
Pierce County Sheriff's Department	Provide expertise in the	Assess hazards to river recreational

	assessment of risks to river recreational users and swift water rescue.	users in unincorporated Pierce County. Provide technical support to local jurisdictions. Restrict recreational use in the river within unincorporated Pierce County, when necessary. Provide swift water rescue and flood response within unincorporated Pierce County.
Burlington Northern – Santa Fe Railway	Ensure safe railway operations and protect BNSF infrastructure.	Inspect and maintain the railroad bridge. Maintain the 24-inch concrete culvert within BNSF right-of-way.
The Boeing Company	Operation of Government Canal.	Maintain the function of Government Canal within Boeing's easements.
Valley Regional Fire Authority	Emergency service provider for Pacific and Auburn	Assess public safety risks. Coordinate with cities they serve to restrict recreational use in the river. Provide rescue and recovery from flood and swiftwater environments.
East Pierce Fire and Rescue	Emergency service provider for Sumner and unincorporated Pierce County.	Assess public safety risks. Coordinate with the jurisdictions they serve to restrict recreational use in the river. Provide rescue and recovery from flood and swiftwater environments.

As the project proponent, King County will serve as the lead agency for the management, monitoring and inspection of the various elements comprising the Countyline facility. King County will play an active role in the assessment of hazards that present a risk to the function and integrity of the Countyline facility and will provide input and assistance to the various jurisdictions and agencies to address hazardous conditions that may pose a risk to public safety and river recreational users.

4.2 Emergency Response

In the event of a flood emergency, the King County flood patrols and project technical leads would report observations to the Flood Warning Center. If the Flood Warning Center is not open, observations would be reported directly to the King County Emergency Coordination Center and the Pierce County Emergency Operations Center. Depending on the emergency, County staff may also contact the cities, regional fire districts, and the USACE Emergency Management and Water Management/RCC. In accordance with Policy ER-3 in the 2006 King County Flood Hazard Management Plan (and incorporated

by reference in the 2013 Flood Hazard Management Plan Update and Progress Report), King County should consider long-term objectives for risk reduction and habitat restoration when implementing emergency response actions.

4.3 Facility Monitoring, Inspection and Maintenance

The inspection, monitoring, and maintenance of the new Countyline facility will occur in accordance with the Site Management Plan, which includes this Public Safety Management Plan (PSMP) and the 10-year Countyline Effectiveness Monitoring Plan (EMP) as appendices to the Site Management Plan. The Site Management Plan specifies overarching goals and uses of the project site and the inspection, monitoring, and maintenance protocols for the flood-protection components of the facility as documented in the PSMP and EMP. The Site Management Plan will be updated periodically to reflect changes in site conditions and site management needs and strategies. The Site Management Plan also includes protocols for the monitoring and reporting of river recreational hazards related to large wood. The Habitat Monitoring Plan includes a one-time assessment of project conformance with the project design and the periodic monitoring of habitat conditions and fish use for the first ten years following project construction. The EMP includes habitat monitoring elements that meet the requirement of federal and state permits issued for the Countyline project.

4.3.1 Monitoring

The County will monitor physical channel conditions, habitat conditions, and fish use in accordance with the 10-year Effectiveness Monitoring Plan (Appendix E). The Effectiveness Monitoring Plan will compare site conditions with established performance standards and implement adaptive management actions if the performance standards are not met according to the monitoring schedule. The physical channel conditions to be monitored include the formation of new side-channels within the setback area. The habitat conditions to be monitored include changes in the area of slow water (velocities less than 1.5 feet per second), the area of inundation, wood loading, percent coverage by native riparian vegetation and invasive plants, and the restoration of wetland areas impacted by construction. The fish use to be monitored includes the use of low-velocity water by juvenile salmonids. The flood hazard conditions to be monitored include the stability of the structural elements (levees, revetments, and engineered log structures), change in flood risks outside of the project area relative to anticipated future conditions without the project, and the containment of channel migration to within the project area.

The County will also monitor site conditions that might pose a risk to infrastructure and recreation safety. Sediment aggradation will be monitored by comparing surveys of the topography and bathymetry of the active channel. The surveys will be conducted every one to three years depending on magnitude and frequency of sediment-transporting flows since the last survey and the availability of funding to conduct the surveys and analyses. The County will monitor the locations and conditions of large wood placed as part of the project and naturally occurring large wood accumulating within the project reach. Monitoring will be conducted during and after large flood events to characterize changing patterns in wood loading and to evaluate the risks that accumulations of large wood might

pose to recreational users, the Countyline facility, bridges, and other infrastructure and public safety. The observations of the large wood monitoring will be posted on the County's website of known hazards in King County rivers. Monitoring and reporting protocols will be modified as needed to address changing conditions.

4.3.2 Facility Inspection

The Countyline facility will be inspected annually during summer, low-flow conditions (when most of the facility is visible) and immediately after major flood events. The facility will also be observed during major flood events (phase 3 or greater) by flood patrols for purposes of providing early detection of potentially hazardous conditions. As part of the flood emergency response protocols, King County dispatches flood patrols to inspect levees after an earthquake with a moment magnitude greater than 5.5 in the Puget Sound area. The routine and post-flood inspections will document conditions using the standard King County facility inspection form and digital photographs. The inspections will identify and characterize the location, nature, and severity of any damage and note any follow-up assessments needed by an engineer, geologist, ecologist, or maintenance specialist. The inspections will also note any noxious or invasive weeds, viability of installed native plantings, accessibility issues, or any other maintenance concerns. The routine and post-flood (and post-earthquake) inspections will target specific elements of the Countyline facility:

<u>Setback Levee</u>

- Soil erosion or slumping on the landward and waterward slopes.
- Seepage or piping through the levee.
- Sinkholes or sand boils on the landward side of levee.
- Overtopping or breaching.
- Large wood or other debris directing flow into the facility.
- Damage to perimeter fencing along landward toe of levee.
- Downed trees or damaged or distressed vegetation.
- High water mark indicators (locations flagged for future survey).

<u>Access Road</u>

- Damage to security gates at points of entry.
- Damage or wear to road surface.
- Vegetation encroaching into roadway.
- Illegally dumped waste.
- Illegal encampments.

<u>BNSF Culvert</u>

- Damaged or blocked check valve.
- Encroaching vegetation or sediment deposits at check valve.

<u>Potelco Revetment</u>

- Bank erosion.
- Loss of rock armoring.
- Tree recruitment.
- Large wood or other debris directing flow into the facility.

Riparian Buffer along setback levee

- Erosion and evidence of channelization.
- Sediment deposition.
- Damaged or distressed native plantings.
- Presence of noxious and invasive weeds.
- Presence/absence of naturally occurring wood racked on floodplain roughening structures and cottonwood boles.
- Illegal encampments.

Engineered Log Structures (ELJs and Biorevetment)

- Structure location and identification number.
- Missing key logs, piles, or racking wood placed during construction.
- Large wood or other debris directing flows into the structure.
- Erosion of ballast material.
- Damaged or distressed native plantings.
- Presence of noxious and invasive weeds.
- Presence/absence of naturally occurring wood racked on the structure.
- Presence/absence of pool and gravel bars associated with structures.

Upper Countyline Levee

- Bank erosion.
- Location of thalweg and presence/absence of pool formation along toe.
- Large wood or other debris directing flow into the facility.
- Damage to coir lifts and willow stakes.
- Loss of rock armoring.
- Tree recruitment.
- Illegal encampments.
- Vegetation encroaching onto access on top of levee.

King County will use the information obtained from the periodic monitoring and inspections to perform preliminary assessments of potential hazards and risks to public safety. The County will then share this information with the appropriate jurisdictions and governmental agencies listed in Table 1.

4.3.3 Maintenance

Most of the project site would be maintained as a natural area. For the first several years, maintenance will focus on the establishment of native vegetation installed in the riparian buffer and on levee side slopes during construction. An irrigation system operating for the first two to three years after construction will require periodic adjustments and maintenance. Maintenance may also include chemical and physical weed control for the first three to four years after construction. Any damage to perimeter fencing, access gates, and signs will be promptly repaired. While native vegetation will be encouraged to grow on the side slopes of the levee, the gravel access road on the top of the levee will require periodic mowing to keep the road surface usable for vehicle access.

4.4 Adaptive Management Actions

The findings from the monitoring and inspections will determine the need for adaptive management actions at the project site. The County will consider a range of adaptive management actions to address site conditions that may pose a risk to public safety, threaten the structural integrity of the flood facility, or indicate habitat parameters that do not meet the performance standards for project effectiveness required by the federal and state permits. Alternatives for adaptive management actions will be developed in collaboration with regulatory agencies, Muckleshoot and Puyallup tribe representatives, and river recreation groups such as the River Safety Council. Any actions taken by the County will be in accordance with all regulatory requirements, King County Public Rules and DNRP policies, procedures, and guidelines for the management and maintenance of flood facilities and in-stream projects.

4.4.1 Public Outreach and Education

Prior to project construction, King County will initiate public outreach to alert river recreational users, the general public, and the local jurisdictions to the construction periods and the potential for changing river conditions once the project is substantially completed. The County will issue press releases through local media, post updated information regarding large wood hazards on the County's website of known hazards in King County rivers, and maintain communications with the local jurisdictions and river recreational groups. Additional measures recommended by MIG (2015) include placing signs at upstream parks that river users are likely to use as put-in locations. When warranted, signs will also be placed on bridges upstream of the project site to notify boaters of potentially hazardous conditions and possible take-out locations to avoid these hazards.

4.4.2 Levees and Revetments

Damage that has already occurred or that appears imminent to any segment of the new Countyline levee or to the resurfaced levee segment downstream of the BNSF Railway bridge would be addressed on a case-by-case basis by King County in coordination with the local jurisdictions, regulatory agencies, Tribal representatives and adjacent property owners. The main goals of any adaptive management action would be aimed at protecting public safety and minimizing future maintenance costs of the facility.

If damage to levees or revetments maintained by agencies other than King County is observed or deemed to be imminent, King County would report the observations to the levee/revetment owner and participate in coordinated efforts with the local jurisdictions to assist by providing technical assistance to assess the hazard and develop options for possible emergency response actions. Emergency actions occurring on property owned by King County would be conducted upon approval from the WLRD Director.

4.4.3 Stormwater

King County would coordinate with the local jurisdictions and property owners to address stormwater concerns if related to the operation of the Countyline project. Although the check valves installed on the stormwater outfalls along the right bank in the City of Pacific are the responsibility of the City to operate and maintain, King County could provide technical assistance if the check valves do not function

as intended. The County and City will likely have close coordination if stormwater pumps are expected to me mobilized. Stormwater pumps may be mobilized by the City if ponded stormwater poses a threat to property. The county may also deploy pumps as related to maintaining the flood protection integrity of the HESCO barriers.

4.4.4 Roads

King County will participate in a coordinated effort with the local jurisdictions before and during a major flood event to address and adaptively manage the flooding of Butte Ave SE. Potential adaptive management actions before a flood event might involve public outreach to residences and businesses to inform them of the likelihood of flooding and the construction of temporary berms, the strategic placement of sandbags, or the deployment of pumps.

4.4.5 Large Wood

King County will lead the coordination with the local jurisdictions, regulators, Tribal representatives and first responders (e.g., police departments and regional fire districts) to assess the need for wood removal or relocation within the project site to address identified hazards to public safety. Because the project area is outside of unincorporated King County, the King County Sheriff's Office (KCSO) does not have the authority to regulate or restrict river access to recreational users. The authority lies with the local jurisdictions and their law enforcement agencies and regional fire districts. If requested by those local authorities, KCSO could be available to provide technical assistance to the local jurisdictions and agencies for the development of potential actions to address public safety concerns. Activities involving the placement, repositioning, or removal of large wood from stream or river channels require the issuance of a Hydraulics Project Approval (HPA) from the Washington Department of Fish and Wildlife and consultation with the Tribes. Should these activities occur, they would typically involve some form of mitigation to offset impacts to aquatic habitat.

4.4.6 Bridges

King County would play an active role in assessing hazards at the Stewart Road SE Bridge related to the operation of the Countyline project and would coordinate with the city of Sumner, Pierce County, and East Pierce Fire and Rescue. In the past, the City of Sumner has contracted with Pierce County for inspections, maintenance, and the removal of accumulated wood from the Stewart Road SE bridge piers. Prior to completion of the Countyline project, King County will pursue the development of a Memorandum of Understanding (MOU) with the City of Sumner to define responsibilities related to the assessment of hazards, development of recommendations for adaptive management, submittal of permits for wood removal, contracting the removal of large wood, temporary bridge closures, and the liability associated with such actions or by not taking any action at all.

4.5 Agency Contact Information

Table 2. List of Agency Contacts.

Jurisdiction or Agency	Contact Name	Phone Number
King County Office of Emergency Management	Duty Officer	206-296-3830
King County Sheriff's Office, Marine Police Unit		206-205-0579
U.S. Army Corps of Engineers, Water Management, Reservoir Control Center (RCC)	Ken Brettmann	206-764-6702
U.S Army Corps of Engineers, Emergency Management (EM)	Mike Peele	206-764-6195 (office) 253-732-9082 (mobile)
City of Pacific	Lance Newkirk, Public Works Manager	253-929-1113 (office) 253-508-4731 (mobile)
City of Auburn	Jacob Sweeting, City Engineer	253-804-3118 (office) 253-261-3774 (mobile)
City of Sumner	Bill Pugh, Public Works Director	253-299-5701 (office)
Pierce County Surface Water Management Division	Tony Fantello	253-798-4132 (office) 253-377-8272 (mobile)
Pierce County Sheriff's Department		253-798-7530
Burlington Northern – Santa Fe Railway	Glen Gaz	206-625-6150
The Boeing Company	Fred Urben	253-657-1247
Valley Regional Fire Authority	Mike Gerber	253-288-5800
East Pierce Fire and Rescue	Jim Jaques	253-863-1800

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Appendix A

Procedures for Managing Naturally Occurring Large Wood in King County Rivers
(January 15, 2013)

King County

PROCEDURES FOR MANAGING NATURALLY OCCURRING LARGE WOOD IN KING COUNTY RIVERS

I. Purpose

The purpose of this document is to define and document procedures that the Department of Natural Resources and Parks (Department) and the King County Sheriff's Office (KCSO) will follow in order to:

a. Investigate reports of naturally occurring large wood in King County rivers that may pose a hazard to persons, property or infrastructure;

b. Develop, document and implement action recommendations to address hazards to public safety associated with natural wood;

c. Document existing habitat conditions and changes resulting from actions taken to address hazards to public safety associated with natural wood.

d. Establish a mechanism for addressing public safety issues in the design, monitoring, maintenance and continuing management of all Department capital projects that may affect the recruitment, mobility and accumulation of natural large wood in King County rivers.

e. Inform and receive feedback from the public on County projects that may affect the recruitment, mobility and accumulation of large wood in King County rivers.

II. Applicability

These procedures apply to all reports to the KCSO and Department of potentially or known hazardous natural wood in rivers and to all Department projects that may affect the recruitment, mobility and accumulation of large wood in King County rivers. These procedures are an update and replacement for the "King County Protocol for Responding to Reports of Naturally-Occurring Large Woody Debris in Navigable Rivers and Streams", developed in 2008 and included as Appendix D in the "Report Addressing Public Safety in Placement of Large Wood in King County Waterways".

III. Definitions

Large wood: Trees or tree parts larger than four inches in diameter and longer than six feet, and root wads, wholly or partially waterward of the ordinary high water line (WAC 220-110-020 (57)). Large wood is also known as large woody material, logs, large woody debris, coarse woody debris, snags, and large organic debris.

Naturally-occurring large wood (Natural Large Wood): Large wood that has not been deliberately placed as part of any publicly or privately sponsored project.

Large wood recruitment: The action of wood deposition or accumulation by natural river processes. This action results from the delivery of natural large wood from: 1) existing individual trees or stands of trees that are downed by tree death and toppling, bank undercutting, wind-

throw and breakage, avalanches, or landslides; and 2) upstream reaches via transport by water and subsequent trapping by shoals and bars, boulders, trees, and other channel obstructions (naturally occurring or otherwise).

Emergency: A situation that poses an imminent threat to life or critical infrastructure.

King County Rivers: For purposes of this procedure, King County Rivers are those segments of rivers and streams within King County where recreational use or infrastructure are known to be prevalent or could be expected. A list of waterway segments covered, which may be subject to change pending updated information about use or river conditions, includes the following:

- South Fork Skykomish River, County Line to Foss River Confluence (RM 19.7)
- North Fork Snoqualmie River, Mouth to Big Creek (RM 12.1)
- Middle Fork Snoqualmie River, Snoqualmie Falls (RM 41) to Taylor River (RM 65)
- South Fork Snoqualmie River, Mouth to Franklin Falls (RM 27.9)
- Lower Snoqualmie River, Mouth to Snoqualmie Falls (RM 40)
- Lower Tolt River, Mouth to Forks (RM 8.7)
- North Fork Tolt River, Mouth to above Yellow Creek (RM 15)
- South Fork Tolt River, Mouth to Dam (RM 21)
- Raging River, Mouth to State Route 18 (RM 8)
- Sammamish River, Lake Washington to Lake Sammamish
- Cedar River, Mouth to Landsburg Dam (RM 21)
- Green River, Mouth to Tacoma Headworks (RM 61)
- Miller River, Skykomish River to confluence of East and West Forks
- White River, King-Pierce County Boundary (RM 5.5) to Greenwater River (RM 46) excluding the Mud Mountain Dam reservoir (RM 29.5 – RM 35)
- Greenwater River, White River confluence to Twentyeight Mile Creek (RM 5.5)
- Issaquah Creek, Mouth to SE 56th Street (RM 1.2)

IV. Background and policy context

Pacific Northwest rivers and streams have historically contained large amounts of naturally-deposited large woody materials recruited through bank erosion, channel migration, wind-throw and other causes. Wood plays a major role in channel forming, changing and stabilizing processes, including flow deflection and dampening of flood velocities, sediment and organic-matter storage, diversification of aquatic habitat conditions and the provision of flood refuge habitat for aquatic organisms. However, during the 19th and 20th centuries, logging, navigational improvements and flood control efforts resulted in the removal of most of the large wood from Pacific Northwest rivers, including those in King County. The historic removal of large wood

contributed to the degradation of fish and wildlife habitat, including habitat for species currently listed as threatened or endangered under the Endangered Species Act (ESA). It has become widely understood and accepted that encouraging large wood to recruit to and remain in local rivers is vital to the recovery of salmonid populations (a bibliography regarding the ecological role of large wood can be found on the County website). To restore some of these historic beneficial functions, some King County projects support, or actively encourage, natural processes of large wood recruitment, adjustment and deposition.

At the same time, boating and other water-oriented recreation activities have a long history in King County. Recreational users may come into contact with wood in King County's rivers and streams. It is widely recognized that riverine water sports, including fishing, wading, swimming, boating, and floating, can involve considerable risk. The level of risk is influenced by many factors, including location and positioning of instream elements, such as large wood, boulders, artificial structures and debris; flow levels, depth, turbulence, velocity, temperature, and bank form; the recreationist's health, maturity, level of experience, skill, and judgment; and the appropriateness of their vessel and associated safety equipment. Many recreational water users recognize wood as a natural feature of the river which, while requiring caution, can enhance their experiences – for example, wood can make river trips more interesting and aesthetically pleasing and can improve fishing opportunities.

Many County projects are intended to produce a more healthy, dynamic, and natural river. As a result, rivers may look and behave differently than they have in the recent past. The changes may pose unfamiliar challenges to both river managers and river users. The County is committed to maintaining public safety as a high priority in river management and to communicating with community members and stakeholders about specific projects as well as river management efforts in general. As historic practices of aggressive wood removal are understood to be inconsistent with contemporary policies and programs aimed at long term sustainability in river management, it has become clear that large wood and dynamic conditions should become more common in our waterways. In some locations, recreational use of a river may not be advisable for all users at all times as a result of the changes and dynamic nature of the river. Therefore, it is important that King County find ways to provide for public safety as rivers develop conditions more akin to what nature originally provided. The procedures outlined below represent one mechanism for King County to address that public safety need.

Specifically, these procedures explain the steps to be taken to address the risks associated with natural accumulations of wood through the combined efforts of the DNRP and KCSO. The procedures outline a systematic method for case-by-case evaluation of naturally occurring wood reported as a potential risk to public safety in our rivers. The *Wood Investigation Report* (see Attachment 1) has been developed as a standardized tool to provide consistency and guidance when KCSO and WLRD assess potential public safety risks due to natural wood in rivers.

In cases where the evaluation determines that the public safety risk is low, King County may choose not to modify naturally recruited wood. In cases where the evaluation determines that the wood poses a high risk to public safety, resulting in a recommendation to take mitigating actions that may include modifying or removing the wood, the actions taken by the county must be done in a manner that is consistent with all applicable federal, state, and local policies and regulations,

and may require mitigation. Actions to modify natural wood accumulations in a fish-bearing river or stream must be permitted in a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife (WDFW). As state law requires there be no net adverse impact to habitat, any changes resulting from the county's actions to modify wood will need to be described and quantified sufficiently to develop commensurate mitigation.

In addition, these procedures make a distinction between natural wood accumulations, and natural wood accumulations that occur on, or as a result of, County-sponsored projects. Where a DNRP capital project may affect the recruitment, mobility and accumulation of natural large wood in King County's rivers, the success of a project may be affected by how wood is managed on the site. As a result, project outcome, grant funding, and the success of other County programs could be jeopardized by the decisions made in response to large wood recruitment on project sites. Therefore, the procedures outline a proactive approach for considering public safety in all phases of the project, including design, monitoring, maintenance and continuing management. Guidance is provided through a set of standardized tools used at key stages of project implementation:

- Project Design: An *Instream Project Design Checklist* (see Attachment 2) will be completed by the design team to address public safety during the design phase of any new project where recruitment of wood is an expected or intended outcome. In order to proactively plan for public safety in the design, an *Instream Project Design Checklist* will be used to compile relevant information about the project purpose and site characteristics, including instream and adjacent land uses, geomorphology, flood patterns and ecology.
- Project Monitoring, Maintenance, and Adaptive Management: The design team will prepare a *Public Safety Management Plan* (see Attachment 3) to define potential risks to public safety as the site evolves following construction, and to guide the County's adaptive management response to changes on the ground or in the water. This management plan will be implemented through the project monitoring and maintenance programs and in response to reports of potential log hazards.

Actions taken by the County must be done in a manner that is consistent with all applicable federal, state, and local policies and regulations. Examples of King County policies that pertain to large wood in rivers and streams, related primarily to the goals of flood risk reduction, salmon recovery, and watershed restoration, include:

- King County Comprehensive Plan policies E-405, E-406, E-408, E-422, E438, E-471, supporting watershed restoration and protection to support river and stream ecological processes;
- King County Council adopted salmon recovery plans for Water Resource Inventory Areas 7, 8, and 9 (King County Council Action 2005 and 2006) and Federally Approved Endangered Species Act Chinook Salmon Conservation Plan (2007);
- King County Flood Hazard Management Plan (King County Council Action 2007) policies G-3, G-9, G-10, PROJ-6, RCM-1, RCM-2, and other references.

This set of procedures and guidance tools is one element among several County efforts and interests related to public safety and management of our rivers, including flood hazard management, habitat restoration, and recreation. As to the safety of recreational users of rivers and streams in King County, it should be noted that the decision to recreate in rivers is ultimately the responsibility of each individual. Current and future efforts to enhance awareness through public education and outreach by the State, County, and non-governmental organizations will complement these procedures for addressing public safety needs, and are perhaps the most important strategy for reducing risks for recreational river users.

V. PROCEDURES:

1. Reporting Concerns about Naturally-Occurring Large Wood in River Corridors

All reports of potential public safety risks associated with large wood (LW) in a King County waterway should be directed to "911" if urgent, or (206) 296-3311 if not urgent. Reports will be forwarded to the designated point of contact in the King County Sheriff's Office Marine Unit (KCSO).

2. Preliminary Assessment

KCSO will make a preliminary assessment of the potential risk posed by the LW and determine if the situation requires an emergency or a non-emergency response.

If the location of the wood is outside of unincorporated King County, the KCSO will refer the report to the communications center for the appropriate jurisdiction. On request, King County will provide technical support to the local jurisdiction.

A. Emergency Conditions

- If the KCSO determines that there may be a life-threatening situation or an immediate threat to public or private property or infrastructure, requiring an emergency response, they will take immediate steps to secure public safety.

- Emergency measures may include, but are not limited to:
    - Dispatching rescue personnel,
    - Closing the waterway to recreational use until the emergency situation can be addressed,
    - Issuing public notification via web posting, signage and news outlets, and
    - Removing or relocating the wood.

- Emergency actions involving physical modifications of wood in and adjacent to rivers and streams require prior permit approval from the Washington Department of Fish and Wildlife (WDFW), and may also require subsequent mitigation actions.
    - WDFW may issue verbal HPA approval for emergency work to alter naturally recruited wood, and allow for completion of permit requirements after the emergency action. Emergency permit approval from WDFW may be obtained by calling (425) 775-1311 or contacting the Area Habitat Biologist during business hours or calling 360-902-2537 after hours. Contact information for the Area Habitat Biologist can be found at: http://wdfw.wa.gov/conservation/habitat/ahb/.
    - Photo-documentation showing the large wood positioning before and after physical modifications is recommended to provide a basis for development of appropriate mitigation actions.
    - Habitat conditions should be assessed to inform final permit approval, either as

part of the response or as a follow-up action.

- The KCSO may request assistance from King County Water and Land Resources Division (WLRD) in conducting an emergency response.

B. Non-Emergency Conditions

- KCSO will:
  - Perform an initial site investigation, verify the location of the wood, and make a preliminary assessment of the potential hazard;
  - Initiate a standard KCSO *Incident Report*;
  - Consider factors relevant to instream risks, such as position of the wood within the channel, threat to public and private property and infrastructure, flow conditions, typical recreational use and timing, adjacent land uses, and physical characteristics of the wood within the context of the site; and
  - Transmit a copy of the *Incident Report* to the designated point of contact in the Water and Land Resources Division (WLRD).

3. Evaluate Potential Public Safety Risks and Recommend Response Action(s)

A. Risk to Instream Users

If the KCSO's preliminary assessment determines that the wood poses a risk to public safety for instream users (e.g., recreationists), warranting action by the County:

- KCSO will:
  - Contact WLRD, provide information on the findings of the preliminary assessment, and set up a joint site inspection.

- WLRD will:
  - Determine if the wood is associated with a King County Project, and subject to guidance under a project-specific *Public Safety Management Plan*; and
  - Determine if wood is known, or appears, to be associated with a non-King County project, and if so, will consult with the project owner, to the extent feasible.

- KCSO and WLRD will:
  - Perform a joint site investigation (normally within 24-72 hours depending on level of perceived risk) to evaluate the risk posed by the wood using the *Wood Investigation Report*;
  - Estimate the expected longevity of the wood in its present configuration;
  - Jointly develop an action recommendation for reducing the risk - action recommendations should be guided by the *Public Safety Management Plan* for wood associated with a King County project, if applicable, or by findings of Wood Investigation Report for non-project related wood; and
  - Document the findings of the risk evaluation and the recommended action(s).

- Actions should be selected to mitigate the risk to public safety while minimizing disturbance to the river. Actions may include, in general order of preference, site monitoring, installation of informational or warning signs, pruning portions of the large wood pieces, closure of a river reach, or repositioning or relocation of large wood pieces.

- Geomorphologists, engineers, ecologists and permit agency staff, will participate in the site investigation to assist in site assessment, permitting, development of response alternatives and determination of commensurate mitigation, as necessary.

B. Risk to Adjacent Lands Affecting Residences, Businesses, or Infrastructure

If the KCSO's preliminary assessment determines that risks to instream users posed by the wood are avoidable, but that the wood may pose a risk to other people, property, or infrastructure on adjacent lands:

- KCSO will:
  - Inform WLRD of their findings; and
  - Complete the *Incident Report*.

- WLRD will:
  - Initiate a *Wood Investigation Report*;
  - Perform a site investigation (normally within 24-72 hours depending on level of perceived risk);
  - Determine if the wood is associated with a King County Project, and subject to guidance under a project-specific *Public Safety Management Plan*.
  - Determine if the wood poses a risk to public safety (e.g., flood hazard) for infrastructure, critical facilities, people or property based on the *Wood Investigation Report*;
  - Estimate the expected longevity of the wood in its present configuration;
  - Develop an action recommendation, if warranted, for reducing identified risks; and
  - Document the findings of the risk evaluation and the recommended action(s).

- Actions should be selected to mitigate the risk to public safety while minimizing disturbance to the river. Actions may include, in general order of preference, site monitoring, installation of informational or warning signs, pruning portions of the large wood pieces, closure of a river reach, or repositioning or relocation of large wood pieces.

- Action recommendations:
  - Should be directed by *a Public Safety Management Plan* for any wood associated with a King County project; or
  - Should be determined by the findings of the *Wood Investigation Form* for non-project related wood.

- Geomorphologists, engineers, ecologists and permit agency staff, will participate in the

site investigation to assist in site assessment, permitting development of response alternatives and determination of commensurate mitigation, as necessary.

4. Short Term Action Response

If recommended actions will involve physical modification of instream or project-related features, such as repositioning wood or installing signage:

- WLRD will:
  - Implement interim river safety measures as needed;
  - Post hazard warning information on the King County website if the response action cannot be completed within one week of the determination;
  - Evaluate the ecological function of the wood within the context of the site or reach in order to inform the development of mitigation actions;
  - Seek applicable permit approvals to implement action recommendations;
  - Work with permit agencies to establish required mitigation actions;
  - Oversee construction or contracting for completion of the work; and
  - Notify the KCSO about anticipated timing and techniques involved in implementation.

- KCSO may choose to:
  - Issue bulletins or news releases or disseminate informational materials to advise the public of the potential risks of wood in the waterway - press releases issued by King County may be posted to King County's "Flooding Topics" web page at www.kingcounty.gov/flood and to the Regional Public Information Network (RPIN) at www.rpin.org;
  - Use its authority, under King County Code 12.44, to close a waterway or portion of a waterway to recreational use, either temporarily or indefinitely, if they determine its use may pose a significant risk to public safety;
  - Contact the King County Office of Emergency Management (OEM) Duty Officer at 206 296-3830 (24-hour number) to notify of the wood situation; or
  - Request assistance from OEM for resources necessary to implement recommended actions.

King County will not perform actions without appropriate safety measures in place for employees. Permit approvals are required for modification of wood or other instream features, which includes but is not limited to an HPA from the WDFW and, where occurring in state-owned aquatic lands, consultation with Washington Department of Natural Resources. If it is determined that the recommended action is not feasible, does not meet permit requirements, or cannot safely be implemented, then WLRD and KCSO will select another course of action from the list of potential actions.

5. Long Term Risk Mitigation

KCSO and WLRD will work together to promote river safety over the long term through planning and outreach efforts that will include pro-actively considering the consequences of natural wood accumulation at a project site during project design; increasing public awareness about the presence, function and risks of wood in rivers; promoting the use of appropriate equipment and preparation when making recreational choices; and managing allowable uses within King County's waterways.

- KCSO and WLRD will coordinate efforts to:
    - Periodically monitor reported or placed wood that remains in the river to observe changes in condition over time - new conditions may warrant a new site investigation and re-evaluation;
    - Discourage or prevent risky behaviors in waterways through educational campaigns, media, websites, or other outreach tools; and
    - Inform the public of potential changes to river conditions that may affect recreation.

When designing projects that are expected or are likely to cause wood from onsite or elsewhere in the watershed to accumulate at the project site:

- WLRD will:
    - Complete an *Instream Project Design Checklist* to guide and document thorough evaluation of public safety considerations during project design and implementation;
    - Solicit public input at 30% design, as is done for placed wood per public rule;
    - Develop a *Public Safety Management Plan* to establish a proactive approach to monitoring, maintenance, and modification of the site over time in order to assure public safety and success of the project; and
    - Work with neighboring jurisdictions and the public to inform them of potential changes to river conditions that may affect instream or adjacent land uses.

6. Final Documentation

For all reports of potential large wood hazards:

- WLRD and KCSO will coordinate to:
    - Complete and maintain a record of all *Wood Investigation Report* and *Incident Reports*;
    - Contact the person who reported the wood, when known, to inform them of any action taken.

For reports of wood that is associated with a King County project:

- WRLD will:
    - Complete and maintain a record of the *Instream Project Design Checklist* and a *Public Safety Management Plan*.

Attachments:

1. Wood Investigation Report
2. Instream Project Design Checklist
3. Public Safety Management Plan Outline

Appendix B

Public Rule LUD-12-1. Procedures for Considering Public Safety when Placing Large Wood in King County Rivers (March 31, 2010)

King County

King County
Public Rules and Regulations

Public Rules

Title	Document Code No.
Procedures for Considering Public Safety When Placing Large Wood in King County Rivers	LUD 12-1 (PR)
Department/Issuing Agency: Department of Natural Resources and Parks (DNRP)	Date: March 31, 2010

Approved: _____ Bob Burns, Interim Director

1.0 SUBJECT TITLE: Procedures for Considering Public Safety When Placing Large Wood in King County Rivers

1.1 EFFECTIVE DATE: The effective date of this Public Rule is March 31, 2010 or thirty days after filing with the Clerk of the Council, whichever comes later.

1.2 TYPE OF ACTION: New.

1.3 KEY WORDS: (1) large wood; (2) large wood placement; (3) mitigation; (4) public safety; (5) recreation.

2.0 PURPOSE:

2.1 To consider public safety issues in the design of projects involving the placement of large wood in King County rivers and streams.

2.2 To evaluate strategies for design of wood placements that will maximize project benefits and minimize risks to public safety.

2.3 To make available to the public the opportunity to provide input on proposed projects utilizing large wood.

3.0 ORGANIZATIONS AFFECTED:

3.1 The Department of Natural Resources and Parks.

4.0 REFERENCES:

4.1 King County Code chapter 2.98.

4.2 King County Ordinance No. 16581 (2009).

4.3 King County Code Title 21A.

4.4 King County Comprehensive Plan Policies E-405, E-406, E-408, E-422, E-438, E-471 (2008) available at: http://www.kingcounty.gov/property/permits/codes/growth/CompPlan/2008.aspx

4.5 King County Council adopted salmon recovery plans for Water Resource Inventory Areas 7, 8 and 9 (2005 and 2006) available at: http://www.kingcounty.gov/environment/animalsAndPlants/salmon-and-trout.aspx

4.6 King County Flood Hazard Management Plan Policies G-3, G-9, G-10, PROJ-6, RCM-1, RCM-2 (2006) available at: http://www.kingcounty.gov/environment/waterandland/flooding/documents/flood-hazard-management-plan.aspx

5.0 DEFINITIONS:

5.1 Large wood: The term "large wood" refers to downed trees, but does not include rooted, standing vegetation. (Large wood is also known as logs, large woody debris, coarse woody debris, snags, and large organic debris.)

5.2 Large wood placement: The deliberate placement of large wood in rivers and streams by physically depositing pieces in or near the channel, or installing them in an engineered structure, for any purpose, including flood protection, bank stabilization, mitigation, and habitat improvement or restoration.

5.3 Public safety: Unless otherwise noted, the term public safety is used in this document to reflect the safety of members of the public and water users of the rivers and streams in King County

6.0 POLICIES:

6.1 The *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers* contained in Appendix A to this public rule, which is incorporated herein by this reference, presents the processes and procedures that the Department of Natural Resources and Parks shall follow in order to properly consider public safety in the design and implementation of projects involving placement of large wood in King County rivers and streams.

6.2 This Public Rule is exempt from the rule of strict construction and shall be liberally construed to give full effect to the objects and purposes for which it was adopted.

7.0 PROCEDURES:

Action By: Department of Natural Resources and Parks.

Action: Implements the requirements of Ordinance No. 16581 (2009) by developing *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers* set forth in Appendix A of this rule.

8.0 RESPONSIBILITIES:

8.1 Department of Natural Resources and Parks.

8.1.1 Identifies projects involving the placement of large wood to which the *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers*, Appendix A to this public rule, is applicable.

8.1.2 Implements the specific procedures provided for in the *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers,* Appendix A to this public rule.

8.1.3 At least once every three years, or sooner if significant new data becomes available, convenes a group of stakeholders, including but not limited to river residents, recreationalists, tribes, river boating interests, appropriate regulatory agencies, King County sheriff office representatives, Water Resource Inventory Area representatives, and experienced project practitioners to review and comment on the *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers,* Appendix A to this public rule, and update them as needed.

9.0 APPENDICES:

9.1 The *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers*, King County Department of Natural Resources and Parks, Water and Land Resources Division, December 2009 constitutes Appendix A to this public rule.

King County

PROCEDURES FOR MANAGING NATURALLY OCCURRING LARGE WOOD IN KING COUNTY RIVERS

I. Purpose

The purpose of this document is to define and document procedures that the Department of Natural Resources and Parks (Department) and the King County Sheriff's Office (KCSO) will follow in order to:

a. Investigate reports of naturally occurring large wood in King County rivers that may pose a hazard to persons, property or infrastructure;

b. Develop, document and implement action recommendations to address hazards to public safety associated with natural wood;

c. Document existing habitat conditions and changes resulting from actions taken to address hazards to public safety associated with natural wood.

d. Establish a mechanism for addressing public safety issues in the design, monitoring, maintenance and continuing management of all Department capital projects that may affect the recruitment, mobility and accumulation of natural large wood in King County rivers.

e. Inform and receive feedback from the public on County projects that may affect the recruitment, mobility and accumulation of large wood in King County rivers.

II. Applicability

These procedures apply to all reports to the KCSO and Department of potentially or known hazardous natural wood in rivers and to all Department projects that may affect the recruitment, mobility and accumulation of large wood in King County rivers. These procedures are an update and replacement for the "King County Protocol for Responding to Reports of Naturally-Occurring Large Woody Debris in Navigable Rivers and Streams", developed in 2008 and included as Appendix D in the "Report Addressing Public Safety in Placement of Large Wood in King County Waterways".

III. Definitions

Large wood: Trees or tree parts larger than four inches in diameter and longer than six feet, and root wads, wholly or partially waterward of the ordinary high water line (WAC 220-110-020 (57)). Large wood is also known as large woody material, logs, large woody debris, coarse woody debris, snags, and large organic debris.

Naturally-occurring large wood (Natural Large Wood): Large wood that has not been deliberately placed as part of any publicly or privately sponsored project.

Large wood recruitment: The action of wood deposition or accumulation by natural river processes. This action results from the delivery of natural large wood from: 1) existing individual trees or stands of trees that are downed by tree death and toppling, bank undercutting, wind-

throw and breakage, avalanches, or landslides; and 2) upstream reaches via transport by water and subsequent trapping by shoals and bars, boulders, trees, and other channel obstructions (naturally occurring or otherwise).

Emergency: A situation that poses an imminent threat to life or critical infrastructure.

King County Rivers: For purposes of this procedure, King County Rivers are those segments of rivers and streams within King County where recreational use or infrastructure are known to be prevalent or could be expected. A list of waterway segments covered, which may be subject to change pending updated information about use or river conditions, includes the following:

- South Fork Skykomish River, County Line to Foss River Confluence (RM 19.7)
- North Fork Snoqualmie River, Mouth to Big Creek (RM 12.1)
- Middle Fork Snoqualmie River, Snoqualmie Falls (RM 41) to Taylor River (RM 65)
- South Fork Snoqualmie River, Mouth to Franklin Falls (RM 27.9)
- Lower Snoqualmie River, Mouth to Snoqualmie Falls (RM 40)
- Lower Tolt River, Mouth to Forks (RM 8.7)
- North Fork Tolt River, Mouth to above Yellow Creek (RM 15)
- South Fork Tolt River, Mouth to Dam (RM 21)
- Raging River, Mouth to State Route 18 (RM 8)
- Sammamish River, Lake Washington to Lake Sammamish
- Cedar River, Mouth to Landsburg Dam (RM 21)
- Green River, Mouth to Tacoma Headworks (RM 61)
- Miller River, Skykomish River to confluence of East and West Forks
- White River, King-Pierce County Boundary (RM 5.5) to Greenwater River (RM 46) excluding the Mud Mountain Dam reservoir (RM 29.5 – RM 35)
- Greenwater River, White River confluence to Twentyeight Mile Creek (RM 5.5)
- Issaquah Creek, Mouth to SE 56th Street (RM 1.2)

IV. Background and policy context

Pacific Northwest rivers and streams have historically contained large amounts of naturally-deposited large woody materials recruited through bank erosion, channel migration, wind-throw and other causes. Wood plays a major role in channel forming, changing and stabilizing processes, including flow deflection and dampening of flood velocities, sediment and organic-matter storage, diversification of aquatic habitat conditions and the provision of flood refuge habitat for aquatic organisms. However, during the 19th and 20th centuries, logging, navigational improvements and flood control efforts resulted in the removal of most of the large wood from Pacific Northwest rivers, including those in King County. The historic removal of large wood

contributed to the degradation of fish and wildlife habitat, including habitat for species currently listed as threatened or endangered under the Endangered Species Act (ESA). It has become widely understood and accepted that encouraging large wood to recruit to and remain in local rivers is vital to the recovery of salmonid populations (a bibliography regarding the ecological role of large wood can be found on the County website). To restore some of these historic beneficial functions, some King County projects support, or actively encourage, natural processes of large wood recruitment, adjustment and deposition.

At the same time, boating and other water-oriented recreation activities have a long history in King County. Recreational users may come into contact with wood in King County's rivers and streams. It is widely recognized that riverine water sports, including fishing, wading, swimming, boating, and floating, can involve considerable risk. The level of risk is influenced by many factors, including location and positioning of instream elements, such as large wood, boulders, artificial structures and debris; flow levels, depth, turbulence, velocity, temperature, and bank form; the recreationist's health, maturity, level of experience, skill, and judgment; and the appropriateness of their vessel and associated safety equipment. Many recreational water users recognize wood as a natural feature of the river which, while requiring caution, can enhance their experiences – for example, wood can make river trips more interesting and aesthetically pleasing and can improve fishing opportunities.

Many County projects are intended to produce a more healthy, dynamic, and natural river. As a result, rivers may look and behave differently than they have in the recent past. The changes may pose unfamiliar challenges to both river managers and river users. The County is committed to maintaining public safety as a high priority in river management and to communicating with community members and stakeholders about specific projects as well as river management efforts in general. As historic practices of aggressive wood removal are understood to be inconsistent with contemporary policies and programs aimed at long term sustainability in river management, it has become clear that large wood and dynamic conditions should become more common in our waterways. In some locations, recreational use of a river may not be advisable for all users at all times as a result of the changes and dynamic nature of the river. Therefore, it is important that King County find ways to provide for public safety as rivers develop conditions more akin to what nature originally provided. The procedures outlined below represent one mechanism for King County to address that public safety need.

Specifically, these procedures explain the steps to be taken to address the risks associated with natural accumulations of wood through the combined efforts of the DNRP and KCSO. The procedures outline a systematic method for case-by-case evaluation of naturally occurring wood reported as a potential risk to public safety in our rivers. The *Wood Investigation Report* (see Attachment 1) has been developed as a standardized tool to provide consistency and guidance when KCSO and WLRD assess potential public safety risks due to natural wood in rivers.

In cases where the evaluation determines that the public safety risk is low, King County may choose not to modify naturally recruited wood. In cases where the evaluation determines that the wood poses a high risk to public safety, resulting in a recommendation to take mitigating actions that may include modifying or removing the wood, the actions taken by the county must be done in a manner that is consistent with all applicable federal, state, and local policies and regulations,

and may require mitigation. Actions to modify natural wood accumulations in a fish-bearing river or stream must be permitted in a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife (WDFW). As state law requires there be no net adverse impact to habitat, any changes resulting from the county's actions to modify wood will need to be described and quantified sufficiently to develop commensurate mitigation.

In addition, these procedures make a distinction between natural wood accumulations, and natural wood accumulations that occur on, or as a result of, County-sponsored projects. Where a DNRP capital project may affect the recruitment, mobility and accumulation of natural large wood in King County's rivers, the success of a project may be affected by how wood is managed on the site. As a result, project outcome, grant funding, and the success of other County programs could be jeopardized by the decisions made in response to large wood recruitment on project sites. Therefore, the procedures outline a proactive approach for considering public safety in all phases of the project, including design, monitoring, maintenance and continuing management. Guidance is provided through a set of standardized tools used at key stages of project implementation:

- Project Design: An *Instream Project Design Checklist* (see Attachment 2) will be completed by the design team to address public safety during the design phase of any new project where recruitment of wood is an expected or intended outcome. In order to proactively plan for public safety in the design, an *Instream Project Design Checklist* will be used to compile relevant information about the project purpose and site characteristics, including instream and adjacent land uses, geomorphology, flood patterns and ecology.
- Project Monitoring, Maintenance, and Adaptive Management: The design team will prepare a *Public Safety Management Plan* (see Attachment 3) to define potential risks to public safety as the site evolves following construction, and to guide the County's adaptive management response to changes on the ground or in the water. This management plan will be implemented through the project monitoring and maintenance programs and in response to reports of potential log hazards.

Actions taken by the County must be done in a manner that is consistent with all applicable federal, state, and local policies and regulations. Examples of King County policies that pertain to large wood in rivers and streams, related primarily to the goals of flood risk reduction, salmon recovery, and watershed restoration, include:

- King County Comprehensive Plan policies E-405, E-406, E-408, E-422, E438, E-471, supporting watershed restoration and protection to support river and stream ecological processes;

- King County Council adopted salmon recovery plans for Water Resource Inventory Areas 7, 8, and 9 (King County Council Action 2005 and 2006) and Federally Approved Endangered Species Act Chinook Salmon Conservation Plan (2007);

- King County Flood Hazard Management Plan (King County Council Action 2007) policies G-3, G-9, G-10, PROJ-6, RCM-1, RCM-2, and other references.

This set of procedures and guidance tools is one element among several County efforts and interests related to public safety and management of our rivers, including flood hazard management, habitat restoration, and recreation. As to the safety of recreational users of rivers and streams in King County, it should be noted that the decision to recreate in rivers is ultimately the responsibility of each individual. Current and future efforts to enhance awareness through public education and outreach by the State, County, and non-governmental organizations will complement these procedures for addressing public safety needs, and are perhaps the most important strategy for reducing risks for recreational river users.

V. PROCEDURES:

1. Reporting Concerns about Naturally-Occurring Large Wood in River Corridors

All reports of potential public safety risks associated with large wood (LW) in a King County waterway should be directed to "911" if urgent, or (206) 296-3311 if not urgent. Reports will be forwarded to the designated point of contact in the King County Sheriff's Office Marine Unit (KCSO).

2. Preliminary Assessment

KCSO will make a preliminary assessment of the potential risk posed by the LW and determine if the situation requires an emergency or a non-emergency response.

If the location of the wood is outside of unincorporated King County, the KCSO will refer the report to the communications center for the appropriate jurisdiction. On request, King County will provide technical support to the local jurisdiction.

A. Emergency Conditions

- If the KCSO determines that there may be a life-threatening situation or an immediate threat to public or private property or infrastructure, requiring an emergency response, they will take immediate steps to secure public safety.

- Emergency measures may include, but are not limited to:
  - Dispatching rescue personnel,
  - Closing the waterway to recreational use until the emergency situation can be addressed,
  - Issuing public notification via web posting, signage and news outlets, and
  - Removing or relocating the wood.

- Emergency actions involving physical modifications of wood in and adjacent to rivers and streams require prior permit approval from the Washington Department of Fish and Wildlife (WDFW), and may also require subsequent mitigation actions.
  - WDFW may issue verbal HPA approval for emergency work to alter naturally recruited wood, and allow for completion of permit requirements after the emergency action. Emergency permit approval from WDFW may be obtained by calling (425) 775-1311 or contacting the Area Habitat Biologist during business hours or calling 360-902-2537 after hours. Contact information for the Area Habitat Biologist can be found at: http://wdfw.wa.gov/conservation/habitat/ahb/.
  - Photo-documentation showing the large wood positioning before and after physical modifications is recommended to provide a basis for development of appropriate mitigation actions.
  - Habitat conditions should be assessed to inform final permit approval, either as

part of the response or as a follow-up action.

- The KCSO may request assistance from King County Water and Land Resources Division (WLRD) in conducting an emergency response.

B. Non-Emergency Conditions

- KCSO will:
  - Perform an initial site investigation, verify the location of the wood, and make a preliminary assessment of the potential hazard;
  - Initiate a standard KCSO *Incident Report*;
  - Consider factors relevant to instream risks, such as position of the wood within the channel, threat to public and private property and infrastructure, flow conditions, typical recreational use and timing, adjacent land uses, and physical characteristics of the wood within the context of the site; and
  - Transmit a copy of the *Incident Report* to the designated point of contact in the Water and Land Resources Division (WLRD).

3. Evaluate Potential Public Safety Risks and Recommend Response Action(s)

A. Risk to Instream Users

If the KCSO's preliminary assessment determines that the wood poses a risk to public safety for instream users (e.g., recreationists), warranting action by the County:

- KCSO will:
  - Contact WLRD, provide information on the findings of the preliminary assessment, and set up a joint site inspection.

- WLRD will:
  - Determine if the wood is associated with a King County Project, and subject to guidance under a project-specific *Public Safety Management Plan*; and
  - Determine if wood is known, or appears, to be associated with a non-King County project, and if so, will consult with the project owner, to the extent feasible.

- KCSO and WLRD will:
  - Perform a joint site investigation (normally within 24-72 hours depending on level of perceived risk) to evaluate the risk posed by the wood using the *Wood Investigation Report*;
  - Estimate the expected longevity of the wood in its present configuration;
  - Jointly develop an action recommendation for reducing the risk - action recommendations should be guided by the *Public Safety Management Plan* for wood associated with a King County project, if applicable, or by findings of Wood Investigation Report for non-project related wood; and
  - Document the findings of the risk evaluation and the recommended action(s).

- Actions should be selected to mitigate the risk to public safety while minimizing disturbance to the river. Actions may include, in general order of preference, site monitoring, installation of informational or warning signs, pruning portions of the large wood pieces, closure of a river reach, or repositioning or relocation of large wood pieces.

- Geomorphologists, engineers, ecologists and permit agency staff, will participate in the site investigation to assist in site assessment, permitting, development of response alternatives and determination of commensurate mitigation, as necessary.

B. Risk to Adjacent Lands Affecting Residences, Businesses, or Infrastructure

If the KCSO's preliminary assessment determines that risks to instream users posed by the wood are avoidable, but that the wood may pose a risk to other people, property, or infrastructure on adjacent lands:

- KCSO will:
  - Inform WLRD of their findings; and
  - Complete the *Incident Report*.

- WLRD will:
  - Initiate a *Wood Investigation Report*;
  - Perform a site investigation (normally within 24-72 hours depending on level of perceived risk);
  - Determine if the wood is associated with a King County Project, and subject to guidance under a project-specific *Public Safety Management Plan.*
  - Determine if the wood poses a risk to public safety (e.g., flood hazard) for infrastructure, critical facilities, people or property based on the *Wood Investigation Report*;
  - Estimate the expected longevity of the wood in its present configuration;
  - Develop an action recommendation, if warranted, for reducing identified risks; and
  - Document the findings of the risk evaluation and the recommended action(s).

- Actions should be selected to mitigate the risk to public safety while minimizing disturbance to the river. Actions may include, in general order of preference, site monitoring, installation of informational or warning signs, pruning portions of the large wood pieces, closure of a river reach, or repositioning or relocation of large wood pieces.

- Action recommendations:
  - Should be directed by *a Public Safety Management Plan* for any wood associated with a King County project; or
  - Should be determined by the findings of the *Wood Investigation Form* for non-project related wood.

- Geomorphologists, engineers, ecologists and permit agency staff, will participate in the

site investigation to assist in site assessment, permitting development of response alternatives and determination of commensurate mitigation, as necessary.

4. Short Term Action Response

If recommended actions will involve physical modification of instream or project-related features, such as repositioning wood or installing signage:

- WLRD will:
  - Implement interim river safety measures as needed;
  - Post hazard warning information on the King County website if the response action cannot be completed within one week of the determination;
  - Evaluate the ecological function of the wood within the context of the site or reach in order to inform the development of mitigation actions;
  - Seek applicable permit approvals to implement action recommendations;
  - Work with permit agencies to establish required mitigation actions;
  - Oversee construction or contracting for completion of the work; and
  - Notify the KCSO about anticipated timing and techniques involved in implementation.

- KCSO may choose to:
  - Issue bulletins or news releases or disseminate informational materials to advise the public of the potential risks of wood in the waterway - press releases issued by King County may be posted to King County's "Flooding Topics" web page at www.kingcounty.gov/flood and to the Regional Public Information Network (RPIN) at www.rpin.org;
  - Use its authority, under King County Code 12.44, to close a waterway or portion of a waterway to recreational use, either temporarily or indefinitely, if they determine its use may pose a significant risk to public safety;
  - Contact the King County Office of Emergency Management (OEM) Duty Officer at 206 296-3830 (24-hour number) to notify of the wood situation; or
  - Request assistance from OEM for resources necessary to implement recommended actions.

King County will not perform actions without appropriate safety measures in place for employees. Permit approvals are required for modification of wood or other instream features, which includes but is not limited to an HPA from the WDFW and, where occurring in state-owned aquatic lands, consultation with Washington Department of Natural Resources. If it is determined that the recommended action is not feasible, does not meet permit requirements, or cannot safely be implemented, then WLRD and KCSO will select another course of action from the list of potential actions.

5. Long Term Risk Mitigation

KCSO and WLRD will work together to promote river safety over the long term through planning and outreach efforts that will include pro-actively considering the consequences of natural wood accumulation at a project site during project design; increasing public awareness about the presence, function and risks of wood in rivers; promoting the use of appropriate equipment and preparation when making recreational choices; and managing allowable uses within King County's waterways.

- KCSO and WLRD will coordinate efforts to:
    - Periodically monitor reported or placed wood that remains in the river to observe changes in condition over time - new conditions may warrant a new site investigation and re-evaluation;
    - Discourage or prevent risky behaviors in waterways through educational campaigns, media, websites, or other outreach tools; and
    - Inform the public of potential changes to river conditions that may affect recreation.

When designing projects that are expected or are likely to cause wood from onsite or elsewhere in the watershed to accumulate at the project site:

- WLRD will:
    - Complete an *Instream Project Design Checklist* to guide and document thorough evaluation of public safety considerations during project design and implementation;
    - Solicit public input at 30% design, as is done for placed wood per public rule;
    - Develop a *Public Safety Management Plan* to establish a proactive approach to monitoring, maintenance, and modification of the site over time in order to assure public safety and success of the project; and
    - Work with neighboring jurisdictions and the public to inform them of potential changes to river conditions that may affect instream or adjacent land uses.

6. Final Documentation

For all reports of potential large wood hazards:

- WLRD and KCSO will coordinate to:
    - Complete and maintain a record of all *Wood Investigation Report* and *Incident Reports*;
    - Contact the person who reported the wood, when known, to inform them of any action taken.

For reports of wood that is associated with a King County project:

- WRLD will:
    - Complete and maintain a record of the *Instream Project Design Checklist* and a *Public Safety Management Plan*.

Attachments:

1. Wood Investigation Report
2. Instream Project Design Checklist
3. Public Safety Management Plan Outline

APPENDIX A

PROCEDURES FOR CONSIDERING PUBLIC SAFETY WHEN PLACING LARGE WOOD IN KING COUNTY RIVERS

I. Purpose

The purpose of this document is to define and document procedures that the Department of Natural Resources and Parks will follow in order to:

a. Consider public safety issues in the design of projects involving the placement of large wood in King County rivers and streams;

b. Evaluate strategies for design of wood placements that will maximize project benefits and minimize risks to public safety; and

c. Make available to the public the opportunity to provide input on proposed projects utilizing large wood.

II. Applicability

This procedure applies to all King County Department of Natural Resources and Parks' projects involving the placement of large wood in King County rivers and streams.

III. Definitions

- Large wood: The term "large wood" refers to downed trees, but does not include rooted, standing vegetation. (Large wood is also known as logs, large woody debris, coarse woody debris, snags, and large organic debris.)

- Large wood placement: The deliberate placement of large wood by physically depositing pieces in or near the channel, or installing them in an engineered structure, for any purpose, including flood protection, bank stabilization, mitigation, and habitat improvement or restoration.

- Public safety: Unless otherwise noted, the term public safety is used in this document to reflect the safety of members of the public and water users of the rivers and streams in King County.

IV. Background and policy context

Pacific Northwest rivers and streams have historically contained large amounts of naturally-deposited large woody materials recruited through bank erosion, channel migration and wind-throw. Wood plays a major role in channel forming and stabilizing processes, physical habitat formation, sediment and organic-matter storage and the formation of flood refuge habitat. However, during the 19th and 20th centuries, logging,

navigational improvements and flood control efforts resulted in the removal of most of the large wood from Pacific Northwest rivers, including those in King County. Moreover, logging and clearing of riparian areas has compromised the future potential for large wood recruitment.

For many reasons, it is neither possible nor desirable to return to the wood clearing practices of the past, and in fact, there are many reasons King County is actively replacing wood in its rivers and streams. At the same time, boating and other water-oriented recreation have a long history in King County. Recreational users may come into contact with the wood being placed in King County's rivers and streams. It is widely recognized that riverine water sports, including fishing, wading, swimming, boating, and floating, can involve considerable risk. The level of risk is influenced by many factors, including the recreationist's health, maturity, level of experience, skill, and judgment; the appropriateness of their vessel and associated safety equipment; river conditions, such as flow levels, depth, turbulence, velocity, temperature, and bank form; and instream elements, such as large wood, boulders, artificial structures and debris. Large wood may be a potential hazard for some recreational water users, depending on its location and positioning within the channel, as well as flow levels and decisions taken by the users themselves. On the other hand, many recreational water users recognize wood as a natural feature of the river which, while requiring caution, can enhance their experiences – for example, wood can make river trips more interesting and aesthetically pleasing and can improve fishing opportunities.

The historic removal of large wood contributed to the degradation of fish and wildlife habitat, including habitat for species currently listed as threatened or endangered under the Endangered Species Act (ESA). It has become widely understood and accepted that placing large wood in local rivers is vital to the recovery of salmonid populations (A bibliography regarding the ecological role of large wood can be found on the County website). Large wood placement is frequently included as a major component of habitat restoration projects in the Puget Sound Salmon Recovery Plan, in part to compensate for the long time-lag between riparian reforestation efforts and subsequent, natural wood recruitment. Wood placement is also often required as mitigation for habitat impacts resulting from public works projects and other human activities.

Since the early 1990s, King County has placed wood in rivers for several reasons. The County places wood in rivers to improve public safety by reducing scour and erosion through the repair and maintenance of streambank protection facilities, and frequently incorporates bioengineered bank stabilization techniques that may include installation of large wood in combination with large rock and live plant materials. The function of the wood is to interact with river sediments, deflect and slow erosive stream velocities along the banks, and provide ecological benefits. In many cases, large wood is needed to comply with permit conditions.

The County also designs and constructs projects that restore the ecological function of wetlands, streams and rivers. Wood is used to improve ecological processes that create complex, productive, self-sustaining aquatic habitats. Large wood installations are necessary for implementation of King County Council approved watershed recovery plans, particularly in the absence of mature riparian corridors that would naturally recruit

wood. The intent of wood installation in this context is to capture and stabilize sediment; absorb hydraulic energy; create geomorphic complexity, such as scour pools and gravel bars; shade and cool water; retain nutrients to support a healthy fauna; and to provide spawning, rearing and foraging habitat for anadromous salmonids as well as other fish and amphibians.

Finally, federal, state, and local regulatory agencies often require King County and other applicants to install wood as mitigation for unavoidable impacts associated with transportation and flood control projects. Regulatory agencies – such as the U.S. Army Corps of Engineers, Washington Department of Fish and Wildlife (WDFW), and the County's Department of Development and Environmental Services – routinely require the placement of large wood in rivers as a condition for approval of permits and final project designs.

Whatever the specific purpose of a large wood placement project, any actions taken by the County must be done in a manner that is consistent with all applicable federal, state, and local policies and regulations. Examples of policies that pertain to the placement of large wood in rivers and streams and the goal of salmon recovery include:

- King County Comprehensive Plan policies E-405, E-406, E-408, E-422, E438, E-471, supporting watershed restoration and protection to support river and stream ecological processes;
- King County Council adopted salmon recovery plans for Water Resource Inventory Areas 7, 8, and 9 (King County Council Action 2005 and 2006) and Federally Approved Endangered Species Act Chinook Salmon Conservation Plan (2007);
- King County Flood Hazard Management Plan (King County Council Action 2007) policies G-3, G-9, G-10, PROJ-6, RCM-1, RCM-2, and other references.

Moreover, up to fifteen permits or environmental review processes are commonly needed for projects in unincorporated King County, including: Hydraulic Project Approval (HPA), National Environmental Policy Act, State Environmental Policy Act, Clean Water Act Section 404, Rivers and Harbors Act Section 10, Endangered Species Act Section 7, Critical Areas Ordinance, clearing and grading permits, and others. Not all permits are required for all projects. The HPA, administered by the WDFW, is the most commonly needed permit for work in rivers, streams and wetlands, and is the most frequent permit to require large wood placement to reduce or mitigate environmental impacts of a project.

It is within this policy and regulatory context that the proposed procedure addresses public safety in King County rivers. This procedure explains the steps to be taken in the design and decision-making process as it relates to public safety, and identifies specific opportunities for the incorporation of public input. The County recognizes that input from knowledgeable members of the public may help to inform the design teams in their efforts to produce projects that meet the County's primary design objectives while minimizing risks to public safety.

As to public safety as it relates to recreational users of rivers and streams in King County, it should be noted that the decision to recreate in rivers is ultimately the responsibility of each individual. Enhancing awareness through public education and outreach – whether by the State, County, or non-governmental organizations – is perhaps the most important strategy for reducing risks for recreational river users.

V. Procedure for considering public safety in the development and design of capital projects that include placement of large wood in rivers and streams in King County

1. Responsibility and use of the procedures

The Department will coordinate the implementation of this procedure. This section describes the process for considering public safety in the development and design of capital projects involving the placement of large wood in King County rivers and streams. The process includes opportunities for public input. Some procedures may need to be modified or streamlined for emergency situations, such as urgent repairs to flood protection facilities. The Department will ensure that, in implementing the rules, the procedures and design options affording the greatest safety for river users shall be of primary consideration in design concerns involving a balancing of important public purposes as the county addresses safety issues in large wood emplacements and other in-stream designs.

2. Assess recreational uses, potential project impacts on public safety, and develop project design

The Department's project design teams rely on sound engineering and design practices in the development of all Department projects and consider a wide range of public safety issues, including recreational safety, as well as potential flooding and erosion effects on infrastructure, neighborhoods, critical facilities, and other land uses. The responsibility for design decisions rests with the County's multi-disciplinary design teams and licensed professional engineers. All projects must be designed to meet their important underlying goals and objectives. Within the context of those goals and objectives, public safety will be of primary consideration in selecting design alternatives.

King County design teams refer to many relevant technical guidance documents in the course of project design, including but not limited to, the King County Guidelines for Bank Stabilization Projects in the Riverine Environments of King County and the State of Washington's Integrated Streambank Protection Guidelines and Stream Habitat Restoration Guidelines. Potential impacts of large wood on public safety are considered on a case-by-case basis during project development and design. Recreational use information and other stakeholder input will be sought during the conceptual design phase (up to approximately 30% design).

A. Conceptual (0%-30%) Design Phase

During the conceptual design phase (resulting in approximately 30% plan development), the design team assembles information and considers the design

objectives, constraints, risks (including, but not limited to, risks to public safety), and potential solutions. Analyses of alternatives may be conducted during this phase and the design team may consider a range of design options for large wood placement. By the conclusion of the conceptual design phase, each project should be developed sufficiently to describe the basic details of wood placement (e.g., number and type of installation, location, approximate size). Project managers will seek input from the public during this phase, when it can most effectively be included in design considerations. The specific mechanisms for sharing information and soliciting public input are described in detail in Section V.3 .

The following describes key steps during the conceptual design phase.

i) In designing the placement of wood in the project, the project team will gather available information and take into account the expected type, frequency and seasonality of recreational uses as an important element in its overall consideration of impacts to public safety of the proposed project.

ii) Consideration of public safety in the conceptual design will include but not be limited to the following factors: the location, orientation, elevation, and size of the wood placement, the method of anchoring or securing the wood placement, the degree of interaction between flowing water and the placed wood during projected flow regimes, including flows commonly experienced in the recreational seasons, and input received through the public outreach process.

iii) In designing the specific placement of large wood, the design team will seek to maximize achievement of stated project goals and objectives while minimizing potential public safety risks, including risks to recreational users, and will seek to ensure that the procedures and design options affording the greatest safety for river users are of primary consideration in design concerns involving a balancing of important public purposes as it addresses safety issues.

iv) Conceptual project designs will be informed by standard design practices with input from professional designers with expertise in fluvial geomorphology, ecology, river hydraulics and civil engineering with hydraulic analysis expertise.

v) All projects that incorporate large wood in rivers and streams will undergo review and approval of engineering plans and analysis from a Licensed Professional Civil Engineer.

vi) All projects that incorporate large wood with the stated objective of providing ecological benefits will undergo review and approval from a professional ecologist (i.e., persons with an advanced degree in aquatic and/or biological sciences from an accredited university or equivalent level of experience).

At the conclusion of the conceptual (30%) design phase, the project manager will document how public safety considerations have been addressed in the design, including why and how any impacts to recreational safety in particular can be or have already been avoided or reduced through the design of the project. Factors that will be addressed may include, as applicable, wood stability and anchoring technique; intended function of placed wood features and how they meet projects goals and objectives; expected longevity and recruitment potential; and a brief description of other design alternatives that may have been evaluated as part of an alternatives analysis.

At the conclusion of the conceptual (30%) design phase, the Department will:

- Update the project list (described in Section V.3, Public Outreach) to reflect project-specific outcomes of the conceptual design; and
- Share the updated list with the public via the procedures described below in Section V.3, Public Outreach.

If the Department determines the project is unable to successfully meet its goals and objectives while minimizing risks to public safety, it may choose to employ any of the following options:

- Work with the King County Sheriff's Office to alert river users to potential hazards using signage or other means, or to restrict use in the project area so that the project can meet its objectives while also protecting public safety; or
- Modify the project to further reduce public safety risks and concurrently implement mitigation measures (such as additional large wood placement at a comparable location in the same river reach) to fulfill the project goals and objectives; or
- Reconsider the scope of the project and whether to proceed or relocate the project, if possible, to an alternative site where objectives and public safety concerns can be fully achieved.

Not all of these options are applicable to all projects, and it will be the responsibility of the Department to make an appropriate selection.

B. Conceptual to Final (30%-100%) Design Phase

In this design phase, the design team will complete any remaining technical studies, refine the project design, and obtain permits.

If the Department determines that substantial changes to the large wood design have occurred during finalization of the design, as a result of permit submittals or other design factors, the Department will:

- Disseminate new design information to, and seek input from the public as appropriate.
- Update documentation of the project design and public safety considerations.

3. Public outreach

Public outreach is intended to reach a broad spectrum of the community, including river user groups, environmental groups, tribes, cities and other public agencies, river residents and property owners, emergency responders and numerous others. The goal of this effort is to keep the public informed and, at the same time, allow for two-way communication between project managers and the public. The Department's public outreach effort for each project using large wood will include one or more of the following: website information, e-mail notification, and public meetings.

A. Development of project list/database

The Department will develop and maintain a list of projects where large wood will be or is likely to be installed in a King County river or stream. This project list will be updated every year and made available by request and via the county website or e-mail notifications. For each project, the project manager will develop the following information for use in the public outreach process:

- Brief project description, including approximate type and amounts of wood expected to be used;
- Location of project;
- Primary purpose of the project and its relative importance to the success of County programs and mandates;
- Project goals and objectives;
- Existing project site conditions;
- Type, intensity and seasonality of recreational uses, if known;
- Intended function of the wood, including identification of how wood meets project goals and objectives;
- Project status and timing of conceptual design input opportunities; and
- Timing of planned and completed project construction.

B. Website information or e-mail notifications

The public outreach process will make use of the King County website or e-mail notifications to the public and interested stakeholders to provide the following types of information:

- Notices of upcoming public meetings;
- Documents, including these procedures, and other pertinent policy or technical documents;
- List of pending projects that are expected to utilize large wood, and notice of opportunities to comment;

- List of completed projects;
- Contact information for project managers; and
- Other resources and information, as appropriate.

The notification process will, at a minimum, include an electronic mailing list that will be established for this purpose. Interested individuals will be able to sign up for e-mail notifications. Printed/mailed notifications may also be used.

Annual notifications will provide a copy or web link to the comprehensive project list/database.

C. Public meetings

The department will hold two meetings every year to discuss the project list. The meetings, though similar in content and intent, will be held at different times and locations to enhance public involvement. One meeting should be held during daytime/business hours, and the other during evening hours. Department staff will describe the project list and each project's status as well as opportunities for public input. Conceptual designs for each project will be presented when available. Attendees will be invited to ask questions and engage in discussion with appropriate staff about the project list.

4. Monitor project outcome and apply adaptive management strategies

- The Department will conduct post-construction monitoring to assess overall project effectiveness and safety, including relevant changes in the function, location, orientation, elevation, and size of the placed wood. The need for, and feasibility of, any maintenance or retrofitting will also be assessed, including any anticipated regulatory requirements. The scope, timeframe and schedule for post-construction monitoring will vary according to project need and availability of funding.
- Monitoring and adaptive management will be used to assess whether any new actions at the sites of large wood installations are warranted. Actions may include:

    a. Issuing bulletins or news releases or disseminating informational materials to advise the public of the potential risks posed by placed large wood in the river; or

    b. Signing a river or a project site as potentially hazardous and warranting particular caution, notifying the King County Sheriff's Office who may impose use restrictions, or both; or

    c. Removing or altering the position of structural components of the placed large wood in order to further reduce any associated risk. This step may require additional regulatory review, permitting, and mitigation actions.

- The Department will provide for periodic independent monitoring and inspection of large wood emplacements by an appropriate third-party provider. This additional monitoring effort will be conducted every three years on a representative sampling of

large wood emplacement projects. Reports of such inspections shall be provided to the Department and to all King County Council members.

5. Final Documentation

- The Department will maintain electronic or paper records of all relevant large wood project documentation in accordance with existing local and state record-keeping requirements for project information, including documentation of public input and any resulting project modifications.

Appendix C

Risk Assessment Report for the Countyline Levee Setback Project, Recreational Safety, Third-party Review (MIG, 2015)

Final Risk Assessment for Countyline Levee Setback Project Recreational Safety, Third-Party Review

Lower White River, Washington

May 2015

Submitted to:
King County

Prepared by MIG, Inc.

Introduction

Tetra Tech/MIG has contracted with King County to conduct a third-party recreational safety review of the Countyline Levee Setback project (Contract Number: E00202E10, WO#: 1112049/3.6/ E00202LL). The need to conduct a recreational safety review of the Countyline project is based in part on King County Ordinance 16581 and Public Rule LUD-12-1 (PR) (Appendix A). The ordinance and public rule establish procedures for the consideration of public safety when placing large wood in King County rivers. Additionally, in 2013, King County developed procedures for managing naturally occurring large wood in King County rivers that consider and balance public safety with flood protection and habitat restoration goals. These procedures apply to all King County projects that might affect the recruitment, mobility, or accumulation of large wood in King County rivers. The goals of this scope of work are to assess the relative changes in risk to river recreational users as a result of the Countyline Levee Setback project, develop measures to reduce risks, and document this information in a final report.

MIG accomplished the goals of this safety assessment by completing the following tasks:

- Reviewed background information.
- Conducted a site visit with County staff and expert whitewater boaters to assess existing conditions.
- Assessed potential impacts to river recreational users for three scenarios: existing conditions, future conditions without the project, and future conditions after construction of the project.
- Participated in two stakeholder meetings with the County and recreational users.
- Recommended actions to reduce the identified risks to river recreational users, while balancing other public safety goals of the project.

Project Background

The Countyline Levee Setback Project ("project") is a flood risk reduction and habitat enhancement project on the Lower White River that will lower flood elevations for hundreds of residential properties in the city of Pacific. The project will also restore approximately 121 acres of off-channel rearing habitat for multiple species, including ESA-listed Chinook salmon and Steelhead. The project is located on the left (east) bank of the Lower White River between river mile (RM) 5.00 and RM 6.33 (Figure 1). The project spans the King-Pierce County boundary line and will be constructed in the cities of Pacific and Sumner, as well as in a portion of unincorporated Pierce County. As the project proponent, King County has responsibility in perpetuity for the management and maintenance of the designed project features.

There is an elevated flood risk along the project reach as a result of ongoing sediment deposition within the alluvial fan reach of the Lower White River. Since the cessation of maintenance dredging in the mid-1980s, the Countyline reach of the White River has aggraded approximately five feet, which has resulted in a substantial reduction in its flood-

carrying capacity. The results of hydraulic modeling and historical trends in sediment deposition measured from decades of channel monitoring by the County indicate that continued sediment deposition will result in the overtopping of the existing left bank (Countyline) levee during mean annual flow (approximately 1500 cubic feet per second, or cfs) in the next 10-20 years if no action is taken. This would result in the avulsion (rapid shift in the channel location) of the river into the lower elevation of the wetland and through developed areas within the City of Sumner.

The Countyline reach of the Lower White River was historically known for its high rate of wood loading and today transports significantly more large wood than other rivers in King County. Large wood can pose a hazard to river recreational users when present in the wetted channel and can threaten public infrastructure such as bridges, levees, and revetments when it accumulates on bridge piers or deflects flows into erosive banks. To understand the severity of these hazards on the Lower White River and to inform the project design, King County completed a wood budget for the Countyline project reach in 2010 and conducted a study of recreational use on King County rivers (including the project reach) in 2013. The results of the 2010 wood budget found that an average of 600 pieces of large wood are transported through the project reach each year. This quantity is projected to increase five-fold if the river avulses into the existing forested wetland area before the project is constructed. An additional five-fold increase in wood transport through the project reach is expected following project construction, when the existing levee will be removed. The results of the 2013 recreational study found that recreational use of the Lower White River was less than one percent of the use measured on any other river in King County. During a 168-day time period, remote cameras documented only 30 people floating within the project reach. The vessels used by the majority of the recreational users were inner tubes, followed by inflatable rafts and a canoe.

Study Methods

Large Wood Hazard Type and Protocol

MIG developed a method to evaluate large wood hazards based on a river recreation safety study completed for the Yakama Nation (MIG 2012). The method is based on the idea that large wood (LW) present in a river can result in changes in navigability that are not adequately addressed by the International River Scale of Difficulty (Appendix B) . These changes in navigability can range from being barely noticeable to needing to portage around highly hazardous LW accumulations. Table 1 presents the typology developed. LW rated as an "A" or "B" poses little or no navigational challenges to boaters. LW that is rated from "C" to "E" poses increasing levels of navigational challenge. LW rated as an "F" requires portaging, and represents the greatest potential hazard to boaters.

In order to assign a LW type to a particular channel location, the following characteristics were considered, based in part on guidelines developed by American Whitewater (Colburn 2012):

- Location of LW in the channel (right side, center, left side)
- LW projection into the channel (as a rough percentage of the boatable channel if LW was not present)
- LW angle relative to flow direction
- Current velocity and power (high, medium, low)[1] relative to user ability
- Roughness: amount of branches and roots
- LW complexity ranging from a single log to a group of logs
- Sight distance from a boater's perspective approaching LW from upstream

For example, a LW accumulation located outside of the channel would be rated as an "A." A LW accumulation that projects into a significant portion of the wetted channel that would otherwise be boatable, has high roughness (including branches and rootwads), has high complexity (multiple logs) and has low sight distance, etc. would be rated as "D" or "E", assuming the LW accumulation does not span the entire width of the boatable channel.

[1] Current velocity interacts with flow and water depth. For example a side channel with high velocity could have very low flow or depth and therefore be insignificant to boater safety.

Table 1. Large Wood Types and Evaluation Protocol

LW Type and Assessment Action	Type Description
A: *(do not count)*	Located below ordinary high water but dry or projecting less than 5 feet into boatable current at the observed flow.
B: *(do not count)*	In general, it would take active navigation toward LW to make contact with a Type B, and the consequences of contact are generally low. Located in water at this flow. Generally, projects more than five feet into boatable channel, though does not pose a boating obstacle or hazard. Located in side channels or on the inside of a bend, or is aligned parallel to current. Angle relative to the current does not create the conditions that pose a notable hazard. Typically in a reach with velocity and flow rates that allow for casual use by novice boaters.
C: *Count, characterize, GPS and take select photos*	In general, "routine navigation" allows a floater to avoid contacting a Type C, but contact could occur if a floater is inattentive, unskilled, or has limited means of navigation. If contact occurs, consequences are uncertain and could be serious. Compared with "B", more than one additional channel feature (limited sight distance, rapids, shallow depth, narrow width) increases the potential for boater navigability challenges and contact with a Type C.
D: *Count, characterize, GPS and take select photos*	In general, these require floaters to engage in "active navigation" (at least one substantial positive maneuver) to avoid contact with a Type D ("routine navigation" may not be sufficient to avoid). If contact occurs, consequences are uncertain and could be serious. Three or more characteristics increase potential for interaction (at least one level higher from "low") or there is at least one characteristic that is at a "high" level.

LW Type and Assessment Action	Type Description
	Center piling bridges and similar man-made features also fall into this category.
E: *Count, characterize, GPS and photograph all. When relevant, estimate width of boatable channel and describe other navigational issues (eddy locations, class of rapids if relevant)*	A boatable channel may exist, but substantial "active and accurate navigation" is likely needed to avoid contact. If contact occurs, consequences are uncertain and likely to be serious. Multiple characteristics at "high" levels that substantially increase potential for contact.
F*: Count, characterize, and photograph all. Describe eddy and portage characteristics.*	Channel-spanning LW or characteristics that prevent navigation (portage required).

Source: MIG (2012).

Site Observations of Existing Conditions

On January 14, 2015, John Baas, Teresa Fish and Kyle Koger (MIG) and Chris Brummer (King County) floated the project reach (RM 5.0 to 6.3) and reaches both upstream and downstream of the project. The purpose of the float trip was to observe existing conditions in the setback area expected to be occupied by river flows under future conditions with and without the construction of the Countyline Levee Setback project. The site visit was conducted in accordance with the study workplan prepared by MIG. The put-in was located on Muckleshoot Indian Reservation Tribal lands at approximately RM 10.6. Flow at the R Street gaging station was approximately 1,800 cfs.

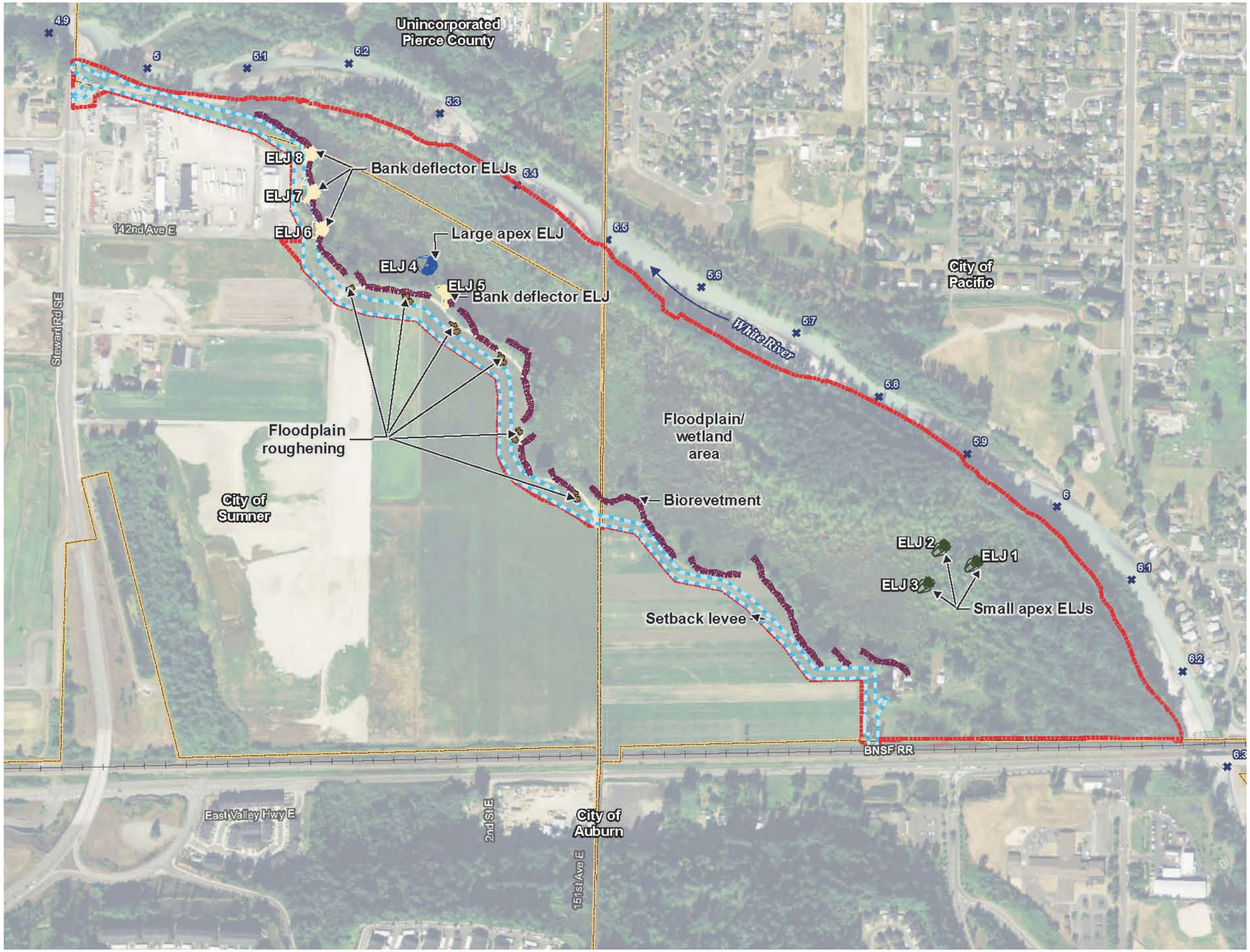
The team floated the river to the project reach and stopped on the left bank levee near RM 6.0. The project team then walked to the top of the left bank levee to observe the wetland, which according to the County's analysis will: a) be occupied by river flows under future conditions without the project due to a levee breach and b) be occupied by river flows the first winter after project completion, which includes removal of the left bank levee. The project team then returned to the raft and floated through the project reach to the established take-out at the 24th Street pedestrian bridge.

Review of County Reports and Project Design

MIG reviewed the "Basis of Design" report dated February 13, 2014. This report describes existing conditions, opportunities and constraints, alternative project designs, proposed project design, hydraulic modeling of existing and future conditions (with and without the project), the expected geomorphic changes in the project reach (with and without the project), and the 60% design drawings. This information, as well as aerial photographs of existing and historic conditions, and the 2013 countywide recreational boating study, were reviewed by MIG staff. MIG staff held two conference calls with County staff to seek clarification on likely future conditions following project implementation.

Stakeholder Meetings

King County hosted two stakeholder meetings to receive public input on recreational concerns related to the Countyline project and the risk assessment conducted by MIG. The first meeting was held on February 18, 2015 to receive input on the proposed 60% design for the Countyline Levee Setback Project. The meeting was attended by representatives from King County, MIG, the River Safety Council (RSC), the Muckleshoot Indian Tribe (MIT), and the Washington Department of Fish and Wildlife (WDFW). Representatives from the Puyallup Tribe of Indians (PTI) and American Whitewater were invited but unable to attend. The full list of attendees and meeting notes were provided to all invitees and are included in Appendix C. The stakeholder meeting began with brief introductions by participants and was followed by a 20-minute presentation on the Countyline Levee Setback Project by King County staff and the scope of the recreational study and preliminary recommendations by MIG. Following the presentation, attendees shared comments about the design of the Countyline Levee Setback Project and their concerns regarding recreational safety.



Legend

- Project site
- Setback Levee
- River Mile
- City boundary
- King Pierce County boundary
- Railroad

N

0 250 500 1,000 Feet

Aerial: USDA (2013)
Coordinates: NAD 1983 Washington State Plane North (ft)
K:\Projects\Y2010\10-04770-000\Project\GIS_Reports\Map_w_proposed_ELJs.mxd

April 2015, Modified from Herrera (2014)

King County, Washington

Figure 1. White River at Countyline Levee Setback Project Site with Proposed Locations of Engineered Log Structures

The second meeting was held on April 16, 2015. The purpose of the second meeting was for the County and MIG to present the results of the Draft Risk Assessment report and recommendations, to receive any additional public input on recreational concerns, and to initiate a two-week period for public comment on the Draft Risk Assessment. The meeting was attended by representatives from King County, MIG, the River Safety Council (RSC), the Muckleshoot Indian Tribe (MIT), and the Washington Department of Fish and Wildlife (WDFW). Representatives from the Puyallup Tribe of Indians (PTI) and American Whitewater were invited but unable to attend. The full list of attendees and meeting notes for the second meeting were provided to all invitees and are included in Appendix C. The stakeholder meeting began with brief introductions by participants and was followed by a 10-minute recap on the third-party review process by King County staff and a 20-minute presentation of the Risk Assessment and findings and recommendations by MIG. Following the presentation, attendees asked additional questions about the design and risk assessment that were addressed by the County and MIG.

Results

Site Observations of Existing Conditions

During the site visit on January 14, 2015, the team viewed several examples of well-established "small" engineered logjams (ELJs) at the put-in location that were constructed in 2005 by an entity other than King County (Photo 1). From RM 10.6 to RM 6.0 the team noted several examples of naturally occurring LW (Photos 2-4). The wetted portion of the channel appeared to be relatively free of readily observable LW. The LW that was observed was of varying complexity and size, and was located mostly along banks and on gravel bars; none of these would be rated higher than a "C."

The team observed the existing levee along the left bank within the project reach and upstream and downstream of the project reach. Upstream of the project reach, the river level was observed to be several feet below the top of the left bank levee (Photo 5). Within the project reach, portions of the left bank (existing Countyline) levee were at approximately the same elevation as the tops of gravel bars. No exposed rebar or in-channel weirs were observed outside or within the project reach. A concrete revetment was observed within the project reach on the right bank downstream of the BNSF Railway bridge. Large wood was observed on the upstream side of the single, in-water pier of the A Street bridge and on the two in-water piers of the Stewart Road bridge (Photo 6). Due to riverbed aggradation, the water surface elevation of the river at RM 6.0 during the relatively low flow level was within approximately two feet of the top of the left bank levee.

Figure 2 depicts areas where boaters and tubers are likely to encounter the greatest navigational challenges. The first and greatest navigational challenge is expected to occur where river flows make a left turn into the wetland area. At this location, the wetland is about six feet below the existing river bed elevation. As a result of this elevation difference, the 200-foot portion of the new channel entering the wetland will have an approximately four foot elevation difference for the first few years after construction. This will create a new navigational challenge until equilibration of the bed profile is achieved by upstream incision of the channel following removal of the existing levee and natural sediment deposition in the wetland. Boaters and tubers entering the wetland area would need to react quickly to any changes in the current, to the steepening channel slope, and to the three proposed ELJs, all within the first 300 feet of the entrance to the wetland. This combination of features within a short distance may create a substantial hazard to tubers and novice boaters.

The biorevetment units proposed along the east side of the wetland to protect the new setback levee from channel migration may also pose a hazard to boaters and tubers as they attempt to negotiate the right turn, where the channel changes direction to the south. Throughout the setback area, the flow is likely to split into several channels. The shallow flow in these channels could make navigation more difficult, and could result in boaters becoming stranded as a result of encountering shallow water, gravel bars, and substantial accumulations of LW. Boaters and tubers may also need to portage to find a passable channel. Due to the presence of numerous dead and dying trees, the wetland area (Photo 6) will provide good opportunities for natural LW recruitment into the new channel(s). As a

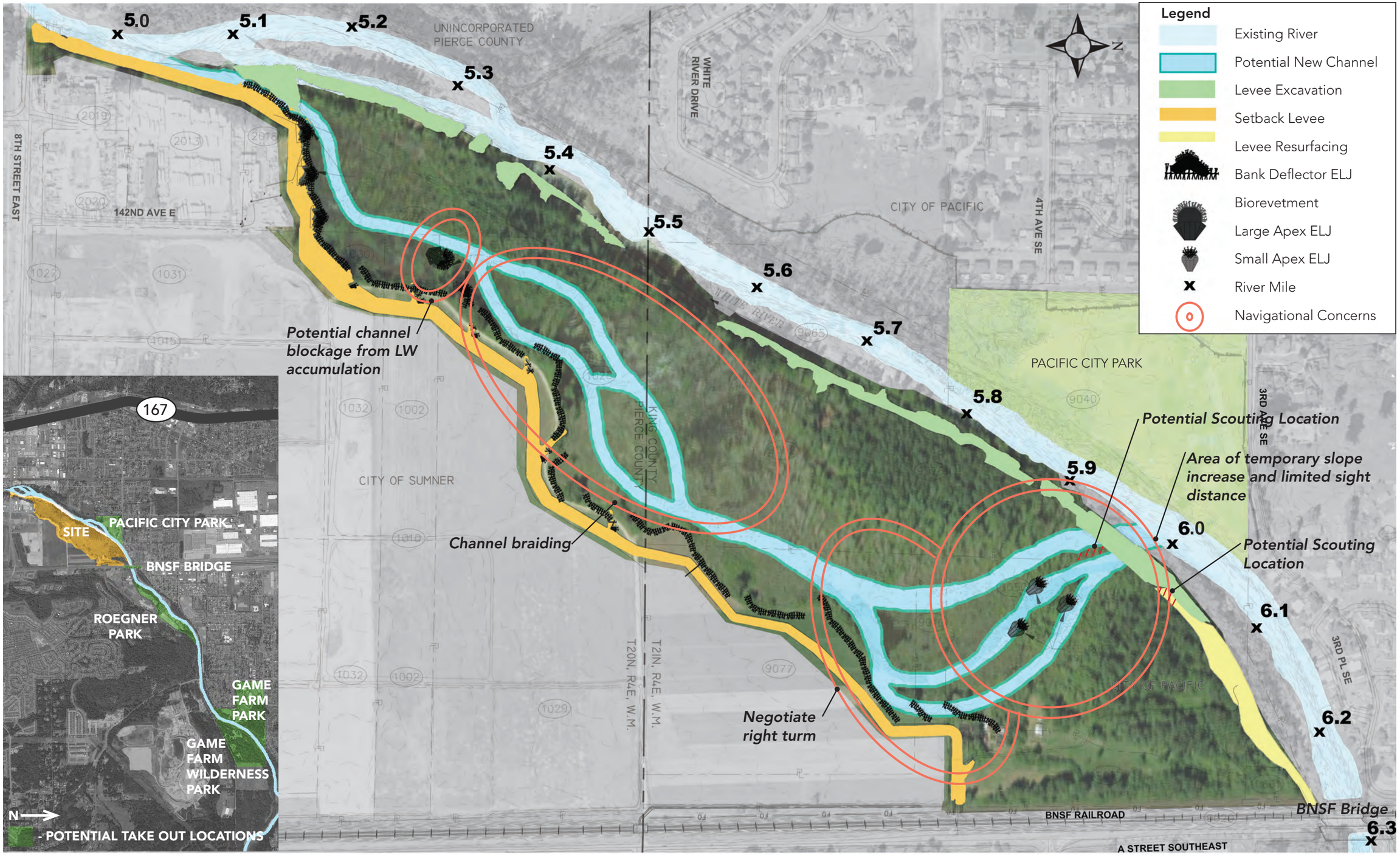


Figure 2. Changes in navigation under future conditions with project

result, in some years, the project reach may require portages or be impassable to boaters. On the south end of the reach, boaters may encounter a navigational hazard in regard to ELJ 4 (location shown in Figure 1). This ELJ will be approximately 90 feet wide and may accumulate sufficient LW (spanners) to make this location impassable at low flow. Boaters may need to portage around this location or select another more passable channel.

The team reviewed options for take-out upstream of RM 6.0. There are few opportunities for take-out on the right bank upstream of the A Street bridge due to private land. Opportunities for take-out on the right bank include the downstream side of the BNSF bridge abutment (at the intersection of 3rd Ave SE and Skinner Road) and at Pacific City Park. There are good put-in and take-out locations at Game Farm Wilderness Park (Photo 7) and at Roegner Park, both on the left bank, and at Game Farm Park on the right bank (see inset map, Figure 2). These locations provide opportunities to inform boaters of potentially changing conditions in the project reach.

The take-out at the Stewart Road bridge was determined to be unsafe due to the amount of accumulated LW on both in-water piers (Photo 8). Using the criteria from Table 1, this LW complex would rate a "D" or "E", indicating a relatively high hazard. As a result, the team used the right bank immediately downstream of the 24th Street bridge (Photo 9) for take-out. This area was somewhat constrained, and is limited to taking out a single raft at a time. However, if this location was ever considered as a take-out for casual inner tube use, this would probably not be an issue. An alternative take-out is located on the right bank, upstream of the end of 16th Street, but is only accessible by walking several hundred feet along a pedestrian trail.

Photo 1: Put-in location near RM 10.6, looking upstream at established ELJs on both banks.

Photo 2: "C"-rated LW in channel near RM 10.0, looking downstream.

Photo 3: "B"-rated LW along the channel near RM 9.5, upstream of the Project reach.

Photo 4: LW on gravel bars near RM 9.0, looking downstream. These accumulations would be "A"-rated since they are not in the boatable channel.

Photo 5: Left bank levee with riprap, near RM 8.5, upstream of the project reach.

Photo 6: River level at the top of the left bank levee, near RM 5.8, within the project reach.

Photo 7: Potential signage and take-out or put-in location at Game Farm Park, near RM 8.2.

Photo 8: Potential take-out location at the Stewart Road bridge near RM 5.0, with accumulated LW. This LW complex would rate a "D" or "E" based on criteria in Table 1.

Photo 9: 24th Street bridge near RM 3.5, looking downstream. Take-out is on the right bank, immediately south of the bridge.

Public Input from the Stakeholder Meetings

Meeting minutes from the February 18, 2015 meeting and the April 16, 2015 meeting documenting stakeholder comments are included in Appendix C. During the first meeting, Mike Grijalva (RSC Chair) provided comments that were largely focused on concerns regarding the proposed placement of rootwads sticking out from the engineered logjams (ELJs). Mr. Grijalva suggested burying the rootwads in the bank or cutting the rootwads off to eliminate the hazard.

Martin Fox (MIT) provided comments that were focused mainly on design refinements that would improve sight distance for river recreational users while not diminishing the habitat value of the proposed ELJs. Mr. Fox noted that the setback area would be hazardous without ELJs and would not be a good place to boat if the river shifts into this area after the project. Mr. Fox noted that the rootwads provide habitat when they are over pools and can also help provide stability when they are buried in the bed. He suggested adding logs out in front of the rootwads on targeted ELJs that are more likely to be encountered by boaters, or adding logs in the future if the targeted ELJs do not rack up natural wood.

Larry Fisher (WDFW) commented that the White River can be dangerous to boaters and that they must take responsibility when entering rivers. He stated that rootwads sticking out

into the river provide the best habitat and expressed support for adding extra logs on rootwads only for the ELJs with short sight distance.

Written comments (via email) were received only from Mike Grijalva (RSC), wherein he reiterated concerns about the danger of the rootwads proposed on the exterior of the ELJs shown in the 60% Countyline design plans. He also conveyed concerns about the three small apex ELJs proposed at the upstream inlet to the wetland, and the hazards that the rootwads on the upstream face of these structures would pose to boaters. He further noted that bumper logs installed on these structures might not be effective in most situations because the water would need to be at the level of the log and at a sufficiently slow velocity for a boater to be deflected off of the structure.

During the second meeting, Mr. Grijalva reiterated previous concerns regarding the need for the quantity of rootwads in the engineered log structures and noted the potential for sharp roots to snag people. Mr. Grijalva asked how the expert boaters rated the risk to inner tubers from the rootwads. John Baas replied that when MIG's expert boaters were asked to consider the design features, they responded with recommendations to improve visibility that would allow boaters to avoid these types of hazards. Mr. Grijalva provided sketches of alternative log structures that he thought would be safer to recreational users.

There was also a discussion among attendees about the location of signs to inform boaters of changed conditions and options for take-out upstream of the project. Mr. Fisher asked where most people take out. Mr. Brummer replied that he has taken out at the BNSF bridge twice and that Tom O'Keefe with American Whitewater indicated most boaters take out there as well.

Mr. Fox asked how many trees the County estimated in their wood budget. Mr. Brummer replied that an estimated average of 600 trees pass through the project reach each year, and that number is expected to quadruple when the river enters the wetland. Mr. Fox noted that previous studies of historical wood loading before the area was settled indicated substantially more wood, and that we would never return to those conditions.

The second meeting concluded with a commitment from MIG to research safe boater guidelines and a request from King County for comments on the Draft Risk Assessment report to be sent to the County within two weeks.

Written comments following the second meeting were received from Mr. Fox and Mr. Grijalva (Appendix C). Written comments from Mr. Fox included a copy of a letter dated February 19, 2010 submitted by the MIT to King County regarding comments on the draft Public Rule: Procedures for Considering Recreational Safety when Placing Large Wood in King County Rivers. The letter expresses the MIT's concern over the negative impact the public rule will have on future salmon habitat restoration efforts in King County rivers. Mr. Grijalva submitted written questions regarding the potential risks for various elements of the design. Responses to these questions from the County and from MIG are included in Appendix C.

Potential River Features Affecting Recreational Use

As part of this study, MIG considered multiple features and conditions that currently exist or will likely exist in the future (with and without the project) that could have an effect on recreational use and navigability in the project reach (Table 2). This evaluation was based on field observations, the types of recreational use observed and documented in the 2013 Countywide recreation study within the project reach, and a review of King County documents describing the anticipated future conditions.

Channel confinement can affect the amount of LW deposited within the project reach. The more confined the channel becomes with non-erodible banks, the greater the likelihood that the river is able to transport LW through the reach with little opportunity for LW recruitment and deposition. As the channel becomes less confined, flows can spread out and increase the likelihood for LW recruitment and deposition. Greater amounts of LW may require boaters to more actively navigate the channel and maneuver around areas with LW deposition.

Braided channels can impair navigability by increasing the difficultly for boaters to follow the thalweg, thereby increasing the likelihood of hitting a gravel bar or LW alongside the channel. Additionally, channel bifurcation decreases channel width, which in turn increases the potential for impassable, channel-spanning wood or shallow water necessitating portage. If boaters become stranded on a side-channel, it can result in more potential for entrapment or entanglement in channel-spanning wood or the need for unplanned portages to the downstream side of the obstruction (Photo 10), thereby significantly increasing risk. This increased risk might be partially offset by a reduction in wetted depth and current power as flow is divided into multiple channels; however, unplanned portage locations may be less than ideal (steep banks, rapid flow), and in some cases may create other potential safety issues such as slipping and falling onto rocks, LW or into the channel.

Slope affects navigability by influencing turbulence, the speed of travel, and the force exerted on any object beneath the water surface. The higher the percentage of a reach that is composed of complex turbulent flow, the greater the challenges to a boater's ability to steer a craft, set up for upcoming obstacles, and keep the craft pointed downstream. Sustained rapids increase the scale of difficulty of boating a river, as is reflected in the International Scale of River Difficulty.

Table 2. Summary of Potential Changes in Boatable Conditions and Relative Boater Risk[1]

River Feature	Existing Conditions		Future Conditions without Project		Future Conditions with Project	
		Relative Risk	Potential Changes	Relative Risk	Potential Changes	Relative Risk
Channel confinement	Confined on both banks by revetments and levees	*Low*	Uncontrolled levee breach and avulsion into wetland at high flow	*High*	Controlled diversion of river into wetland at low flow after construction	*Medium*
Braided channels	Mixed single channel with alternating gravel bars and braiding at downstream end of the reach	*Low*	Braided channels would form in the wetland area. Braiding might increase in the existing channel	*Medium*	Braided channels are expected to form in the wetland area. Braiding might increase in the existing channel.	*Medium*
Slope	Consistently 0.4% through the reach	*Low*	2- to 6-foot drop at avulsion location(s) until the riverbed adjusts, otherwise the average slope would be same or less than existing conditions	*High[2] to Low*	4-foot drop over 215 feet at setback inlet until bed adjusts, otherwise the average slope would be the same or less than existing conditions	*High[2] to Low*
Channel wetted width	70-130 feet, wide enough for easy navigation	*Low*	More variability in width; narrower in reaches with multiple channels and wider in unconfined, single-thread reaches	*Medium*	More variability in width; narrower in reaches with multiple channels and wider in unconfined, single-thread reaches	*Medium*
Flow depth at locations with LW	4-7 foot deep pools at meander bends and along rock revetments	*Low*	Similar or slightly deeper than existing conditions, with more variability	*Medium*	Pools deeper than existing conditions are likely to form adjacent to large ELJs, with more variability elsewhere	*High*

[1] Potential changes in conditions are based on the Basis of Design Report, February, 2014
[2] Temporary Condition

River Feature	Existing Conditions		Future Conditions without Project		Future Conditions with Project	
LW accumulation at Stewart Road (8th Street) Bridge	Wood accumulations on both in-water piers. Wood on the eastern pier, spanning pier to the adjacent left bank	*Medium*	Four-fold increase in wood flux to bridge during uncontrolled avulsion, then less than existing wood flux as channels become established in wetland	*High to Low*	Four-fold increase in wood flux to bridge during large flood event after construction, then less than existing wood flux as channels become established in wetland area	*High to Low*
LW in Wetted Channel	LW mostly on banks and tops of bars	*Low*	Wetland would act as a wood "sink" and increase wood loading	*High*	Wetland would act as a wood "sink" and increase wood loading	*High*
Complexity and Roughness of LW in channels	Mostly Types "A" and "B"	*Low*	Wider range of LW types than under existing conditions, including "E's" and "F's"	*High*	Wider range of LW types, including "E's" and "F's" Fewer "C's" and "D's" compared to future, no project scenario	*High*
Mean flow velocity at 2058 cfs	4-6 ft/sec	*Medium*	1.6 ft/sec due to increased channel length and hydraulic roughness. Local increase in velocity first few years at levee breach and inlet to wetland area until channel adjusts	*Medium[2] to Low*	1.6 ft/sec. due to increased channel length and hydraulic roughness. Local increase in velocity first few years at inlet to wetland area until channel adjusts	*Medium[2] to Low*

[2] Temporary Condition

Photo 10: Example of a Type "F" LW accumulation on the Twisp River).

Channel wetted width can affect navigability by limiting the ability to maneuver a watercraft as the wetted channel becomes narrower. A reach will typically have multiple lines of travel; however, a boater's options for lines of travel become more limited as the wetted width narrows. Extremely narrow channels (less than 10 feet wide) require superior boating skills to safely maneuver a watercraft. Also, the narrower the wetted channel, the greater the likelihood of "F" type wood accumulations forming. These conditions can quickly create situations where a reach with a very narrow wetted channel exceeds a novice boater's skill level.

Flow depth is relevant in areas where a boater could become trapped or pinned beneath an obstacle in the river. Scour at locations of LW can create pools deeper than what would typically be found in a reach without LW accumulations. The degree of channel braiding also influences depth and may reduce the extent of boatable reaches.

Large wood accumulation at the Stewart Road bridge presents challenges with safely taking out at this location. Large accumulations could make it difficult to reach the shore and could make it difficult to stabilize the craft as boaters disembark. During the January site visit, this takeout location was not readily accessible due to the presence of large wood.

The relative amount of **large wood in the wetted channel** can affect navigation. As the amount of wood increases, greater navigational skills are required to avoid contacting large wood. This is particularly problematic for novice boaters or individuals floating the river in inner tubes.

The **complexity and roughness of large wood** affects navigation by potentially entrapping boaters or tubers. If contact is made with large wood, the higher the complexity (number of logs) and roughness (number of roots and branches) ratings ("D" through "F") the greater the potential hazard for boaters. In some cases spanners ("F" category) will force boaters to portage, which in turn has potential safety issues (see "channel width" above). In situations where novice boaters are unable to avoid making contact with spanners, they may become stranded at those locations, increasing the risk of capsizing their craft or becoming pinned beneath the water.

Mean flow velocity affects navigability. As flow velocity increases, boaters must have an increased ability to scout ahead for hazards and to perform maneuvers with increasing speed and accuracy to avoid hazards (compared to boating in slower moving water).

Finally, the factors mentioned above can interact in a confounding manner to make navigation more difficult. For example, under some circumstances, a narrow channel in a braided section of river can be deep, since the complexity of LW present can form deep pools. The amount of LW present can also narrow the channel. This is where the term "current power" can have an additional impact on navigability. Current power is the product of velocity and flow rate. For example, a small side channel with a high velocity but low flow rate of 10 cubic foot per second will not be very hazardous to boaters, but a section with a low velocity and high flow rate can be hazardous. So multiple attributes can work together to increase channel depth, channel width, current power, and risk to boaters.

Ideally, take-outs should allow boaters (especially novice boaters) the option to get out of the thalweg easily and quickly, and should allow for safely disembarking from the craft. The accumulation of LW and obstruction at easy-to-use take-outs increases the risk associated with their use and also creates a hazard if boaters are forced to use less than ideal take-outs.

Potential Hazards and Risk Ratings for the Three Scenarios

The project reach is a highly dynamic system. Weather events, the operation of Mud Mountain Dam, and the amount of sediment and LW transported to the project reach can change the river's character and navigability each season and after a moderate flood event. The amount of LW can vary from year to year, and the number of braided channels can also change, as can the location of the river's mainstem. As a result, it is difficult to know with a high degree of confidence the types of conditions that boaters would experience under future conditions with or without the project.

Recognizing that the study reach does and will continue to exhibit a high level of variability in characteristics that can affect boating navigability, MIG and the County developed a summary table (Table 2) of potential changes in river features likely to occur for each scenario over the next 30 years and the relative risk ratings for these conditions.

Based on the possible site conditions described for the three scenarios in Table 2 and MIG's knowledge of boater behaviors, MIG assigned relative risk ratings to the design features for each scenario. Risk ratings are considered relative since they are influenced by flow rate and by user characteristic such as skill level, safety equipment, type of craft used, and knowledge

of river conditions. Given the skill level of users observed by King County (2013) on the Lower White River, MIG evaluated relative risks for novice boaters and individuals floating the river in inner tubes. Given the focus on novice users, risks would most likely be lower for more experienced boaters. Moreover, novice boaters that are well equipped (e.g., wearing a PFD, being attentive) and informed about potential boating hazards will generally be subjected to lower risk levels than what is reported in Table 2.

The relative risk to tubers and novice boaters due to **channel confinement** is low under existing conditions, high under future conditions without the project, and medium under future conditions with the project. Under future conditions without the project there will be uncontrolled avulsion of the levee and river migration into the wetland area. In contrast under future conditions with the project, there will be controlled diversion of river into wetland at low flow after construction.

The number of **braided channels** will probably increase under future conditions with or without the project. This will increase navigational challenges, and could indirectly affect risk if boaters become stranded on a side channel, where portaging might be required. An increase in the number of braided channels could also increase the potential for LW deposition. The decrease in channel width, increase in the number of braided channels, and increase in LW deposition will increase the relative risk from low to medium under both future scenarios.

The relative risk associated with **slope** is expected to be high for the first several years after project implementation and then decrease to a low risk for long-term conditions. Under current conditions, the slope of the river throughout the project reach is approximately 0.4%, resulting in a low relative risk rating. Following project implementation, the slope of the channel where it first enters the wetland at RM 6.0 after making a sharp left turn will initially be steep as the channel drops approximately four feet over 215 feet. Although the slope will decrease within a few years and then have roughly the same slope as existing conditions, the steep slope during the first several years following project implementation will create some navigational challenges, and the relative risk will be high under the future with project scenario and high under the future without project scenario. After several years the risk will decrease to a low rating for the future with project scenario and perhaps after a few decades for the without project (where the levee is overtopped and breached but the rock revetment has not been removed). Additionally, the two- to four-foot drop will occur over a shorter distance for the future without project scenario. Although the risk rating for both future scenarios is expected to initially be high, the future without project scenario will have a slightly higher risk because the slope will be steeper and persist over a longer initial time period.

Channel wetted width in the wetland or setback area will probably narrow under future conditions as a result of channel braiding, with or without the project. This will likely increase navigational challenges since the ability to maneuver around obstacles or rapids will decrease as the channel narrows and the accumulation of channel spanning obstacles increases. Channel width may become problematic in locations of new braided channels at the currently proposed location for ELJs 1 through 3 and the location of ELJ 4 (locations shown in Figure 1). As a result the relative risk ratings for future without the project, and future conditions with the project area are both medium.

Under existing conditions, the maximum **channel depth** (during the summer) varies from four to seven feet in pools located at meander bends and along rock revetments. Based on observations at the time of the site visit, the relative risk under existing conditions was considered low throughout the mainstem channel of the project reach. The local channel depth in pools forming adjacent to LW accumulations will likely be deeper with the project compared to both existing conditions and future conditions without the project, resulting in a high relative risk rating. If boaters make contact with a LW accumulation in deeper pools coinciding with relatively high velocity, there is an increased risk of underwater entrapment.

Large wood accumulation at Stewart Road Bridge (8th Street bridge) on both in-water piers occurs under existing conditions, resulting in a medium risk. In the first several years following project implementation, the relative risk increases from medium to high as a result of a potential four-fold increase in the quantity of LW transported to the Stewart Road bridge crossing. This accumulation could create challenges in safely bringing the boat to the shoreline and stabilizing the boat while users disembark; however, as more LW accumulates in the wetland, the amount of LW transported to the Stewart Road bridge crossing and potentially accumulating at the bridge will substantially decrease, resulting in a low relative risk in the long term after project construction. A similar scenario would apply to the future scenario without the project. Under both scenarios the relative risk rating increases to high in the first several years following project implementation, then decreases to low.

The amount of **large wood in wetted channel** present in the project reach under existing conditions is relatively low in comparison to the unconfined reach upstream of Auburn. The quantity of LW in the project reach will likely increase for both future scenarios. Depending on the complexity, location and amounts of LW, navigating the project reach could become more challenging, increasing the likelihood that boaters will make contact with LW. For both future scenarios, the relative risks are both rated high. In some years, the project reach may have so much LW that portaging is required in multiple locations. In other years, the project reach may be unboatable.

The **complexity and roughness of large wood** present in the project reach will increase under future conditions. The future with project scenario will likely have the highest complexity of LW accumulations. As noted in Table 1, LW accumulations that rate in the "D" through "F" categories (which includes branches and logs with rootwads) require active navigation at a minimum, and in situations where "F" rated LW is encountered, require portaging. The change in risk compared to existing conditions will increase from low to high under both future scenarios.

The **mean current velocity** throughout the project reach will decrease to "low" risk levels under both future scenarios, generally making navigation easier (low risk) compared to current conditions.

The results of hydraulic modeling for existing conditions performed for the 1.01-year flow event (2,058 cfs) indicate maximum velocities ranging from 4 to 6 ft/sec near RM 6.0, presenting a medium level of relative risk. Under both future scenarios the model results indicate the mean velocity would decrease to 1.6 ft/sec in the setback area, resulting in a low relative risk level. The one exception is at the drop into the setback area, where local

velocities might temporarily increase for several years (after construction or an avulsion) until the slope of the channel bed adjusts. Water depth at this location would be less than 2 feet. Since the mean current velocity will change over time, a range of risk ratings is presented in Table 2. Under both future scenarios the short-term relative risk ratings will be medium, but then decrease to low after several years after the slope has decreased.

In summary, navigability of the river will become more difficult under both future scenarios. Both future scenarios will result in more complex LW accumulations, resulting in greater navigational challenges compared to the existing conditions scenario. The addition of more complex LW accumulations and more LW generally are the most significant changes between existing conditions and the two future scenarios. Of the nine river features evaluated for risk, only one (channel depth at ELJ locations) presents a greater risk for the future with project scenario relative for the future without project scenario.

Recommendations

Table 3 summarizes MIG's recommendations for the nine river features and how these measures reduce those risks for the future with project scenario. The higher the relative risk rating, the greater the number of measures required to qualitatively reduce that risk from a high to a medium or from a medium to a low rating. Recommended measures include various communication options, monitoring the changes in LW distribution in the project reach to inform public outreach efforts, identifying take-out locations upstream of where the new channel will likely avulse into the wetland, and making changes to the design and positions of the proposed ELJs.

Channel Confinement

Regarding changes in channel confinement and increases in the number of braided channels, MIG recommends reducing risk by posting signs at upstream parks (likely put-in locations) and on bridges upstream of the project reach to advise users of changed river conditions and options for takeout. At these same locations MIG recommends including information about the purpose of the Countyline Levee Setback Project and the public benefits this project will provide. Coordination on the specific locations and sign design standards will need to occur between the County and the relevant jurisdictions upstream of and within the project reach. MIG understands that the County posts information on their website about hazardous river conditions, and this practice should be continued. This information is available at http://www.kingcounty.gov/recreation/boating/rivers.aspx

Boaters may be more aware of and more responsive to information posted by fellow boaters. These two recommendations are based on the premise that boaters will be aware of and act on the information about changed conditions in the project reach, thus reducing risks from medium to low.

Braided Channels

The relative risk for braided channels is medium for the future with project scenario. MIG recommends posting signs informing boaters of changes in river conditions and options for take-out, and posting information on the County website referenced above. Implementing these recommendations reduces the relative risk to low.

Figure 2 depicts several locations where increased navigation will be required. If boaters do not want to boat the section of river that flows into the wetland, there are options for taking out at Game Farm Park, Game Farm Wilderness Park and Roegner Park, and at the right bank abutment of the BNSF bridge. There are also opportunities for scouting the approximate location of channel avulsion near RM 6.0. Scouting could be done upstream of the location of the wetland inlet, where the left bank levee will remain intact. Walking on the levee is easy, and this would allow boaters to view the left-most channel. Other channels that might form in the area of avulsion could possibly be viewed from this location as well. If channels formed north of the ELJs are blocked, boaters could proceed downstream into the wetland to the right bank of the new channels. Additional scouting could also be achieved from mid-channel bars, but this option is not optimal given its proximity to the currently proposed locations of ELJs 1-3.

Table 3. Summary of Impacts of Proposed Recommendations on Relative Boater Risk

River Feature	Future Conditions with Project		Future Conditions with Project recommendations implemented	
		Relative Risk	Recommendations	Change in Relative Risk
Channel confinement	Controlled diversion of river into wetland at low flow after construction	*Medium*	Post signs to advise of changed river conditions and options for take-out	**Low:** risk is reduced by allowing boaters to make better informed decisions about floating this reach
Braided channels	Braided channels are expected to form in the wetland area. Braiding might increase in the existing channel.	*Medium*	Post signs to advise of changed river conditions and options for take-out Post information of any changed conditions on the County's website	**Low:** risk is reduced by allowing boaters to make better informed decisions about floating this reach. Boaters may be more likely to act on information provided by other boaters than by the County or affected municipalities
Slope	6-foot drop over 100-200 feet at setback inlet until bed adjusts, otherwise the average slope would be the same or less than existing conditions	*High[1] to Low*	Post signs to advise of changed river conditions and options for take-out Post information of any changed conditions on the County's website Identify takeout locations upstream of the left turn into the wetland (see Figure 2) Reposition ELJs 1, 2, and 3 to increase spacing and sight distance	**Medium to Low:** risks are reduced as noted above, and by giving boaters a chance to scout the left turn with the 4-foot drop. Risks are also reduced by giving boaters a longer line of sight distance for ELJs and by repositioning them to increase spacing and sight distance
Channel width	More variability in width; narrower in reaches with	*Medium*	Post signs to advise of changed river conditions and options for take-out	**Low:** risk is reduced by allowing boaters to make better informed

River Feature	Future Conditions with Project		Future Conditions with Project recommendations implemented	
		Relative Risk	Recommendations	Change in Relative Risk
	multiple channels and wider in unconfined, single-thread reaches		Post information of any changed conditions on the County's website	decisions about floating this reach. Boaters may be more likely to act on information provided by other boaters than by the County or affected municipalities
Channel depth at locations with LW	Pools deeper than existing conditions are likely to form adjacent to apex ELJs, with more variability elsewhere	*High*	Post signs to advise of changed river conditions and options for take-out Post information of any changed conditions on the County's website Annually map new/changed "E" and "F" LW accumulations and make information available to the public	**Medium:** risks are reduced as noted above, and by having relatively current information mapped to enable boaters to make decisions about whether to run specific portion of the Project reach, or where they might need to portage
LW accumulation at Stewart Road (8th Street) Bridge	Four-fold increase in wood flux to bridge during large flood event after construction, then less than existing wood flux as channels become established in wetland area	*High to Low*	Post signs informing boaters of alternate take-out option at the 24th Street bridge Post information of any changed conditions on the County's website	**Medium to Low:** risks are reduced as noted above, and by having relatively current information to enable boaters to make decisions about whether to take out at the 8th Street Bridge.
LW in Wetted Channel	Wetland would act as a wood "sink" storing increasing amounts of LW	*High*	Post signs to advise of changed river conditions and options for take-out Post information of any changed conditions on the County's website	**Medium:** risks are reduced as noted above, and by having relatively current, mapped information about LW accumulations to enable boaters

River Feature	Future Conditions with Project		Future Conditions with Project recommendations implemented	
		Relative Risk	Recommendations	Change in Relative Risk
			Shorten the extension of key logs projecting into the channel and perpendicular to flow Annually map new/changed "E" and "F" LW accumulations and make information available on the County's website	to make decisions about whether to float the Project reach
Complexity and Roughness of LW in channels	Wider range of LW types, including "E's" and "F's" Fewer "C's" and "D's" compared to the future, no project scenario	*High*	Post signs to advise of changed river conditions and options for take-out Post information of any changed conditions on the County's website Annually map new/changed "E" and "F" LW accumulations and make information available on the County's website	**Medium:** risks are reduced as noted above, and by having relatively current, mapped information about LW accumulations to enable boaters to make decisions about whether to float the Project reach
Mean flow velocity at 2058 cfs	1.6 ft/sec. due to increased channel length and hydraulic roughness. Local increase in velocity first few years at inlet to wetland area until channel adjusts	*Medium to Low*	Post information on County's website	**Low**

[1]-temporary impact

Slope
The change in river conditions where the river enters the wetland poses the greatest navigational challenge to boaters because of the temporary increase in slope and the presence of ELJs 1 through 3. MIG recommends multiple actions in regard to the increased slope that will be present in the first few years following project implementation. As discussed above, MIG recommends informational public outreach measures and identification of early take-out options (see inset map, Figure 2) and re-positioning ELJs 1 through 3. MIG also recommends re-positioning these ELJs downstream to increase the structure spacing and sight distance, which would provide boaters more reaction time to maneuver around these structures. MIG conducted a line of sight analysis to determine the minimum distances between these three ELJs. MIG assumed a velocity range of one to five miles per hour (1.5 to 7.3 feet per second) in this section of the project reach, and a boater reaction time of 30 to 45 seconds. This yields a distance range of 44 to 330 feet. For this project, a six-foot elevation drop over a distance of 100 to 200 feet would be steep enough to temporarily produce high flow velocities until the channel bed adjusts and the slope decreases a few years after project completion. Therefore, MIG recommends a minimum streamwise spacing distance between ELJs 1 through 3 of 200 to 300 feet and a minimum channel width spacing distance of 200 feet to reduce the likelihood of spanners forming between the structures. Implementing these recommendations in reference to river slope and sight distance will reduce the temporary relative risk from a high to medium rating. However, after several years the relative risk will be reduced to low due to channel aggradation.

In summary, the relative risk rating for slope will be high during the first several years following project implementation. MIG recommends implementing the informational measures referenced above. With informational public outreach measures and the boater's and tuber's ability to scout the new section of river that avulses into the wetland, the high risk rating will be reduced to medium during the first several years following project implementation.

Channel Width
In regard to changes in channel width, MIG recommends the informational public outreach measures described above. Boaters should be aware of the potential for greater navigational challenges and the potential need to portage around LW accumulations that may form in narrow channels and make certain sections of the project reach impassable. The implementation of the informational public outreach measures are expected to reduce the relative risk associated with reduced channel width from a medium to a low rating.

Channel Depth
Under both future scenarios there will be increased pool depths at locations with LW accumulations. MIG recommends the informational public outreach measures stated above and one additional measure. The additional measure is that the County perform annual monitoring of the project reach and map locations of LW with "E" and "F" ratings. Having this specific information about locations of the most hazardous types of LW ratings will augment general information about changed river conditions and locations of potential take-outs. The combined effect of these three measures will reduce the relative risk from a high to a medium rating.

MIG does not recommend adding "bumper" logs to ELJs. The bumper logs could reduce the "pinning" effect because the logs could potentially deflect flow rather than having flow passing through the root wad. However, the construction and orientation of the bumper logs would determine their effectiveness. Their effectiveness could be very sensitive to flow, where the bumper logs help at a certain flow but are largely ineffective at others. The best way for boaters to avoid a wood entrapment hazard is to prevent contact. In some cases knowing that bumper logs are present may create a false sense of security. In other cases, novice boaters may not even know the bumper logs were installed for their safety. Therefore, MIG does not recommend bumper logs as a solution to make the ELJ installations "safer."

LW Accumulation at Stewart Road Bridge

For LW accumulations at the Stewart Road Bridge (a potential take-out location) MIG recommends the same informational measures stated above. By knowing that there are alternative take-out locations downstream of the Stewart Road Bridge at 16th and 24th Streets, boaters will be able to decide whether or not to takeout at Stewart Road Bridge or alternate locations. These recommendations will reduce the relative risk rating from high to low to medium to low.

LW in Wetted Channel

The relative risk rating for LW will be high due to increased LW recruitment. MIG recommends the same informational measures previously mentioned and annual mapping of LW accumulations in the "E" and "F" categories. MIG also recommends shortening the extension of the face of the key logs on structures where the logs are placed perpendicular to the main flow. If water can flow into or under the protruding logs, there is a chance of boaters/tubers being pushed under or pinned to a structure. This recommendation is not to be confused with installing "face" or "bumper" logs. With implementation of these recommendations the relative risk rating will be medium.

Complexity of Large Wood

The complexity of LW present in the project reach will increase under future conditions. The future with project scenario will likely have the highest complexity of LW accumulations. MIG recommends informational measures described above and that the County annually maps changes in "E" and "F" LW accumulations. These measures will reduce the relative risk rating from high to medium.

Mean Current Velocity

The mean current velocity at the approximate location of channel avulsion associated with the project would be in the 1 to 2 ft/sec. range. Water depth at this location would be less than 2 feet. As a result, the risk rating is medium under short term conditions. Implementing recommendations in Table 3 will reduce the relative risk rating from medium to low.

Conclusions

The Countyline project will improve public safety by minimizing flood risk, while improving salmon habitat. Under future conditions without the project the main river channel will continue to aggrade and most likely form a new channel into the wetland. Large wood transport through the project reach, already known for its high rate of wood loading, is expected to increase five-fold when the river avulses into the existing wetland area before the project is constructed. A similar increase in wood transport through the project reach is anticipated upon removal of the existing levee. The new river channels forming in the wetland will most likely have braided channels and locations where LW accumulations make the river impassable to novice boaters and tubers. It should be noted that the river will likely avulse into the wetland with or without the project.

MIG evaluated relative risks for three scenarios by evaluating nine river features that have the potential to affect recreation use. Through an evaluation of on-site and in-stream conditions, and a study of the proposed project design, MIG found that the relative risks to novice boaters and tubers increase for future conditions with and without the project compared to existing conditions. Under future conditions relative risk ratings will increase for all river features evaluated, except mean flow velocity which is expected to decrease as multiple new channels form in the wetland. For one river feature (channel depth at locations with LW) the relative risk is greater with the project than without the project.

While observed recreational use along this reach is low, the majority of users were seen floating in tubes, a vessel which affords very limited ability to navigate or maneuver. This study identifies areas where boaters and tubers are likely to encounter the greatest navigational challenges. The combination of features where the river flows make a left turn into the wetland area may create a substantial hazard to tubers and novice boaters.

MIG's recommendations are the following

1. Post signs upstream of the project advising of changed conditions and options for takeout, and annually map hazards and post that information on the County's website.
2. Reposition ELJs 1, 2, and 3 to increase spacing and sight distance, and
3. Shorten the extension of key logs placed perpendicular to the main flow.

Limitations

This assessment does not endorse specific boating/tubing, scouting, or portaging options for future river users. The assessment does not specifically endorse particular craft or skill levels for specific reaches or flows, nor is it intended to identify specific locations of potential natural or human-built obstacles or hazards for recreation or navigation purposes. All river users need to make their own decisions about whether or how to scout, run, and/or portage these reaches during any on-river boating or tubing activities. These decisions should be based on several sources of information, knowledge of their own skill and equipment, and direct observation of river conditions. Rivers are inherently hazardous settings for users and may be physically, mentally, and emotionally stressful for users, or may aggravate existing physical, mental or emotional conditions. Boating or tubing on rivers may result in

damage to or destruction of personal property; serious physical injury or even death arising from a variety of hazards including, but not limited to (and by way of example only), rocks, hazardous terrain, trees, debris, powerful waves, waterfalls, hydraulics, and various built or natural hazards; and difficulty or improbability of rescue.

References

Colburn, Kevin, 2012. Integrating Recreational Boating Considerations Into Stream Channel Modification & Design Projects. American Whitewater.

King County, 2014. Basis of Design Report. White River at Countyline Levee Setback Project. King County Department of Natural Resources and Parks, Water and Land Resources Division.

King County, 2013. Synthesis of 2013 River Recreation Studies, King County River Recreation Study. King County Department of Natural Resources and Parks, Water and Land Resources Division.

MIG, 2012. Yakama Nation Upper Columbia River Habitat Restoration River Safety Assessment Project Report: Upper Wenatchee River Study Reach.

http://www.kingcounty.gov/recreation/boating/rivers.aspx

Appendix A: King County Ordinance 16581 and Public Rule LUD-12-1 (PR)

King County

1200 King County Courthouse
516 Third Avenue
Seattle, WA 98104

KING COUNTY

Signature Report

June 30, 2009

Ordinance 16581

Proposed No. 2009-0367.3 **Sponsors** Phillips, Dunn, Ferguson and Lambert

AN ORDINANCE requiring the adoption of rules addressing procedures for establishing large wood emplacements in rivers or streams.

STATEMENT OF FACTS:

1. Public agencies, development and habitat restoration project proponents and private landowners have increasingly made use of large wood emplacement in recent years, as a means of enhancing fisheries and aquatic habitat values, reducing erosion and scouring to river banks, deflecting flows to minimize impacts to river banks, offsetting the impacts of development projects and protecting shorelines.

2. Public safety concerns have emerged regarding the potential hazard presented by some of these emplacements to recreational boaters, floaters and other water users.

3. Based on these concerns, the King County council directed that the department of natural resources and parks prepare a report on the

circumstances associated with large wood emplacements, addressing means of mitigating against public safety hazards.

4. That report was prepared and presented to the council, noting, among other findings, certain procedural approaches to large wood emplacements that are generally observed by the department of natural resources and parks.

5. Those procedural approaches have not been adopted as administrative rules and are not readily available to the public.

BE IT ORDAINED BY THE COUNCIL OF KING COUNTY:

SECTION 1.

A. By March 31, 2010, the executive shall adopt rules addressing the procedures that the King County department of natural resources and parks shall follow when installing large wood emplacements in rivers or streams.

B. The rules shall require the department of natural resources and parks to:

1. Develop a conceptual design of the wood emplacement for each proposed project. The project-specific conceptual design shall address proposed location, size, shape and anchoring of the wood; whether wood recruitment, which is the intentional accumulation of wood, floating down the river, at the installed emplacement site, is proposed; whether wood is intended to remain fixed or is intended to be moveable; and how the emplacement is to function to meet project goals;

2. Include in each conceptual design a description of how public safety considerations have been incorporated into the project's design;

3. Provide timely notice by the department of natural resources and parks to recreational water users, environmental interests, the neighboring community and others indicating an interest, about a proposed project and how interested parties may comment on the conceptual design;

4. Involve interested parties, who commented on the conceptual design, in a discussion and outreach to revise and refine the wood emplacement design for a proposed project, including:

a. identifying the type and extent of recreational use in the project area;

b. identifying public concerns related to the conceptual design; and

c. considering ideas for reducing or eliminating concerns regarding public safety, to the extent possible; and

5. Provide for periodic independent monitoring and inspection of large wood emplacements by an appropriate third-party provider. Reports of such inspections shall be provided to the department and to all councilmembers. Eleven copies of any inspection report made under this subsection shall be filed with the clerk of the council for distribution to councilmembers.

C. The rules shall include reference to the Guidelines for Bank Stabilization Projects in Riverine Environments in King County and the State of Washington's Integrated Streambank Protection Guidelines as the guide for project design for wood emplacements. At least every three years, the department of natural resources and parks shall convene a group of stakeholders, including but not limited to river residents, recreationalists, tribes, river boating interests, appropriate regulatory agencies, King County sheriff office representatives, and water resource inventory area representatives,

to review the department's large-wood emplacement rules and update them as needed. The department shall report to the chair of the physical environment committee, or its successor, any changes to the rules resulting from this review process. Two copies of any report made under this subsection shall be filed with the clerk of the council, for distribution to the chair of the physical environment committee, or its successor.

D. The adopted rules are intended to support the department of natural resources and parks' process to evaluate various strategies for location and design of wood emplacements, to maximize project benefits and to minimize risks to public safety.

E. The rules shall apply over all rivers within the jurisdiction of the department of natural resources and parks.

F. In implementing the rules, the procedures and design options affording the greatest safety for river users shall be of primary consideration in design concerns involving a balancing of important public purposes as the county addresses safety issues in large wood emplacements and other in-stream designs.

G. The rules are supplemental to applicable provisions of the Revised Code of Washington and Washington Administrative Code.

Ordinance 16581 was introduced on 6/15/2009 and passed as amended by the Metropolitan King County Council on 6/29/2009, by the following vote:

Yes: 8 - Mr. Constantine, Mr. Ferguson, Ms. Lambert, Mr. von Reichbauer, Mr. Gossett, Mr. Phillips, Ms. Patterson and Mr. Dunn
No: 0
Excused: 1 - Ms. Hague

KING COUNTY COUNCIL
KING COUNTY, WASHINGTON

Dow Constantine, Chair

ATTEST:

Anne Noris, Clerk of the Council

APPROVED this 10th day of July, 2009.

Kurt Triplett, County Executive

RECEIVED
2009 JUL 10 PM 3:18
KING COUNTY COUNCIL
CLERK

Attachments None

King County

King County
Public Rules and Regulations

Public Rules

Title	Document Code No.
Procedures for Considering Public Safety When Placing Large Wood in King County Rivers	LUD 12-1 (PR)
Department/Issuing Agency: Department of Natural Resources and Parks (DNRP)	Date: March 31, 2010
Approved: Bob Burns, Interim Director	

1.0 SUBJECT TITLE: Procedures for Considering Public Safety When Placing Large Wood in King County Rivers

1.1 EFFECTIVE DATE: The effective date of this Public Rule is March 31, 2010 or thirty days after filing with the Clerk of the Council, whichever comes later.

1.2 TYPE OF ACTION: New.

1.3 KEY WORDS: (1) large wood; (2) large wood placement; (3) mitigation; (4) public safety; (5) recreation.

2.0 PURPOSE:

2.1 To consider public safety issues in the design of projects involving the placement of large wood in King County rivers and streams.

2.2 To evaluate strategies for design of wood placements that will maximize project benefits and minimize risks to public safety.

2.3 To make available to the public the opportunity to provide input on proposed projects utilizing large wood.

3.0 ORGANIZATIONS AFFECTED:

3.1 The Department of Natural Resources and Parks.

4.0 REFERENCES:

4.1 King County Code chapter 2.98.

4.2 King County Ordinance No. 16581 (2009).

4.3 King County Code Title 21A.

4.4 King County Comprehensive Plan Policies E-405, E-406, E-408, E-422, E-438, E-471 (2008) available at: http://www.kingcounty.gov/property/permits/codes/growth/CompPlan/2008.aspx

4.5 King County Council adopted salmon recovery plans for Water Resource Inventory Areas 7, 8 and 9 (2005 and 2006) available at: http://www.kingcounty.gov/environment/animalsAndPlants/salmon-and-trout.aspx

4.6 King County Flood Hazard Management Plan Policies G-3, G-9, G-10, PROJ-6, RCM-1, RCM-2 (2006) available at: http://www.kingcounty.gov/environment/waterandland/flooding/documents/flood-hazard-management-plan.aspx

5.0 DEFINITIONS:

5.1 Large wood: The term "large wood" refers to downed trees, but does not include rooted, standing vegetation. (Large wood is also known as logs, large woody debris, coarse woody debris, snags, and large organic debris.)

5.2 Large wood placement: The deliberate placement of large wood in rivers and streams by physically depositing pieces in or near the channel, or installing them in an engineered structure, for any purpose, including flood protection, bank stabilization, mitigation, and habitat improvement or restoration.

5.3 Public safety: Unless otherwise noted, the term public safety is used in this document to reflect the safety of members of the public and water users of the rivers and streams in King County

6.0 POLICIES:

6.1 The *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers* contained in Appendix A to this public rule, which is incorporated herein by this reference, presents the processes and procedures that the Department of Natural Resources and Parks shall follow in order to properly consider public safety in the design and implementation of projects involving placement of large wood in King County rivers and streams.

6.2 This Public Rule is exempt from the rule of strict construction and shall be liberally construed to give full effect to the objects and purposes for which it was adopted.

7.0 PROCEDURES:

Action By: Department of Natural Resources and Parks.

Action: Implements the requirements of Ordinance No. 16581 (2009) by developing *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers* set forth in Appendix A of this rule.

8.0 RESPONSIBILITIES:

8.1 Department of Natural Resources and Parks.

8.1.1 Identifies projects involving the placement of large wood to which the *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers*, Appendix A to this public rule, is applicable.

8.1.2 Implements the specific procedures provided for in the *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers,* Appendix A to this public rule.

8.1.3 At least once every three years, or sooner if significant new data becomes available, convenes a group of stakeholders, including but not limited to river residents, recreationalists, tribes, river boating interests, appropriate regulatory agencies, King County sheriff office representatives, Water Resource Inventory Area representatives, and experienced project practitioners to review and comment on the *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers,* Appendix A to this public rule, and update them as needed.

9.0 APPENDICES:

9.1 The *Procedures for Considering Public Safety When Placing Large Wood in King County Rivers*, King County Department of Natural Resources and Parks, Water and Land Resources Division, December 2009 constitutes Appendix A to this public rule.

King County

PROCEDURES FOR MANAGING NATURALLY OCCURRING LARGE WOOD IN KING COUNTY RIVERS

I. Purpose

The purpose of this document is to define and document procedures that the Department of Natural Resources and Parks (Department) and the King County Sheriff's Office (KCSO) will follow in order to:

a. Investigate reports of naturally occurring large wood in King County rivers that may pose a hazard to persons, property or infrastructure;

b. Develop, document and implement action recommendations to address hazards to public safety associated with natural wood;

c. Document existing habitat conditions and changes resulting from actions taken to address hazards to public safety associated with natural wood.

d. Establish a mechanism for addressing public safety issues in the design, monitoring, maintenance and continuing management of all Department capital projects that may affect the recruitment, mobility and accumulation of natural large wood in King County rivers.

e. Inform and receive feedback from the public on County projects that may affect the recruitment, mobility and accumulation of large wood in King County rivers.

II. Applicability

These procedures apply to all reports to the KCSO and Department of potentially or known hazardous natural wood in rivers and to all Department projects that may affect the recruitment, mobility and accumulation of large wood in King County rivers. These procedures are an update and replacement for the "King County Protocol for Responding to Reports of Naturally-Occurring Large Woody Debris in Navigable Rivers and Streams", developed in 2008 and included as Appendix D in the "Report Addressing Public Safety in Placement of Large Wood in King County Waterways".

III. Definitions

Large wood: Trees or tree parts larger than four inches in diameter and longer than six feet, and root wads, wholly or partially waterward of the ordinary high water line (WAC 220-110-020 (57)). Large wood is also known as large woody material, logs, large woody debris, coarse woody debris, snags, and large organic debris.

Naturally-occurring large wood (Natural Large Wood): Large wood that has not been deliberately placed as part of any publicly or privately sponsored project.

Large wood recruitment: The action of wood deposition or accumulation by natural river processes. This action results from the delivery of natural large wood from: 1) existing individual trees or stands of trees that are downed by tree death and toppling, bank undercutting, wind-

throw and breakage, avalanches, or landslides; and 2) upstream reaches via transport by water and subsequent trapping by shoals and bars, boulders, trees, and other channel obstructions (naturally occurring or otherwise).

Emergency: A situation that poses an imminent threat to life or critical infrastructure.

King County Rivers: For purposes of this procedure, King County Rivers are those segments of rivers and streams within King County where recreational use or infrastructure are known to be prevalent or could be expected. A list of waterway segments covered, which may be subject to change pending updated information about use or river conditions, includes the following:

- South Fork Skykomish River, County Line to Foss River Confluence (RM 19.7)
- North Fork Snoqualmie River, Mouth to Big Creek (RM 12.1)
- Middle Fork Snoqualmie River, Snoqualmie Falls (RM 41) to Taylor River (RM 65)
- South Fork Snoqualmie River, Mouth to Franklin Falls (RM 27.9)
- Lower Snoqualmie River, Mouth to Snoqualmie Falls (RM 40)
- Lower Tolt River, Mouth to Forks (RM 8.7)
- North Fork Tolt River, Mouth to above Yellow Creek (RM 15)
- South Fork Tolt River, Mouth to Dam (RM 21)
- Raging River, Mouth to State Route 18 (RM 8)
- Sammamish River, Lake Washington to Lake Sammamish
- Cedar River, Mouth to Landsburg Dam (RM 21)
- Green River, Mouth to Tacoma Headworks (RM 61)
- Miller River, Skykomish River to confluence of East and West Forks
- White River, King-Pierce County Boundary (RM 5.5) to Greenwater River (RM 46) excluding the Mud Mountain Dam reservoir (RM 29.5 – RM 35)
- Greenwater River, White River confluence to Twentyeight Mile Creek (RM 5.5)
- Issaquah Creek, Mouth to SE 56th Street (RM 1.2)

IV. Background and policy context

Pacific Northwest rivers and streams have historically contained large amounts of naturally-deposited large woody materials recruited through bank erosion, channel migration, wind-throw and other causes. Wood plays a major role in channel forming, changing and stabilizing processes, including flow deflection and dampening of flood velocities, sediment and organic-matter storage, diversification of aquatic habitat conditions and the provision of flood refuge habitat for aquatic organisms. However, during the 19th and 20th centuries, logging, navigational improvements and flood control efforts resulted in the removal of most of the large wood from Pacific Northwest rivers, including those in King County. The historic removal of large wood

contributed to the degradation of fish and wildlife habitat, including habitat for species currently listed as threatened or endangered under the Endangered Species Act (ESA). It has become widely understood and accepted that encouraging large wood to recruit to and remain in local rivers is vital to the recovery of salmonid populations (a bibliography regarding the ecological role of large wood can be found on the County website). To restore some of these historic beneficial functions, some King County projects support, or actively encourage, natural processes of large wood recruitment, adjustment and deposition.

At the same time, boating and other water-oriented recreation activities have a long history in King County. Recreational users may come into contact with wood in King County's rivers and streams. It is widely recognized that riverine water sports, including fishing, wading, swimming, boating, and floating, can involve considerable risk. The level of risk is influenced by many factors, including location and positioning of instream elements, such as large wood, boulders, artificial structures and debris; flow levels, depth, turbulence, velocity, temperature, and bank form; the recreationist's health, maturity, level of experience, skill, and judgment; and the appropriateness of their vessel and associated safety equipment. Many recreational water users recognize wood as a natural feature of the river which, while requiring caution, can enhance their experiences – for example, wood can make river trips more interesting and aesthetically pleasing and can improve fishing opportunities.

Many County projects are intended to produce a more healthy, dynamic, and natural river. As a result, rivers may look and behave differently than they have in the recent past. The changes may pose unfamiliar challenges to both river managers and river users. The County is committed to maintaining public safety as a high priority in river management and to communicating with community members and stakeholders about specific projects as well as river management efforts in general. As historic practices of aggressive wood removal are understood to be inconsistent with contemporary policies and programs aimed at long term sustainability in river management, it has become clear that large wood and dynamic conditions should become more common in our waterways. In some locations, recreational use of a river may not be advisable for all users at all times as a result of the changes and dynamic nature of the river. Therefore, it is important that King County find ways to provide for public safety as rivers develop conditions more akin to what nature originally provided. The procedures outlined below represent one mechanism for King County to address that public safety need.

Specifically, these procedures explain the steps to be taken to address the risks associated with natural accumulations of wood through the combined efforts of the DNRP and KCSO. The procedures outline a systematic method for case-by-case evaluation of naturally occurring wood reported as a potential risk to public safety in our rivers. The *Wood Investigation Report* (see Attachment 1) has been developed as a standardized tool to provide consistency and guidance when KCSO and WLRD assess potential public safety risks due to natural wood in rivers.

In cases where the evaluation determines that the public safety risk is low, King County may choose not to modify naturally recruited wood. In cases where the evaluation determines that the wood poses a high risk to public safety, resulting in a recommendation to take mitigating actions that may include modifying or removing the wood, the actions taken by the county must be done in a manner that is consistent with all applicable federal, state, and local policies and regulations,

and may require mitigation. Actions to modify natural wood accumulations in a fish-bearing river or stream must be permitted in a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife (WDFW). As state law requires there be no net adverse impact to habitat, any changes resulting from the county's actions to modify wood will need to be described and quantified sufficiently to develop commensurate mitigation.

In addition, these procedures make a distinction between natural wood accumulations, and natural wood accumulations that occur on, or as a result of, County-sponsored projects. Where a DNRP capital project may affect the recruitment, mobility and accumulation of natural large wood in King County's rivers, the success of a project may be affected by how wood is managed on the site. As a result, project outcome, grant funding, and the success of other County programs could be jeopardized by the decisions made in response to large wood recruitment on project sites. Therefore, the procedures outline a proactive approach for considering public safety in all phases of the project, including design, monitoring, maintenance and continuing management. Guidance is provided through a set of standardized tools used at key stages of project implementation:

- Project Design: An *Instream Project Design Checklist* (see Attachment 2) will be completed by the design team to address public safety during the design phase of any new project where recruitment of wood is an expected or intended outcome. In order to proactively plan for public safety in the design, an *Instream Project Design Checklist* will be used to compile relevant information about the project purpose and site characteristics, including instream and adjacent land uses, geomorphology, flood patterns and ecology.
- Project Monitoring, Maintenance, and Adaptive Management: The design team will prepare a *Public Safety Management Plan* (see Attachment 3) to define potential risks to public safety as the site evolves following construction, and to guide the County's adaptive management response to changes on the ground or in the water. This management plan will be implemented through the project monitoring and maintenance programs and in response to reports of potential log hazards.

Actions taken by the County must be done in a manner that is consistent with all applicable federal, state, and local policies and regulations. Examples of King County policies that pertain to large wood in rivers and streams, related primarily to the goals of flood risk reduction, salmon recovery, and watershed restoration, include:

- King County Comprehensive Plan policies E-405, E-406, E-408, E-422, E438, E-471, supporting watershed restoration and protection to support river and stream ecological processes;
- King County Council adopted salmon recovery plans for Water Resource Inventory Areas 7, 8, and 9 (King County Council Action 2005 and 2006) and Federally Approved Endangered Species Act Chinook Salmon Conservation Plan (2007);
- King County Flood Hazard Management Plan (King County Council Action 2007) policies G-3, G-9, G-10, PROJ-6, RCM-1, RCM-2, and other references.

This set of procedures and guidance tools is one element among several County efforts and interests related to public safety and management of our rivers, including flood hazard management, habitat restoration, and recreation. As to the safety of recreational users of rivers and streams in King County, it should be noted that the decision to recreate in rivers is ultimately the responsibility of each individual. Current and future efforts to enhance awareness through public education and outreach by the State, County, and non-governmental organizations will complement these procedures for addressing public safety needs, and are perhaps the most important strategy for reducing risks for recreational river users.

V. PROCEDURES:

1. Reporting Concerns about Naturally-Occurring Large Wood in River Corridors

All reports of potential public safety risks associated with large wood (LW) in a King County waterway should be directed to "911" if urgent, or (206) 296-3311 if not urgent. Reports will be forwarded to the designated point of contact in the King County Sheriff's Office Marine Unit (KCSO).

2. Preliminary Assessment

KCSO will make a preliminary assessment of the potential risk posed by the LW and determine if the situation requires an emergency or a non-emergency response.

If the location of the wood is outside of unincorporated King County, the KCSO will refer the report to the communications center for the appropriate jurisdiction. On request, King County will provide technical support to the local jurisdiction.

A. Emergency Conditions

- If the KCSO determines that there may be a life-threatening situation or an immediate threat to public or private property or infrastructure, requiring an emergency response, they will take immediate steps to secure public safety.

- Emergency measures may include, but are not limited to:
    - Dispatching rescue personnel,
    - Closing the waterway to recreational use until the emergency situation can be addressed,
    - Issuing public notification via web posting, signage and news outlets, and
    - Removing or relocating the wood.

- Emergency actions involving physical modifications of wood in and adjacent to rivers and streams require prior permit approval from the Washington Department of Fish and Wildlife (WDFW), and may also require subsequent mitigation actions.
    - WDFW may issue verbal HPA approval for emergency work to alter naturally recruited wood, and allow for completion of permit requirements after the emergency action. Emergency permit approval from WDFW may be obtained by calling (425) 775-1311 or contacting the Area Habitat Biologist during business hours or calling 360-902-2537 after hours. Contact information for the Area Habitat Biologist can be found at: http://wdfw.wa.gov/conservation/habitat/ahb/.
    - Photo-documentation showing the large wood positioning before and after physical modifications is recommended to provide a basis for development of appropriate mitigation actions.
    - Habitat conditions should be assessed to inform final permit approval, either as

part of the response or as a follow-up action.

- The KCSO may request assistance from King County Water and Land Resources Division (WLRD) in conducting an emergency response.

B. Non-Emergency Conditions

- KCSO will:
  - Perform an initial site investigation, verify the location of the wood, and make a preliminary assessment of the potential hazard;
  - Initiate a standard KCSO *Incident Report*;
  - Consider factors relevant to instream risks, such as position of the wood within the channel, threat to public and private property and infrastructure, flow conditions, typical recreational use and timing, adjacent land uses, and physical characteristics of the wood within the context of the site; and
  - Transmit a copy of the *Incident Report* to the designated point of contact in the Water and Land Resources Division (WLRD).

3. Evaluate Potential Public Safety Risks and Recommend Response Action(s)

A. Risk to Instream Users

If the KCSO's preliminary assessment determines that the wood poses a risk to public safety for instream users (e.g., recreationists), warranting action by the County:

- KCSO will:
  - Contact WLRD, provide information on the findings of the preliminary assessment, and set up a joint site inspection.

- WLRD will:
  - Determine if the wood is associated with a King County Project, and subject to guidance under a project-specific *Public Safety Management Plan*; and
  - Determine if wood is known, or appears, to be associated with a non-King County project, and if so, will consult with the project owner, to the extent feasible.

- KCSO and WLRD will:
  - Perform a joint site investigation (normally within 24-72 hours depending on level of perceived risk) to evaluate the risk posed by the wood using the *Wood Investigation Report*;
  - Estimate the expected longevity of the wood in its present configuration;
  - Jointly develop an action recommendation for reducing the risk - action recommendations should be guided by the *Public Safety Management Plan* for wood associated with a King County project, if applicable, or by findings of Wood Investigation Report for non-project related wood; and
  - Document the findings of the risk evaluation and the recommended action(s).

- Actions should be selected to mitigate the risk to public safety while minimizing disturbance to the river. Actions may include, in general order of preference, site monitoring, installation of informational or warning signs, pruning portions of the large wood pieces, closure of a river reach, or repositioning or relocation of large wood pieces.

- Geomorphologists, engineers, ecologists and permit agency staff, will participate in the site investigation to assist in site assessment, permitting, development of response alternatives and determination of commensurate mitigation, as necessary.

B. Risk to Adjacent Lands Affecting Residences, Businesses, or Infrastructure

If the KCSO's preliminary assessment determines that risks to instream users posed by the wood are avoidable, but that the wood may pose a risk to other people, property, or infrastructure on adjacent lands:

- KCSO will:
  - Inform WLRD of their findings; and
  - Complete the *Incident Report*.

- WLRD will:
  - Initiate a *Wood Investigation Report*;
  - Perform a site investigation (normally within 24-72 hours depending on level of perceived risk);
  - Determine if the wood is associated with a King County Project, and subject to guidance under a project-specific *Public Safety Management Plan*.
  - Determine if the wood poses a risk to public safety (e.g., flood hazard) for infrastructure, critical facilities, people or property based on the *Wood Investigation Report*;
  - Estimate the expected longevity of the wood in its present configuration;
  - Develop an action recommendation, if warranted, for reducing identified risks; and
  - Document the findings of the risk evaluation and the recommended action(s).

- Actions should be selected to mitigate the risk to public safety while minimizing disturbance to the river. Actions may include, in general order of preference, site monitoring, installation of informational or warning signs, pruning portions of the large wood pieces, closure of a river reach, or repositioning or relocation of large wood pieces.

- Action recommendations:
  - Should be directed by *a Public Safety Management Plan* for any wood associated with a King County project; or
  - Should be determined by the findings of the *Wood Investigation Form* for non-project related wood.

- Geomorphologists, engineers, ecologists and permit agency staff, will participate in the

site investigation to assist in site assessment, permitting development of response alternatives and determination of commensurate mitigation, as necessary.

4. Short Term Action Response

If recommended actions will involve physical modification of instream or project-related features, such as repositioning wood or installing signage:

- WLRD will:
  - Implement interim river safety measures as needed;
  - Post hazard warning information on the King County website if the response action cannot be completed within one week of the determination;
  - Evaluate the ecological function of the wood within the context of the site or reach in order to inform the development of mitigation actions;
  - Seek applicable permit approvals to implement action recommendations;
  - Work with permit agencies to establish required mitigation actions;
  - Oversee construction or contracting for completion of the work; and
  - Notify the KCSO about anticipated timing and techniques involved in implementation.

- KCSO may choose to:
  - Issue bulletins or news releases or disseminate informational materials to advise the public of the potential risks of wood in the waterway - press releases issued by King County may be posted to King County's "Flooding Topics" web page at www.kingcounty.gov/flood and to the Regional Public Information Network (RPIN) at www.rpin.org;
  - Use its authority, under King County Code 12.44, to close a waterway or portion of a waterway to recreational use, either temporarily or indefinitely, if they determine its use may pose a significant risk to public safety;
  - Contact the King County Office of Emergency Management (OEM) Duty Officer at 206 296-3830 (24-hour number) to notify of the wood situation; or
  - Request assistance from OEM for resources necessary to implement recommended actions.

King County will not perform actions without appropriate safety measures in place for employees. Permit approvals are required for modification of wood or other instream features, which includes but is not limited to an HPA from the WDFW and, where occurring in state-owned aquatic lands, consultation with Washington Department of Natural Resources. If it is determined that the recommended action is not feasible, does not meet permit requirements, or cannot safely be implemented, then WLRD and KCSO will select another course of action from the list of potential actions.

5. Long Term Risk Mitigation

KCSO and WLRD will work together to promote river safety over the long term through planning and outreach efforts that will include pro-actively considering the consequences of natural wood accumulation at a project site during project design; increasing public awareness about the presence, function and risks of wood in rivers; promoting the use of appropriate equipment and preparation when making recreational choices; and managing allowable uses within King County's waterways.

- KCSO and WLRD will coordinate efforts to:
    - Periodically monitor reported or placed wood that remains in the river to observe changes in condition over time - new conditions may warrant a new site investigation and re-evaluation;
    - Discourage or prevent risky behaviors in waterways through educational campaigns, media, websites, or other outreach tools; and
    - Inform the public of potential changes to river conditions that may affect recreation.

When designing projects that are expected or are likely to cause wood from onsite or elsewhere in the watershed to accumulate at the project site:

- WLRD will:
    - Complete an *Instream Project Design Checklist* to guide and document thorough evaluation of public safety considerations during project design and implementation;
    - Solicit public input at 30% design, as is done for placed wood per public rule;
    - Develop a *Public Safety Management Plan* to establish a proactive approach to monitoring, maintenance, and modification of the site over time in order to assure public safety and success of the project; and
    - Work with neighboring jurisdictions and the public to inform them of potential changes to river conditions that may affect instream or adjacent land uses.

6. Final Documentation

For all reports of potential large wood hazards:

- WLRD and KCSO will coordinate to:
    - Complete and maintain a record of all *Wood Investigation Report* and *Incident Reports*;
    - Contact the person who reported the wood, when known, to inform them of any action taken.

For reports of wood that is associated with a King County project:

- WRLD will:
    - Complete and maintain a record of the *Instream Project Design Checklist* and a *Public Safety Management Plan*.

Attachments:

1. Wood Investigation Report
2. Instream Project Design Checklist
3. Public Safety Management Plan Outline

APPENDIX A

PROCEDURES FOR CONSIDERING PUBLIC SAFETY WHEN PLACING LARGE WOOD IN KING COUNTY RIVERS

I. Purpose

The purpose of this document is to define and document procedures that the Department of Natural Resources and Parks will follow in order to:

a. Consider public safety issues in the design of projects involving the placement of large wood in King County rivers and streams;

b. Evaluate strategies for design of wood placements that will maximize project benefits and minimize risks to public safety; and

c. Make available to the public the opportunity to provide input on proposed projects utilizing large wood.

II. Applicability

This procedure applies to all King County Department of Natural Resources and Parks' projects involving the placement of large wood in King County rivers and streams.

III. Definitions

- Large wood: The term "large wood" refers to downed trees, but does not include rooted, standing vegetation. (Large wood is also known as logs, large woody debris, coarse woody debris, snags, and large organic debris.)

- Large wood placement: The deliberate placement of large wood by physically depositing pieces in or near the channel, or installing them in an engineered structure, for any purpose, including flood protection, bank stabilization, mitigation, and habitat improvement or restoration.

- Public safety: Unless otherwise noted, the term public safety is used in this document to reflect the safety of members of the public and water users of the rivers and streams in King County.

IV. Background and policy context

Pacific Northwest rivers and streams have historically contained large amounts of naturally-deposited large woody materials recruited through bank erosion, channel migration and wind-throw. Wood plays a major role in channel forming and stabilizing processes, physical habitat formation, sediment and organic-matter storage and the formation of flood refuge habitat. However, during the 19th and 20th centuries, logging,

navigational improvements and flood control efforts resulted in the removal of most of the large wood from Pacific Northwest rivers, including those in King County. Moreover, logging and clearing of riparian areas has compromised the future potential for large wood recruitment.

For many reasons, it is neither possible nor desirable to return to the wood clearing practices of the past, and in fact, there are many reasons King County is actively replacing wood in its rivers and streams. At the same time, boating and other water-oriented recreation have a long history in King County. Recreational users may come into contact with the wood being placed in King County's rivers and streams. It is widely recognized that riverine water sports, including fishing, wading, swimming, boating, and floating, can involve considerable risk. The level of risk is influenced by many factors, including the recreationist's health, maturity, level of experience, skill, and judgment; the appropriateness of their vessel and associated safety equipment; river conditions, such as flow levels, depth, turbulence, velocity, temperature, and bank form; and instream elements, such as large wood, boulders, artificial structures and debris. Large wood may be a potential hazard for some recreational water users, depending on its location and positioning within the channel, as well as flow levels and decisions taken by the users themselves. On the other hand, many recreational water users recognize wood as a natural feature of the river which, while requiring caution, can enhance their experiences – for example, wood can make river trips more interesting and aesthetically pleasing and can improve fishing opportunities.

The historic removal of large wood contributed to the degradation of fish and wildlife habitat, including habitat for species currently listed as threatened or endangered under the Endangered Species Act (ESA). It has become widely understood and accepted that placing large wood in local rivers is vital to the recovery of salmonid populations (A bibliography regarding the ecological role of large wood can be found on the County website). Large wood placement is frequently included as a major component of habitat restoration projects in the Puget Sound Salmon Recovery Plan, in part to compensate for the long time-lag between riparian reforestation efforts and subsequent, natural wood recruitment. Wood placement is also often required as mitigation for habitat impacts resulting from public works projects and other human activities.

Since the early 1990s, King County has placed wood in rivers for several reasons. The County places wood in rivers to improve public safety by reducing scour and erosion through the repair and maintenance of streambank protection facilities, and frequently incorporates bioengineered bank stabilization techniques that may include installation of large wood in combination with large rock and live plant materials. The function of the wood is to interact with river sediments, deflect and slow erosive stream velocities along the banks, and provide ecological benefits. In many cases, large wood is needed to comply with permit conditions.

The County also designs and constructs projects that restore the ecological function of wetlands, streams and rivers. Wood is used to improve ecological processes that create complex, productive, self-sustaining aquatic habitats. Large wood installations are necessary for implementation of King County Council approved watershed recovery plans, particularly in the absence of mature riparian corridors that would naturally recruit

wood. The intent of wood installation in this context is to capture and stabilize sediment; absorb hydraulic energy; create geomorphic complexity, such as scour pools and gravel bars; shade and cool water; retain nutrients to support a healthy fauna; and to provide spawning, rearing and foraging habitat for anadromous salmonids as well as other fish and amphibians.

Finally, federal, state, and local regulatory agencies often require King County and other applicants to install wood as mitigation for unavoidable impacts associated with transportation and flood control projects. Regulatory agencies – such as the U.S. Army Corps of Engineers, Washington Department of Fish and Wildlife (WDFW), and the County's Department of Development and Environmental Services – routinely require the placement of large wood in rivers as a condition for approval of permits and final project designs.

Whatever the specific purpose of a large wood placement project, any actions taken by the County must be done in a manner that is consistent with all applicable federal, state, and local policies and regulations. Examples of policies that pertain to the placement of large wood in rivers and streams and the goal of salmon recovery include:

- King County Comprehensive Plan policies E-405, E-406, E-408, E-422, E438, E-471, supporting watershed restoration and protection to support river and stream ecological processes;
- King County Council adopted salmon recovery plans for Water Resource Inventory Areas 7, 8, and 9 (King County Council Action 2005 and 2006) and Federally Approved Endangered Species Act Chinook Salmon Conservation Plan (2007);
- King County Flood Hazard Management Plan (King County Council Action 2007) policies G-3, G-9, G-10, PROJ-6, RCM-1, RCM-2, and other references.

Moreover, up to fifteen permits or environmental review processes are commonly needed for projects in unincorporated King County, including: Hydraulic Project Approval (HPA), National Environmental Policy Act, State Environmental Policy Act, Clean Water Act Section 404, Rivers and Harbors Act Section 10, Endangered Species Act Section 7, Critical Areas Ordinance, clearing and grading permits, and others. Not all permits are required for all projects. The HPA, administered by the WDFW, is the most commonly needed permit for work in rivers, streams and wetlands, and is the most frequent permit to require large wood placement to reduce or mitigate environmental impacts of a project.

It is within this policy and regulatory context that the proposed procedure addresses public safety in King County rivers. This procedure explains the steps to be taken in the design and decision-making process as it relates to public safety, and identifies specific opportunities for the incorporation of public input. The County recognizes that input from knowledgeable members of the public may help to inform the design teams in their efforts to produce projects that meet the County's primary design objectives while minimizing risks to public safety.

As to public safety as it relates to recreational users of rivers and streams in King County, it should be noted that the decision to recreate in rivers is ultimately the responsibility of each individual. Enhancing awareness through public education and outreach – whether by the State, County, or non-governmental organizations – is perhaps the most important strategy for reducing risks for recreational river users.

V. Procedure for considering public safety in the development and design of capital projects that include placement of large wood in rivers and streams in King County

1. Responsibility and use of the procedures

The Department will coordinate the implementation of this procedure. This section describes the process for considering public safety in the development and design of capital projects involving the placement of large wood in King County rivers and streams. The process includes opportunities for public input. Some procedures may need to be modified or streamlined for emergency situations, such as urgent repairs to flood protection facilities. The Department will ensure that, in implementing the rules, the procedures and design options affording the greatest safety for river users shall be of primary consideration in design concerns involving a balancing of important public purposes as the county addresses safety issues in large wood emplacements and other in-stream designs.

2. Assess recreational uses, potential project impacts on public safety, and develop project design

The Department's project design teams rely on sound engineering and design practices in the development of all Department projects and consider a wide range of public safety issues, including recreational safety, as well as potential flooding and erosion effects on infrastructure, neighborhoods, critical facilities, and other land uses. The responsibility for design decisions rests with the County's multi-disciplinary design teams and licensed professional engineers. All projects must be designed to meet their important underlying goals and objectives. Within the context of those goals and objectives, public safety will be of primary consideration in selecting design alternatives.

King County design teams refer to many relevant technical guidance documents in the course of project design, including but not limited to, the King County Guidelines for Bank Stabilization Projects in the Riverine Environments of King County and the State of Washington's Integrated Streambank Protection Guidelines and Stream Habitat Restoration Guidelines. Potential impacts of large wood on public safety are considered on a case-by-case basis during project development and design. Recreational use information and other stakeholder input will be sought during the conceptual design phase (up to approximately 30% design).

A. Conceptual (0%-30%) Design Phase

During the conceptual design phase (resulting in approximately 30% plan development), the design team assembles information and considers the design

objectives, constraints, risks (including, but not limited to, risks to public safety), and potential solutions. Analyses of alternatives may be conducted during this phase and the design team may consider a range of design options for large wood placement. By the conclusion of the conceptual design phase, each project should be developed sufficiently to describe the basic details of wood placement (e.g., number and type of installation, location, approximate size). Project managers will seek input from the public during this phase, when it can most effectively be included in design considerations. The specific mechanisms for sharing information and soliciting public input are described in detail in Section V.3 .

The following describes key steps during the conceptual design phase.

i) In designing the placement of wood in the project, the project team will gather available information and take into account the expected type, frequency and seasonality of recreational uses as an important element in its overall consideration of impacts to public safety of the proposed project.

ii) Consideration of public safety in the conceptual design will include but not be limited to the following factors: the location, orientation, elevation, and size of the wood placement, the method of anchoring or securing the wood placement, the degree of interaction between flowing water and the placed wood during projected flow regimes, including flows commonly experienced in the recreational seasons, and input received through the public outreach process.

iii) In designing the specific placement of large wood, the design team will seek to maximize achievement of stated project goals and objectives while minimizing potential public safety risks, including risks to recreational users, and will seek to ensure that the procedures and design options affording the greatest safety for river users are of primary consideration in design concerns involving a balancing of important public purposes as it addresses safety issues.

iv) Conceptual project designs will be informed by standard design practices with input from professional designers with expertise in fluvial geomorphology, ecology, river hydraulics and civil engineering with hydraulic analysis expertise.

v) All projects that incorporate large wood in rivers and streams will undergo review and approval of engineering plans and analysis from a Licensed Professional Civil Engineer.

vi) All projects that incorporate large wood with the stated objective of providing ecological benefits will undergo review and approval from a professional ecologist (i.e., persons with an advanced degree in aquatic and/or biological sciences from an accredited university or equivalent level of experience).

At the conclusion of the conceptual (30%) design phase, the project manager will document how public safety considerations have been addressed in the design, including why and how any impacts to recreational safety in particular can be or have already been avoided or reduced through the design of the project. Factors that will be addressed may include, as applicable, wood stability and anchoring technique; intended function of placed wood features and how they meet projects goals and objectives; expected longevity and recruitment potential; and a brief description of other design alternatives that may have been evaluated as part of an alternatives analysis.

At the conclusion of the conceptual (30%) design phase, the Department will:

- Update the project list (described in Section V.3, Public Outreach) to reflect project-specific outcomes of the conceptual design; and
- Share the updated list with the public via the procedures described below in Section V.3, Public Outreach.

If the Department determines the project is unable to successfully meet its goals and objectives while minimizing risks to public safety, it may choose to employ any of the following options:

- Work with the King County Sheriff's Office to alert river users to potential hazards using signage or other means, or to restrict use in the project area so that the project can meet its objectives while also protecting public safety; or
- Modify the project to further reduce public safety risks and concurrently implement mitigation measures (such as additional large wood placement at a comparable location in the same river reach) to fulfill the project goals and objectives; or
- Reconsider the scope of the project and whether to proceed or relocate the project, if possible, to an alternative site where objectives and public safety concerns can be fully achieved.

Not all of these options are applicable to all projects, and it will be the responsibility of the Department to make an appropriate selection.

B. Conceptual to Final (30%-100%) Design Phase

In this design phase, the design team will complete any remaining technical studies, refine the project design, and obtain permits.

If the Department determines that substantial changes to the large wood design have occurred during finalization of the design, as a result of permit submittals or other design factors, the Department will:

- Disseminate new design information to, and seek input from the public as appropriate.
- Update documentation of the project design and public safety considerations.

3. Public outreach

Public outreach is intended to reach a broad spectrum of the community, including river user groups, environmental groups, tribes, cities and other public agencies, river residents and property owners, emergency responders and numerous others. The goal of this effort is to keep the public informed and, at the same time, allow for two-way communication between project managers and the public. The Department's public outreach effort for each project using large wood will include one or more of the following: website information, e-mail notification, and public meetings.

A. Development of project list/database

The Department will develop and maintain a list of projects where large wood will be or is likely to be installed in a King County river or stream. This project list will be updated every year and made available by request and via the county website or e-mail notifications. For each project, the project manager will develop the following information for use in the public outreach process:

- Brief project description, including approximate type and amounts of wood expected to be used;
- Location of project;
- Primary purpose of the project and its relative importance to the success of County programs and mandates;
- Project goals and objectives;
- Existing project site conditions;
- Type, intensity and seasonality of recreational uses, if known;
- Intended function of the wood, including identification of how wood meets project goals and objectives;
- Project status and timing of conceptual design input opportunities; and
- Timing of planned and completed project construction.

B. Website information or e-mail notifications

The public outreach process will make use of the King County website or e-mail notifications to the public and interested stakeholders to provide the following types of information:

- Notices of upcoming public meetings;
- Documents, including these procedures, and other pertinent policy or technical documents;
- List of pending projects that are expected to utilize large wood, and notice of opportunities to comment;

- List of completed projects;
- Contact information for project managers; and
- Other resources and information, as appropriate.

The notification process will, at a minimum, include an electronic mailing list that will be established for this purpose. Interested individuals will be able to sign up for e-mail notifications. Printed/mailed notifications may also be used.

Annual notifications will provide a copy or web link to the comprehensive project list/database.

C. Public meetings

The department will hold two meetings every year to discuss the project list. The meetings, though similar in content and intent, will be held at different times and locations to enhance public involvement. One meeting should be held during daytime/business hours, and the other during evening hours. Department staff will describe the project list and each project's status as well as opportunities for public input. Conceptual designs for each project will be presented when available. Attendees will be invited to ask questions and engage in discussion with appropriate staff about the project list.

4. Monitor project outcome and apply adaptive management strategies

- The Department will conduct post-construction monitoring to assess overall project effectiveness and safety, including relevant changes in the function, location, orientation, elevation, and size of the placed wood. The need for, and feasibility of, any maintenance or retrofitting will also be assessed, including any anticipated regulatory requirements. The scope, timeframe and schedule for post-construction monitoring will vary according to project need and availability of funding.
- Monitoring and adaptive management will be used to assess whether any new actions at the sites of large wood installations are warranted. Actions may include:
    a. Issuing bulletins or news releases or disseminating informational materials to advise the public of the potential risks posed by placed large wood in the river; or
    b. Signing a river or a project site as potentially hazardous and warranting particular caution, notifying the King County Sheriff's Office who may impose use restrictions, or both; or
    c. Removing or altering the position of structural components of the placed large wood in order to further reduce any associated risk. This step may require additional regulatory review, permitting, and mitigation actions.
- The Department will provide for periodic independent monitoring and inspection of large wood emplacements by an appropriate third-party provider. This additional monitoring effort will be conducted every three years on a representative sampling of

large wood emplacement projects. Reports of such inspections shall be provided to the Department and to all King County Council members.

5. Final Documentation

- The Department will maintain electronic or paper records of all relevant large wood project documentation in accordance with existing local and state record-keeping requirements for project information, including documentation of public input and any resulting project modifications.

Appendix B: International River Scale of Difficulty

International Whitewater Boating Rating System

Source: http://www.americanwhitewater.org/content/Wiki/safety:start?#class_i_rapids Accessed, January 6, 2015

This is the American version of a rating system used to compare river difficulty throughout the world. This system is not exact; rivers do not always fit easily into one category, and regional or individual interpretations may cause misunderstandings. It is no substitute for a guidebook or accurate first-hand descriptions of a run.

Paddlers attempting difficult runs in an unfamiliar area should act cautiously until they get a feel for the way the scale is interpreted locally. River difficulty may change each year due to fluctuations in water level, downed trees, recent floods, geological disturbances, or bad weather. Stay alert for unexpected problems!

As river difficulty increases, the danger to swimming paddlers becomes more severe. As rapids become longer and more continuous, the challenge increases. There is a difference between running an occasional class-IV rapid and dealing with an entire river of this category. Allow an extra margin of safety between skills and river ratings when the water is cold or if the river itself is remote and inaccessible.

Examples of commonly run rapids that fit each of the classifications are presented in the attached document, "International Scale of River Difficulty - Standard Rated Rapids." Rapids of a difficulty similar to a rapids on this list are rated the same. Rivers are also rated using this scale. A river rating should take into account many factors including the difficulty of individual rapids, remoteness, hazards, etc.

Difficulty Classes

Class I Rapids: Fast moving water with riffles and small waves. Few obstructions, all obvious and easily missed with little training. Risk to swimmers is slight; self-rescue is easy.

Class II Rapids: Novice: Straightforward rapids with wide, clear channels which are evident without scouting. Occasional maneuvering may be required, but rocks and medium-sized waves are easily missed by trained paddlers. Swimmers are seldom injured and group assistance, while helpful, is seldom needed. Rapids that are at the upper end of this difficulty range are designated “Class II+”.

Class III- Intermediate: Rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe. Complex maneuvers in fast current and good boat control in tight passages or around ledges are often required; large waves or strainers may be present but are easily avoided. Strong eddies and powerful current effects can be found, particularly on large-volume rivers. scouting is advisable for inexperienced parties. Injuries while swimming are rare; self-rescue is usually easy but group assistance may be required to

avoid long swims. Rapids that are at the lower or upper end of this difficulty range are designated "Class III-" or "Class III+" respectively.

Class IV- Advanced: Intense, powerful but predictable rapids requiring precise boat handling in turbulent water. Depending on the character of the river, it may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. A fast, reliable eddy turn may be needed to initiate maneuvers, scout rapids, or rest. Rapids may require "must" moves above dangerous hazards. Scouting may be necessary the first time down. Risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. Group assistance for rescue is often essential but requires practiced skills. A strong eskimo roll is highly recommended. Rapids that are at the lower or upper end of this difficulty range are designated "Class IV-" or "Class IV+" respectively.

Class V- Expert: Extremely long, obstructed, or very violent rapids which expose a paddler to added risk. Drops may contain large, unavoidable waves and holes or steep, congested chutes with complex, demanding routes. Rapids may continue for long distances between pools, demanding a high level of fitness. What eddies exist may be small, turbulent, or difficult to reach. At the high end of the scale, several of these factors may be combined. Scouting is recommended but may be difficult. Swims are dangerous, and rescue is often difficult even for experts. A very reliable Eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential. Because of the large range of difficulty that exists beyond Class IV, Class 5 is an open-ended, multiple-level scale designated by class 5.0, 5.1, 5.2, etc. Each of these levels is an order of magnitude more difficult than the last. Example: increasing difficulty from Class 5.0 to Class 5.1 is a similar order of magnitude as increasing from Class IV to Class 5.0.

Class VI- Extreme and Exploratory Rapids: These runs have almost never been attempted and often exemplify the extremes of difficulty, unpredictability and danger. The consequences of errors are very severe and rescue may be impossible. For teams of experts only, at favorable water levels, after close personal inspection and taking all precautions. After a Class VI rapids has been run many times, its rating may be changed to an appropriate Class 5.x rating.

Appendix C: Stakeholder Meeting Attendees and Meeting Notes

Countyline Levee Setback Project
Third Party Review of Recreational Safety
February 18, 2015
Stakeholder Meeting #1 – Sign-in Sheet

Name	Organization	Email or Phone
Larry Fisher	WDFW	larry.fisher@dfw.wa.gov
Martin Fox	Muckleshoot Tribe Fisheries	martin.fox@muckleshoot.nsn.us
John Baas	MIG	JBaas@migcom.com
MIKE GRIJALVA	River Safety Council	
Chris Brummer	King County	
Jeanne Stypula	King County	jeanne.stypula@kingcounty.gov
Sarah McCarthy	King County	sarah.mccarthy@kingcounty.g

Countyline Levee Setback Project
Third Party Review of Recreational Safety
Stakeholder Meeting #1
February 18, 2015
10:15 a.m. – 11:45 a.m.
Algona-Pacific Library

Meeting Minutes

Attendees:
Jeanne Stypula – King County (JS)
Chris Brummer – King County (CB)
Sarah McCarthy – King County (SM)
John Baas – MIG (JB)
Mike Grijalva – River Safety Council (MG)
Larry Fisher – WDFW (LF)
Martin Fox – Muckleshoot Indian Tribe (MF)

JS welcomed attendees and asked everyone to go around the room and introduce themselves. After introductions, CB gave a presentation of the project background and design status. JB presented the recreational study that he and two expert boaters are performing under contract with the County. MIG developed a large wood (LW) rating system (A through F) for navigation and safety hazards related to LW. JB noted there is currently not much natural wood in the channel, most is on the margins and on bars. There is expected to be an initial 6' drop into the wetland after levee removal. Boaters entering the new channel would encounter three new apex engineered logjams (ELJs) after descending this drop and would need to navigate around them and then turn right at the biorevetment. MIG's preliminary recommendations include signage, increasing line-of-sight distances, and considering moving the three apex ELJs. JS wrapped up the presentation by going over the schedule and requesting stakeholder comments by 2/23 so they could be provided to MIG and incorporated onto the risks assessment report. A draft of the report will made available to stakeholders before a second meeting to discuss the draft. The meeting was then opened up for discussion.

MG (to JB): what did your boaters have to say about ELJ design?

JB: they focused on placement in the channel and avoidance.
MG: In 2011 at 30% design level, RSC said they do not want to see rootwads in the design. The County's guidelines were amended in 2009 to say County no longer installs rootwads facing upstream. The biorevetment design is "scary" with rootwads sticking out. He cited County ordinance that "safety for recreational users shall be of primary consideration…" He then asked where habitat forms in the river.
MF: we want pools to scour underneath, with a mat of wood overtop. This occurs along the margin of logjams.
MG: Does the shape of the front of the ELJ matter? Bridge piers are smooth and they trap wood. Use smooth piles to trap wood. Why do we need trapping structures?
MF: wood is in short supply. Restoration can't move forward without adding wood. The location of the three apex ELJs could be changed to provide better sightlines.
CB: the rootwads provide habitat and hydraulic roughness to slow down flow and prevent channel migration into setback levee. There is also a shortage of key logs right now. The ELJs function as key logs by providing stable hard points and jumpstarting the process of forming forested islands (like the canyon reach upstream) where mature trees can grow that will later supply key logs.
MG: there is a whole wetland of trees and no shortage of wood. Only put in piles, no rootwads.
LF: The County is concerned about recreational safety and is investing money in MIG, who has expertise to evaluate recreational safety and hazards.
MF: this design has not brought up any red flags for safety because of the alluvial fan. Expects the thalweg to shift back to the right and avoid areas with wood because the wetland will likely fill with a lot of sediment.
MG: At the upper bridge (A Street), there is a logjam on the right side and water goes back to the right after bridge. Expects water to go to the left (into wetland, after project).
MF: the wetland will be a hazardous area (after levee removal) even without ELJs.
JB: We looked at three scenarios (existing conditions, future no-action with levee breach into wetland, and future with the project). There are very few differences in hazards between future scenarios.
MF: the ELJs will help with accelerating sediment deposition. Best thing to do now is assess sight distance.
MG: the only way to make it safe is to clear a channel.

MF: If river goes to the left, it will not be a good place to run. If the river goes to the right, there should still be open areas. This section of river could be closed to boaters until river goes right. This is a scary site for tubers, but not sure how to change that. There should be signs to warn of wood and take-outs.
LF: put a sign on the bridge.
MF: We have had closures on the Green River. If we are catering to tubers, we can't make it safe unless the site is closed.
JB: will ask experts about safe sight distance. It depends on the type of watercraft. Riding on an innertube is like riding a bike without handlebars or brakes.
CB: or is it a timing thing? How much time is needed to set up and react?
MF: 200-250 feet maybe.
MG: Doesn't see the need for having rootwads facing the current. It is dangerous. Why not cut off the rootwads?
CB: The racking and slash are not shown on the plans and will be packed into the voids so the rootwads won't be sticking out as much as is implied on the plans.
MF: Roots don't provide cover at the front, but do provide cover over a pool. Racked facing logs can help while keeping habitat underwater. Rootwads also help provide stability. Cutting rootwads can reduce stability of the logjam. What about adding logs and racking to the front to keep snagging type features away from first point of contact?
LF: cut the first four and add bumper logs.
JB: has not recommended adding facing logs in the past, but have recommended repositioning ELJs.
JS: this needs to consider flow levels.
CB: where would you put the bumper logs? Flow levels will vary as gravel bars and channels shift around and as the setback area fills with sediment.
MG: bury the roots in the ground.
CB: then you would need to build a scour apron of large rock around each buried log to prevent it from being scoured out.
MG: cut off the rootwads. Then boaters can bounce off facing logs.
LF: at some point, the boaters need to take on their own responsibility.
MF: bumper logs out in front of biorevetment may also enhance pool formation while providing safety. Roughness slows water, reduces erosion and shifts swift water away from the structures.
CB: bumper logs may be buried by natural wood accumulation and/or sediment.
JS: the project will be closely monitored once it goes in.

MG: where is the documentation of adaptive management actions that will be taken if a dangerous condition develops? What is the trigger to make corrections? Fish will go where fish like it best.
LF: Rivers are dangerous. If people want to be safe, they can stay off the rivers. People are endangering fish. The County is giving the river an opportunity to restore itself. The White River spring Chinook was one of the first listed species. Steelhead numbers are dropping. Fish are not doing well.
MF: Large wood is one of the limiting factors and we can't restore rivers without adding wood. Trying to make it more benign (for boaters.) could add a huge cost if bumper logs are added. It is less likely that boaters would encounter jams on the margins. Measures could be taken to make certain areas safer with bumpers.
LF: not everywhere. For those ELJs with short sight distance, put bumper logs on corners.
JB: what kind of message does adding bumper logs to ELJs send to the boating public? Seems to say we are making the river safe for boating when it is not.
LF: Sticking rootwads out into the river is because we know they provide the best habitat. We were disappointed with the King County ordinance.
MG: Placing logs down the bank, with rootwads out of the water (showing illustration) is safe and provides better habitat than ELJs.
LF: wood can occur naturally like that, but not always. The rootwad is the best habitat.
MF: individual pieces, if small, don't stay in the system. Large pieces can, but won't stay individual for long. High flows reposition pieces, and large pieces form clusters. Recommend monitoring. If installed ELJs don't recruit enough wood, then lash bumper logs. We don't need bumper logs on all ELJs.
LF: agrees with Martin.
JB: Likes MF's comment on line of sight and will look into that.
MG: make safe and functional.
JS: wrapped up by reviewing schedule again and noting a target date of March 20th for the next meeting.

Meeting adjourned at 11:45.

Countyline Levee Setback Project
Third Party Review of Recreational Safety
April 16, 2015
Stakeholder Meeting #2 – Sign-in Sheet

Name	Organization	Email or Phone
Chris Brummer	King County	206-477-4655
John Baas	MIG	510-845-7549
Joe Rockhill	K.C.	206-477-1096
Larry Fisher	WDFW	larry.fisher@dfw.wa.gov
Jeanne Stypula	King County	206 477-4833
MIKE ORIJALVA	River Safety Consultant	425 213 6646
Martin Fox	Muckleshoot Tribe Fisheries	253-876-3121

Countyline Levee Setback Project
Third-party Review of Recreational Safety
Stakeholder Meeting #2
April 16, 2015
1:00 a.m. – 2:45 a.m.
Algona-Pacific Library

Meeting Minutes

Attendees:
Jeanne Stypula – King County (JS)
Chris Brummer – King County (CB)
Joe Rochelle – King County (JR)
John Baas – MIG (JB)
Mike Grijalva – River Safety Council (MG)
Larry Fisher – WDFW (LF)
Martin Fox – Muckleshoot Indian Tribe (MF)

JS welcomed attendees and asked everyone to go around the room and introduce themselves. Copies of the draft risk assessment report were distributed to attendees. After introductions, CB gave a brief presentation to recap the work done thus far under the third-party review by MIG and to update attendees on the schedule moving forward for this work. JB then presented the results and recommendations of the third-party review by talking through tables 2 and 3 in the draft risk assessment. JB noted the relative risks ratings presented are qualitative. The assessment assumed the river would avulse into the wetland in the future without the project and there would be localized areas of relatively higher velocities with or without the project. The recommendations included informational measures such as posting signs at put-ins and along the river to inform boaters of take-outs upstream of the project. Regarding the sight distance for the three ELJs at the wetland inlet, MIG recommends repositioning the ELJs to achieve a stream-wise spacing of 200-300 feet and a cross-channel spacing of 200 feet. Also, LW with "E" and "F" hazards should be mapped annually and reported on County's website for the public. CB wrapped up the presentation by going over the schedule once again and requesting stakeholder comments by 4/30/15 so they could be provided to MIG and

incorporated onto the final risk assessment report that we would like to complete by May 13. The meeting was then opened up for discussion.

MG: what is the purpose of the 3 ELJs?
CB: in the earlier design, their function was to split up and deflect flow away from the occupied property to the east. The County has since recognized this property is at risk from flooding and has purchased the property. The risk is now less, but we still want the ELJs to split up flow so it is not focused at one point on the biorevetment.
LF: Where do people put in?
MF: Not sure, maybe Game Farm Wilderness Park or Roegner Park.
CB: Tom O'Keefe said most people take out at or before the BNSF bridge. I have taken out there twice.
JB: From our put-in at RM 10.5, down to RM 6.0, the river is a very nice and scenic run. Downstream it is flatter and less interesting because it is confined by levees and runs through an urban and industrial area.
LF: would the signs (recommended by MIG) at Parks (put-ins) inform users of take-outs?
JS: yes.
JB: my experience is that signs need to be at multiple locations and observed several times by users to get the message across. Social media and personal contact are also effective means. RM markers can also help people get oriented to their location and upcoming (posted) hazards. Users interviewed during our upper Wenatchee study said they did not want RM markers to spoil the natural setting.
MF: How many trees did the County's wood budget estimate?
CB: the wood budget estimated about 600 trees per year coming through the project reach, and that number is expected to quadruple in the future due to wood recruitment when flows come into the wetland.
MG: why do you need the biorevetment along the entire edge? Why do you need sharp things sticking out? These could snag people or animals. How would a deer (for example) ever get out if it was trapped in the wetland? Belmondo design is a safe structure providing habitat. Why not make structures with smaller logs. What about the 500 trees that will be removed, why not make logjams out of them?
CB: we are allowing up to 50% of the smaller racking material to be sourced from the trees that will be removed from the existing levee; however, they are mostly cottonwood and alder and will rot in a few years. They are not suitable for the key

member logs in the ELJs. The biorevetment is needed to prevent channel migration into the riparian buffer and setback levee.
JS: the remaining wood could be chipped and used for mulch by contractor.
MG: you could put the pools in with and excavator (no need for ELJs).
CB: they would fill with sediment right away. You need something to continuously scour them out. ELJs also provide stable islands for conifers to grow.
LF: are you aware of the eagle nest in the wetland?
JS: Yes. We submitted an eagle management plan to USFWS.
MF: leave as many trees on levee as possible, while removing rock from around them. Natural processes of wood recruitment should be allowed to occur. This is the only natural reach remaining on the lower White River. Leave some rock if it means leaving more trees. This approach worked well at the Larson project to keep shade and riparian structure.
MG: There is no answer again to why rootwads are needed. What is the safety rating for inner tubers heading toward rootwads?
JB: five of the nine river features we evaluated had a high risk rating and did not involve large wood. The MIG boaters emphasized striving for channels wide enough for boaters and with an adequate line of sight before hazards. These are issues of visibility and position.
MG: a mile of rootwads is a high risk.
MF: Did boaters comment on safe log types?
JB: I prompted the boaters several times to comment on the design features. Each time they came back with recommendations and measures (visibility and position) that would allow boaters to avoid hazards. They did not recommend bumper logs and did not comment on wood along margins.
MG: bumper logs might not be effective on these large structures.
JB: it's about positioning, visibility, and line of sight.
MF: did they consider less-skilled recreationalists?
JB: yes, we focused on novice boaters and tubers.
MG: are there any safe designs in the literature?
LF: I'm not aware of any.
JB: I'm not either.
MF: how wide should channel be? Is there a minimum width (for boaters)?
JB: Boaters said 10' is too narrow. I can check data from the Yakama study to see what percent projected into the channel and still allowed safe width.

MG: there is a Laura Blackmore 2009 presentation cited in the 2012 MWH report. Do you have that?
JS: we will see if we have a copy.
MG: John – would you design these structures with rootwads?
JB: I am not a designer. I only rate risk.
JR: Jeanne – what are the next steps?
JS: the public safety management plan will incorporate the MIG report and consider all safety elements. It will include a plan to monitor, inspect, and maintain the site. It will include a plan for adaptive management involving coordination with jurisdictions. We expect this to be completed in May and made public. Then we will prepare the 90% plans and specs, constructability review, 100% plans and specs in the fall.
MG: has this project ever been presented publically in Pacific?
JS: Yes. We presented this project and the right bank project at a public meeting in October 2013 in the city gymnasium.
CB: The Executive Committee of the Flood Control District held their monthly meeting in this same room, I think in 2013 as well. The Countyline project was presented. The meeting was attended by some members of the public and by the mayors of Pacific and Sumner.
MG: the project sounds fine except for the rootwads.
JS: they are for flow deflection, cover over pools, and to protect the biorevetment from channel migration.
MF: The rootwads are for stability. We need structural stability without compromising function.
CB: we don't know exactly where the river will shift along the biorevetment over time. The rootwads have multiple habitat benefits and are hydraulically rough and push the thalweg away from the bank. This creates slackwater that is beneficial to rearing salmonids, which is the main habitat function of the project.
MF: Brian Collins' report discussed wood loading. It was high before area was settled. We will never get back to that condition. Now with the rootwads, they should be in the interior of the structure, over the pools.
LF: pools will form around ELJs.
CB: the pools will form at the front and sides of the ELJs. That is exactly where the design has placed the rootwads – over these pools that are expected to form.
MG: consider smaller ELJs like this (holding up sketch) with fewer piles and narrower.

CB: A structure like that would need to be properly engineered to address loading from wood accumulation. There are many factors involved: pile bending moment, pile shear, pile depth to resist scour – which depends on surface area and would increase with wood loading on the upstream end.
MF: wood won't accumulate without something to catch on to. ELJs act like key logs to catalyze wood deposition.
MG: the three small ELJs will form one large logjam and block flow.
CB: MIG recommends they be spread out and repositioned for better sight distance. We can reposition them farther from the wetland inlet, but in applying the recommended 200'-300' sight distance, we start to become constrained and shorten the sight distance from them to the biorevetment. So there needs to be a balance here.
LF: there will need to be adaptive management to address public safety.
MF: would any habitat elements be compromised by the MIG recommendations.
JS: no. Are there any more questions or concerns?
JB: Then I will look into safe width guidelines and if there are any safe boater guidelines.
JS: thank you everyone. Please send any further comments to Chris by April 30th.

Meeting adjourned at 3:00.

MUCKLESHOOT INDIAN TRIBE
Fisheries Division
39015 - 172nd Avenue SE • Auburn, Washington 98092-9763
Phone: (253) 939-3311 • Fax: (253) 931-0752

February 19, 2010

King County Department of Natural Resources and Parks
ATTN: Cathy Jimenez
201 S. Jackson Street, Room 600
Seattle, WA 98104-3855

RE: Public Review Draft and Rule January 4, 2010: Procedures for Considering Recreational Safety When Placing Large Wood in King County Rivers

Dear Ms. Jimenez:

Thank you for this opportunity to comment on the proposed procedures and rule referenced above. Their purpose is to implement Ordinance 16581 adopted by the King County Council in 2009. This ordinance directed the King County Department of Natural Resources and Parks (DNRP) to establish procedures to consider recreational safety in projects involving large wood placement in streams, and facilitates public input on projects using large wood design elements. The rule and procedures apply to restoration and mitigation projects managed by the DNRP. Affected streams ("Designated Recreational Waterways") under the proposed rule include all of the most important lower elevation freshwater anadromous fish habitats in King County.

We believe that by implementing this rule, the County will, in effect, prioritize river recreation over the required restoration of salmon habitat in King County. As indicated in earlier correspondence[1], the Muckleshoot Indian Tribe Fisheries Division is concerned that the rule and procedures will discourage the use of wood in fish habitat mitigation and restoration projects and/or result in design restrictions that inhibit the natural habitat processes and functions that create and maintain salmon habitat in rivers and streams. To the extent that implementation of this rule limits and restricts the placement and location of wood and subsequent natural wood recruitment, wood transport, and jam formation, it will limit restoration of habitat productivity and capacity for salmon and steelhead populations in King County.

We are concerned that the rule's purposes *"to evaluate strategies for design of wood placements that minimize risks to recreation while maximizing project benefit to fish habitat"* are in conflict. The procedures state that these design considerations *" will include but not be limited to ...the location, orientation, elevation, and size of the wood placement, and the overall degree of*

[1] September 8, 2008 Muckleshoot Indian Tribe Fisheries Division briefing paper to the County Council's Growth Management and Natural Resource Committee

interaction between flowing water and the placed wood during flows commonly experienced in the recreational seasons." These are the very design factors that need maximum flexibility to mitigate or restore fish habitat. Restrictions on these factors will reduce or eliminate fish habitat benefits. For example, it is the degree of interaction between wood and flowing water that creates pools, and promotes gravel retention, hydraulic and geomorphic complexity, and floodplain connectivity required for high quality fish habitat. As the interaction between flowing water and wood is reduced, so are benefits to fish habitat and habitat forming processes. The proposed procedures will likely result in project design compromises that handicap implementation of the WRIA 8, 9, and 10 salmon habitat plans previously adopted by the National Marine Fisheries Services as part of the Puget Sound Chinook Recovery Plan, as well as handicap mitigation activities needed to lessen the effects of development.

Specific examples of how implementation of the proposed rule will harm fish habitat in King County include prohibitions in placing spanning logs, logs along the outer river bends, large jams, wood extending into the river current, and blanket requirements for anchoring. These prohibitions will result in substantial trade-offs against the functional value of wood placement in habitat restoration and mitigation projects. Restrictions on wood placement, as well as the repositioning or removal of naturally-recruited wood, will further limit fish production potential by permanently curtailing those natural processes that create and maintain productive aquatic habitat, *i.e.*, those that promote high salmon reproduction, growth, and survival rates.

As reflected in the scientific references list prepared by the DNRP (Large Wood References draft v. 12/31/09), large wood is a key natural component of salmonid habitat. In the Puget Sound Chinook Recovery Plan (Shared Strategy Development Committee 2007), the National Research Council states that *"Perhaps no other structural component of the environment is as important to salmon habitat as is large woody debris, particularly in coastal watersheds"*. Restoring large woody material to salmon habitat is a widely used management tool that aims to recover natural process of dynamic river flow and formation of important habitat features such as bars, pools and side channels (Bob Lohn, NOAA, January 25, 2005 letter to Martha Parker). Minimum wood sizes and quantities necessary to provide adequate fish habitat have been defined by resource agencies including the National Marine Fisheries Service and others (see *e.g.*, Fox and Bolton 2007). Wood levels and recruitment rates in the County's rivers and streams do not currently meet these standards by a long shot, and therefore wood is rated a factor of salmon population decline (Shared Strategy Development Committee 2007). The wood shortage results in long reaches of rivers and streams with few pools, constant water velocity, poor gravel stability, a lack of hiding cover from predators, and an inability to form high quality fish habitats needed to restore salmon and steelhead production and survival in King County waterways. WRIA 8 and 9 salmon habitat plans and WRIA limiting factors reports addressing local government Endangered Species Act responsibilities acknowledge the need to increase natural wood recruitment and wood placement.

Hundreds of river miles in King County already exist where land development, dams, industrial forestry, water withdrawals, transportation and flood control infrastructure have taken priority over natural floodplain and river processes to the detriment of natural salmon and steelhead

production. With the proposed rule and procedures, river recreation is now added to this list of priorities for river management within King County at the expense of salmon habitat.

In Section 3, Definitions, Identified Recreational Waterways, the Identified Recreational Waterways listed include all lower elevation major streams in the County, including the entire Cedar River below Landsburg, the entire Green River below the Tacoma Headworks, the entire Sammamish River, the White River from the County line to Greenwater River spanning the Muckleshoot Indian Reservation, and the lower 12 miles of the Greenwater River designated as Recreational Waterways. This list unfortunately allocates to river recreation all the most important and productive lower elevation anadromous stream habitats in the County. All these river segments, except for the White River along much of the Muckleshoot Indian Reservation (MIR), have been depleted of their characteristic natural wood loads. In recognition of Tribal jurisdiction on the reservation, we request that the White River along the MIR be removed from the list and exempted from this rule in order to allow for any potential future DNRP wood placement projects that may be implemented in cooperation with the Tribe. In addition, we recommend that the stream segments associated with the Muckleshoot Tribe's Usual and Accustomed Fishing Area, which includes WRIAs 8, 9, and 10, be removed from the list of Identified Recreational Waterways. The Tribe relies on the quality and quantity of habitat in these rivers to support its treaty protected salmon harvest. While this rule affects only DNRP projects, it is this agency that will likely continue to be the lead county agency implementing stream restoration and river-related projects. Therefore, the proposed rule would have a large impact on future habitat conditions in these rivers.

Section 3, Recreational Uses and Project Design, subsection vii, states that *"All projects that incorporate large wood with the stated objective of providing ecological benefits will undergo review and approval from a professional ecologist (i.e., staff with an advanced degree in aquatic and/or biological sciences from an accredited university)."* As written in the procedures, this review would occur at the 30% conceptual design stage, but we recommend that the ecologist also review the final design stage given a likelihood of further design changes, as well as conduct a post-construction review. The ecologist reviewing and approving projects should have more specific qualifications including graduate level coursework in fluvial geomorphology, fisheries, and aquatic ecology, and should not be affiliated with the project proponent or funding source (e.g. independent review). The reviews by the ecologist should clearly document, and if possible, quantify, the resulting tradeoff made between recreation and an alternative design that would maximize aquatic habitat benefits. The post construction review by the ecologist should be distributed to the Tribe and agencies as well as any grantors funding these projects.

We recognize that any standards and procedures restricting effective wood placement or natural wood recruitment will impose a permanent impact on habitat restoration potential for salmonids, and this impact will be difficult or impossible to mitigate with alternative habitat restoration measures. As part of the adaptive management plan for this rule, shortfalls in habitat quantity and quality that result from implementing the proposed procedures should be assessed and fully documented, and alternative mitigation provided-- including increases in artificial salmon

production if equivalent habitat mitigation opportunities are unavailable. While increased natural salmon production is a goal shared by many, the proposed rule will likely constrain efforts to increase the abundance of naturally produced salmon in King County rivers.

In closing, we are concerned that implementation of this rule will have an extreme negative impact on future salmon habitat restoration efforts and natural salmon production capacity in King County. Thank you, again, for the opportunity to comment on this important issue. For additional information or questions related to this letter, please contact Holly Coccoli at (253) 876-3360 or holly.coccoli@muckleshoot.nsn.us.

Sincerely,

Glen St Amant
Habitat Program Manager

cc: NMFS (Steve Landino)
USFWS (Tom McDowell)
WDFW (Stewart Reinbold)

References

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.

DRAFT Responses by King County to Specific questions about the White River Countyline setback project (received via email on 4/21/15):

How long is the biorevetment on the river left side?

The biorevetment consists of 108 units that are 40' long each, so the total length is approximately 4,300 lineal feet.

Will the biorevetment serve as the outside of a bend?

Portions of the biorevetment may coincide with the outside of meander bends that may form in the setback area. The locations where meander bends may flow along the biorevetment are expected to change over time.

Will the current flow along the biorevetment?

Yes, it is anticipated that current will flow with seasonal variability at different levels (i.e. low flows and flood flows) along portions of the biorevetment because the lowest ground is located along the eastern edge of the wetland (where the biorevetment will be located). The velocity of the current flowing along the biorevetment will vary by location and over time due to changing river conditions.

How many root wads will be exposed and out into the current?

Due to the variability of how much of the river will flow into the setback area, where new channels may form in the setback area, and where natural large wood will accumulate, it is not possible to estimate with confidence how many rootwads (placed and natural) will be exposed in the current at any particular time after construction.

How many total root wads will interact with the flow along the entire project?

Due to the variability of how much of the river will flow into the setback area, where new channels may form in the setback area, and where natural large wood will accumulate, it is not possible to estimate with confidence how many rootwads will interact with flow at any particular time.

Do these root wads pose the possibility of entrapment?

Rootwads impose a level of risk comparable to encountering LW with a rating of "D" or higher using MIG's rating system. For large wood with a "D" rating or higher, active navigation is required to avoid contact. The consequences of contact are uncertain and could be serious. Entrapment within the placed rootwads and within the natural wood expected to accumulate is always a possibility. The likelihood of entrapment would depend on boater skill, awareness of river conditions, location of the rootwads in the channel, the angle of rootwads relative to the current, current strength and velocity, and the complexity (single versus multiple logs) and the roughness of the rootwad. The relatively low average velocity of 1.6 feet per second anticipated in the project reach and the repositioning of the three apex ELJs to provide sight distances of 200 to 300 feet will reduce the likelihood of serious consequences (such as entrapment) if floaters encounter rootwads and other natural large wood in the project reach.

Will the root wads all be trimmed of all sharp projections?

No, the rootwads placed as part of the project are meant to mimic natural large wood and will not be trimmed of all sharp edges. Project features including the ELJs and biorevetment will be subject to annual and post-flood inspections, which will include conditions of public safety. The naturally occurring wood, which is expected to be deposited in the project site, will also be inspected. Any actions to make repairs or modifications to the project features would be evaluated as a part of the annual and post-flood inspections.

Is the purpose of the root wads to make the water more turbulent, which could make navigation more difficult?

No. Although rootwads engaged with the flow may produce localized turbulence (defined as the variation in fluid pressure and flow velocity in both space and time – and experienced by boaters as areas of swirling or chaotic water), the primary purpose of the rootwads is not to produce turbulence that could make navigation more difficult. The primary purposes of the rootwads are to provide complex cover from predators for juvenile and adult fish, increase the surface area for macroinvertebrate communities consumed by fish, increase the roughness of the bank to slow velocities and concentrate nutrient drift consumed by macroinvertebrates and fish, and to provide a quiescent resting place for drift-feeding fish. The added roughness from rootwads also reduces the potential for bank erosion and channel migration into the riparian buffer and setback levee. As to ELJs, the rootwads also function as racking material to fill the voids between the key logs and reduce flow through the face of the ELJ that may produce a straining effect. Furthermore, the incorporation of rootwads into biotechnical techniques for bank protection is encouraged by the Integrated Streambank Protection Guidelines (Chapter 6 and Appendix I) and by the Washington Administrative Code [WAC 220-660-130(1)(b) and 220-660-370(1)] in order to mimic natural processes.

How easy will it be for a tuber to avoid the root wads, and make it safely to the left shore?

As indicated above, some of the rootwads have a rating of "D" or higher and will require active navigation to avoid contact, which could be challenging for a tuber, depending upon tuber experience. The likelihood of avoiding contact with rootwads and making it safely to shore would depend on flow velocity, sight distance, channel width, water depth, streamwise spacing between each apex jam, and the amount of natural wood accumulation and vegetation restricting access to the left shore.

Is a portage path available along the left shore?

Other than the access road on top of the setback levee, there will be no formally maintained trails within the project area. The project interior (riverward of the biorevetment) will be restored to allow natural channel-forming processes to occur, which will result in changing river conditions and the variability as to where the "left shore" will be at any particular time. Opportunities for portage within the project interior will be similar to those found along other natural river segments in King County.

Is a portage path available along the right shore?

Yes. The project will not alter the existing trail along the right bank of the White River. This trail is readily accessible from multiple locations along the river and can be used to portage around the project site.

What is the specific danger score for the biorevetment?

Portions of the biorevetment could be rated as a type "E" because there are three or more characteristics that could increase the potential for interaction (e.g., projection > 5' into flow, angled 30 to 90 degrees to flow, high roughness, short site distance, and high current power).

What is the specific danger score for ELJs, #1-8?

The worst-case scenario for any apex jam would be "F," requiring portages if most of the water pushes into a blocked channel. More likely, the proposed apex jams would fall into the "E" or "D" categories at most flows. As indicated above, LW rated as a "D" require floaters to engage in "active navigation" (at least one substantial positive maneuver) to avoid contact (i.e., "routine navigation" may not be sufficient to avoid). The consequences of contact are uncertain and could be serious.

How many logs are expected to come into the project area in a year?

The wood budget study completed by King County in 2011 estimated that about 640 logs pass through the project reach each year under existing conditions. Under future conditions, with or without the project (conservatively assuming a complete avulsion of the river into the wetland during a moderate flood event), an additional 1,140 logs and 200 downed trees could be recruited to the river. The study estimated that about 1,300 of these logs could leave the site under this scenario, which would result in about 680 logs deposited in the project area. Over the next decade, about 350 logs (from upstream sources and from on-site recruitment) are expected to deposit in the project reach each year, with about 200 logs reaching the Stewart Road Bridge each year.

Where is it likely that all those logs will end up the first year?

It is possible that natural large wood will accumulate in the existing channel downstream of where flow will enter the wetland, on the apex ELJs in the wetland, on some of the bank deflectors along the east side of the wetland, on gravel bars and shallow areas that may form in the wetland, on the bank deflectors at the south end of the wetland, and on the Stewart Road bridge piers. One of the functions of the ELJs is to retain large wood in the project reach to reduce wood loading on bridges and infrastructure downstream of the project.

How big a log jams do you need in this area to match the average in the mile above this area?

The existing quantity of large wood in the river, one mile upstream of the project reach, has not been measured. The wood budget estimated the potential for wood recruitment from the floodplain and delivery to the project reach but did not include an inventory of large wood already in the river.

How do you predict the position of log jams in the future 50 years of the anticipated life of the project?

The ELJs are anticipated to function as stable hard points for about 50 years, so their positions are anticipated to remain fixed at the location where they are constructed. The position of natural log jams in 50 years can be expected to form on gravel bars, side-channel inlets, and the outside of meander bends, but the exact locations cannot be predicted with confidence.

Do you think a danger sign at the top of this project will prevent all floaters from entering this area?

No. The purpose of a sign upstream of the project reach (in addition to other public outreach efforts by the County) will be to characterize and communicate potential hazards in the project reach and provide information for avoidance so that recreational users can make an informed decision about their actions. Previous surveys on the Upper Wenatchee River by MIG indicated river recreationists support having signage about potential LW at put-in locations. The efficacy of signage can be increased by incorporating the following messaging:

1. **Usage of a signal word (e.g., 'Danger' or 'Warning')**
2. **Hazard Statement (e.g., 'Logjams Ahead')**
3. **A brief description of consequences of non-compliance (e.g. 'Passage beyond this point may result in serious injury or loss of life')**
4. **Information on how to avoid hazard (e.g., 'Exit river right')**

How many accidents a year, of floaters being entrapped by root wads, is an acceptable number?

In accordance with the Public Rule, the Department of Natural Resources and Parks employs a number of procedures to minimize risk, but cannot eliminate all risks. We do not have a number that is acceptable with regard to floater accidents near or around rootwads.

Does turbulence of water and scour of gravel in this specific area, rate as more important than public safety?

No. Turbulence and scour of gravel to create pools do not detract from the ability of the design to meet the project's public safety goals of reducing flood hazards, bank erosion, and channel migration. As stated above, the purpose of the rootwads is not to produce turbulence or scour gravels.

What does it mean in King Co Guidelines for Bank Stabilization, page 7-24, when it says: this configuration NO LONGER USED due to SAFETY CONCERNS?

In April 2009, the River Safety Council was discussing the document, "King County Guidelines for Bank Stabilization Projects" and the RSC made the following recommendation: "we recommend the document remain on the web until a new revision come[s] out because of widespread use and the potential for older versions being acquired and shared electronically." The change requested by the RSC at that time was to have Figure 7.16 and Figure 8.11, as stated by the RSC "reimaged with a suitable disclaimer that they [King County] are no longer recommended because of hazards to river users (or similar statement)." The change to the electronic version on the web was made by King County to reflect the RSC's request. The figures are sketches that depict a generalized placement of a single row or single piece of large wood with an attached rootwad that is secured with only a rock toe. The Countyline project design does not include a single row of placed wood. ELJs and the biorevetment have interlocking wood pieces placed in layers and secured to vertical piles designed to provide structural stability against buoyancy, hydraulic, and earth pressures during the design flood. Additionally, the spaces between the rootwad logs will be packed with smaller racking wood.

What does it mean in Herrera guidelines for Recreational Users and Public Safety Checklist: B. structural hazards (hazards associated with structure: size height, log locations, log orientation)?

1. Does the structure have protruding log members that will pose an entrapment risk?

2. Does the structure have the potential to act as a sieve or strainer?
3. Does the structure have entrapment potential?

This document is unfamiliar to us and was not developed for the Countyline project. Please refer questions regarding this document to the authors.

Additional questions added by email on 4/22/15:

What is the width of the exit lane from the project that you show as a narrow slot between standing trees and a continuous line of sharp roots sticking out into the current, which will accelerate here?

The width of the channel excavated as part of construction (as shown on the 60% design plans) is approximately 125 feet, which is about the same width as the existing river channel.

How many logs would it take to jam this section?

Natural log jams form depending upon the size and volume of pieces delivered to an area of the river, by flow patterns and flow competent enough to move large woody material, and depending on the unique flow patterns at any given competent flow to orient wood pieces and allow for their accumulation into a jam. The number of logs to create a jam in this general location cannot be estimated with any confidence because it would depend on the size of available logs and flow conditions.

Appendix D

Countyline Levee Setback Project – Public Safety Management Plan Summary
Matrix of Hazards and Risk

Countyline Levee Setback Project - Public Safety Management Plan Summary Matrix of Hazards and Risk

Hazard	Existing & Future Conditions without Project			Post-project Conditions			Relative Change in Risk
	Consequence	Probability of Occurrence	Risk	Consequence	Probability of Occurrence	Risk	
Sediment deposition	Loss of flood conveyance increases the probability of the other hazards occurring.	High - sediment deposition will continue to occur.	High	The same amount of sediment will accumulate over a larger area, slowing aggradation rate. Reserve design freeboard will accommodate futreflood conveyance losses.	High - sediment deposition will continue to occur.	Low	Decrease
Flooding	The 100-year flood event impacts 200 residental properties ($70 M) today and 700 properties ($200 M) after 15 years of continued sediment aggradation if the project is not constructed.	High - previous and ongoing sediment deposition will increase the frequency of flooding.	High	Protection from flooding for some properties and lower flood elevations in the project reach. Some properties downstream of the project that currently flood will continue to flood.	Low	Low	Decrease
Avulsion	Loss of portions of Stewart Road SE and 142nd Ave E, property damage, damage to buried utilities, and possible injuries or loss of life.	High - previous and ongoing sediment deposition will increase the probability of an avulsion during a moderate flood event.	High	Not applicable. The project is designed to prevent an avulsion through the left bank for flows less than the 500-year event.	Negligible	None	Decrease
Channel migration	Loss of levee and access road, Loss of city stormwater pond, undermining of Stewart Road bridge abutments, property loss along wetland margin.	High - previous and ongoing sediment deposition will increase the probability of channel migration.	Moderate	Not applicable. The project is designed to prevent channel migration through the left bank for flows less than the 500-year event. No change in consequence on right bank.	Negligible on left bank. Low on right bank due to dispersal of flow into seback area.	None on left bank, low on right bank.	Decrease
Large wood accumulation	Damage to the waterline suspended under the Stewart Road bridge, increased risk to river recreational users.	High - a levee breach and avulsion will recruit and deposit large wood in the wetland and on downstream bridge piers.	Moderate	Damage to the waterline suspended under the Stewart Road bridge, increased risk to river recreational users.	High - split flow into the setback area under controlled conditions will recruit large wood.	Moderate	No Change
Damage to levees and revetments	Increased flooding and channel migration, temporary loss of flood protection.	High - segments of levees currently overtop annually.	Moderate	Not applicable on left bank. No change in consequence on right bank	Negligible on left bank. Low on right bank due to dispersal of flow into seback area.	Low	Decrease
Damage to stormwater facilities	flooding and channel migration into Pacific stormwater pond. Ponded stormwater must be pumped when check valves are closed. Backater flooding up BNSF culvert.	Medium	Moderate	flooding of Pacific stormwater pond on right bank. Ponded stormwater must be pumped when check valves are closed.	Medium	Moderate	Decrease (for BNSF culvert)
Damage to Roads	Loss of portions of Stewart Road SE and 142nd Ave E. Flooding of Butte Ave and roads around Pacific City Park.	High - due to ongoing sediment deposition.	High	Flooding of Butte Ave and roads around Pacific City Park.	Medium	Moderate	No Change
Damage to Railroads	Temorary saturation at toe of railroad embankment	High - due to ongoing sediment deposition and levee breach.	Low	Temorary saturation at toe of railroad embankment.	Low - due to lower future flood elevations.	Low	No Change
Damage to the A Street SE bridge	Loss of bridge support at abutments due to channel migration and bank erosion caused by sediment deposition and wood acumulation on bridge pier.	Medium - due to ongoing sediment deposition and wood acumulation on bridge pier.	Moderate	Loss of bridge support at abutments due to channel migration and bank erosion caused by sediment deposition and wood acumulation on bridge pier.	Medium	Moderate	No Change
Damage to the Stewart Road SE bridge	Damage to water main beneath bridge. Loss of abutments due to bank erosion caused by sediment deposition and wood acumulation on bridge piers.	Medium - due to ongoing sediment deposition and wood acumulation on bridge piers.	Moderate	Damage to water main beneath bridge. Loss of abutments due to bank erosion caused by sediment deposition and wood acumulation on bridge piers.	Medium, but slightly higher due to reduction in freeboard and likely increased wood loading first few years after construction, thereafter less wood loading.	Moderate	No Change
Damage to downstream bridges	Minor amounts of wood accumulation on pile bents or banks.	Low	Low	Minor amounts of wood accumulation on pile bents or banks.	Low	Low	Decrease
Damage to utilities - Stewart Road SE Bridge	Damage to water main under Stewart Road SE Bridge from debris impact or bridge failure.	High	Moderate	Damage to water main under Stewart Road SE Bridge from debris impact or bridge failure.	High the first few years after construction due to reduction in freeboard and likely increased wood loading, thereafter less wood loading.	Moderate	No Change
Damage to utilities - Stewart Road SE, east of bridge	Exposure of buried utilities during avulsion through Stewart Road SE.	Low	Low	Not Applicable	Negligible	None	Decrease
Damage to utilities - A Street SE and BNSF bridges.	Damage to utilities during bridge failure.	Low	Low	Damage to utilities during bridge failure.	Low	Low	No Change
In-water recreational safety	Injury, drowning.	Low - due to small number of river recreational users.	Moderate	Injury, drowning.	Low - due to small number of river recreational users, signage, posting river conditions on County website, and increased monitoring and public outreach.	Moderate	No Change
Damage to private property	Property damage due to flooding and channel migration.	Medium	Moderate	Property damage due to flooding and channel migration.	Low - due to increased flood protection	Low	Decrease

Appendix E

White River Countyline Reach – Project Effectiveness Monitoring Plan. July 11, 2013 Draft

WHITE RIVER COUNTYLINE REACH

PROJECT EFFECTIVENESS MONITORING PLAN

RM 5.0 (8TH ST. E BRIDGE) TO RM 6.3 (A ST. SE BRIDGE)

DRAFT

July 11, 2013

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PROJECT SUMMARY

The Countyline Reach of the Lower White River is bounded by the A Street SE and Burlington Northern Santa Fe (BNSF) Railway Bridges at the upstream end (River Mile 6.3) and the 8th Street East Bridge at the downstream end (RM 5.0), and is so named because it spans the King-Pierce County boundary. Portions of this reach fall within the City of Auburn, City of Pacific, City of Sumner, and unincorporated Pierce County.

King County has two discrete proposed levee setback projects within the Countyline Reach: the Countyline Levee Setback Project on the left bank looking downstream and the Right Bank Levee Setback Project on the right bank looking downstream. The Countyline and Right Bank projects will reconnect approximately 115 and 25 acres of floodplain, respectively, to the White River channel, for a combined total of 140 acres in this reach of the Lower White River. Both projects involve property acquisition, levee removal and setback, and floodplain enhancement and restoration. Both projects are designed to reduce flood risk, restore natural river processes, reconnect the river to its adjacent floodplain, and improve fish rearing habitat.

The Countyline Levee Setback Project (left bank) is scheduled for construction from May 2015 through November 2016, and is the focus of this monitoring plan at this time. The Right Bank Levee Setback Project is entering the conceptual design phase and may begin construction by 2017. Baseline monitoring will support design of both projects, and monitoring techniques for the Right Bank project are expected to be the same. Preliminary post-project monitoring results from the left bank project will help inform project design for the right bank.

PROJECT SETTING

The lower White River is a highly modified system. The White River historically flowed into the Green River in the City of Auburn. In 1915, the Auburn Wall was built to permanently divert the White River into the Stuck River channel, a substantially smaller distributary channel that flowed to the Puyallup River. The new channel was enlarged by dredging to accommodate White River flows.

The White River carries a high sediment load because it originates on the Emmons and Winthrop glaciers on Mount Rainier and flows through a high gradient channel through most of its length, eroding through relatively new glacial and volcanic deposits. A marked decrease in channel gradient and valley confinement downstream of the White River canyon near the City of Auburn causes the river to deposit sediment, where a broad alluvial fan has formed. Channelization and construction of a confining levee system in the early 1900s in this broad and naturally depositional alluvial fan environment probably increased the vertical rates of sediment accumulation within the channel. The historical human response to this was a consistent river management program of sediment removal to maintain river channel capacity (Herrera 2010).

Cessation of gravel removal in the late 1980s probably contributed to channel aggradation within the confines of the levees in the lower reaches of the White River.

PROJECT JUSTIFICATION

Habitat Restoration

The levees and their riprapped banks have reduced access to side channels and floodplain wetlands, reduced the quality of channel edge and riparian habitat for fish, aquatic species, and other riparian wildlife, reduced the supply of large wood to the active river channel, and changed the way the river transports and deposits sediment. Channelization associated with the levees has shortened the White River's length.

The lower White River today is geomorphologically simple relative to historic conditions. River habitat is mostly fast-water riffles or runs, with very few pools or off-channel habitats. The lack of slow water areas with good cover results in poor habitat for juvenile salmon, making the lower river less productive for many species at critical life stages.

The need for rearing and off channel salmonid habitat in this reach of the White River is documented in the Puyallup Watershed (WRIA 10) and Chambers/Clover Creek Watershed (WRIA 12) Salmon Habitat Protection and Restoration Strategy (Pierce County 2008). This report notes:

> *"The loss of floodplain habitat that is limiting the performance of Puyallup and White River Chinook is due to the channelization and confinement of the river within an extensive system of revetments and levees (flood works) in the mainstems of the Puyallup, White, and Lower Carbon Rivers. Preferred projects in the mainstem areas would protect and restore floodplain habitat such as side channels and backwaters." (Page 17)*

The Strategy identifies lack of this type of habitat as a bottleneck in meeting basin-wide recovery goals for Chinook salmon and concludes:

> *"Levee setbacks and estuarine habitat creation are the most beneficial types of actions needed for recovery of Chinook in WRIA 10." (Page 21)*

WRIA 10/12 conducted a levee setback feasibility study in 2008, and the Countyline Levee Setback Project was a highly ranked project for its potential to recover lost flood storage and provide aquatic habitat for juvenile salmon rearing habitat (GeoEngineers 2008). The project was also added to the WRIA 10/12 3-Year Implementation List and ranked as having a high benefit to salmon.

Flood Risk Reduction

Problems associated with channel aggradation became increasingly clear during the January 2009 flood, when the U.S. Army Corps of Engineers released up to 11,700 cubic feet per second (cfs) of water from behind Mud Mountain Dam, as had been done in past floods. However, flood damage in 2009 along the Countyline Reach of the Lower White River was much greater than damage during previous floods, with flood damage to over 100 homes in the White River Estates neighborhood, along with several commercial businesses on Butte Avenue and the Megan's Court Apartments near the Pacific City Park. On the left bank, floodwaters inundated agricultural lands in the City of Sumner and overtopped 8th Street E (also known as Stewart Road SE); a major arterial.

Subsequent investigations by King County and Herrera Environmental Consultants have revealed that the channel flood capacity in the Countyline Reach of the White River has decreased from 25,000 cfs in the 1980s (when channel capacity was maintained by dredging) to 8,000 cfs. The channel is projected to completely fill with sediment at the King-Pierce county line in about 15 years, significantly increasing the flood risk for commercial, industrial, and residential parcels adjacent to and downstream of the project area. Analyses indicate that gravel removal would have a relatively minor and short-lived effect on reducing flood water levels in the Countyline Reach, especially when compared with reduced flood levels achieved with a setback levee. The 8th Street E Bridge in Sumner, which has two in-channel piers and little remaining clearance from its low chord, significantly constricts flows and will be at increased risk of overtopping or failing during high flows. The left bank levee currently overtops near the county line at 3,500 cfs, and flows escape the wetland at 7,500 cfs, flowing down 142nd Street and over 8th Street East. The most recent hydraulic model of the 100-year flood event shows one third of the flow (5,000 cfs) moving through this area (Herrera *in preparation*).

PROJECT GOALS AND OBJECTIVES

The Right Bank Levee Setback Project goals and objectives have not yet been developed, but are expected to be similar to the left bank project. The goals of the Countyline (left bank) Levee Setback Project were written to complement goals in both the WRIA 10/12 Salmon Habitat Protection and Restoration Strategy (Pierce County 2008) and the King County Flood Hazard Management Plan (FHMP, King County 2006). Protection and reconnection of floodplain habitat and fluvial processes is expected to support the productivity of freshwater life stages of salmonids, and floodplain reconnection projects have been identified by the Puyallup/White Watershed (WRIA 10) as the highest priority for lower White River Chinook habitat protection and restoration (Pierce County 2008). Floodplain reconnection and levee setbacks are key strategies in the FHMP for reducing flood risks while working with natural riverine processes. These techniques are also thought to be less costly over time than traditional structural approaches to flood hazard management (King County 2006).

The goals and objectives of the Countyline Levee Setback Project are:

Goal 1

Restore riverine processes and functions to the lower White River and its floodplain within the project area (inside the levees) in order to enhance salmonid rearing habitat, in particular for spring and fall Chinook, coho, and steelhead.

Objectives:

1. Allow natural channel movement within the project area by removing and setting back the existing levee along the left bank.
2. Encourage the formation of off-channel rearing habitat (pool complexes and side-channels), such as through installation and future natural recruitment of large wood, that will promote the return of the complexity, diversity, and morphology found in an unconstrained floodplain.
3. Provide off-channel flood refuge for salmonids by allowing a more natural frequency of inundation of the floodplain complex during flood events within the project boundaries.
4. Protect existing mature riparian buffer areas and restore a corridor of mature riparian vegetation within the project boundaries to provide shoreline and stream channel shading, invertebrate prey supply, and large wood recruitment.

Goal 2

Prevent an increase in flood hazards outside of the project area due to this restoration project and, if possible, reduce existing flood hazard.

Objectives:

1. Design the project to ensure flood hazards (on private property or public infrastructure) outside of the project area do not increase due to the project.
2. Increase flood storage along the length of the project which will also have a net benefit on flood elevations in the immediate vicinity of the project, particularly the right bank.
3. Avoid or minimize the need for sediment management actions.

Goal 3

Design and construct a project that best meets the goals and objectives of the project using the most cost-effective means.

Objectives:

1. Evaluate individual and collective project components based on cost-effectiveness and ability to achieve the goals and objectives primarily for salmonid habitat but also for flood hazards.

2. Avoid or minimize the need for remedial actions (habitat restoration or construction to avoid or repair public damage) by incorporating self-sustaining habitat restoration and flood hazard reduction components in the design.
3. Work with landowners to negotiate acquisitions or conservations easements.
4. Work with all stakeholders, including the City of Pacific, City of Sumner, and Pierce County, Washington State Fish and Wildlife, the Puyallup Tribe and the Muckleshoot Tribe throughout the project to foster project support and a clear understanding of any needs or issues.

PROJECT ACTIONS

Because the lower White River is highly modified and constricted, the approach to resolving existing flood risks focuses on increasing flood flow and sediment load capacity. The strategy is two-fold: (1) acquire land rights (fee or easements), and (2) implement capital improvements to modify levees and retrofit revetments so that the river is reconnected to its floodplain. This will increase flood conveyance and storage as well as accommodate sediment deposition. Returning the lower White River to a more naturally functioning floodplain will improve aquatic and wildlife habitat. Levees will be reconstructed along an alignment set back from the current active channel, large wood structures will be installed to disperse adversely erosive flows and provide complex habitat, and native vegetation will be planted to eventually provide a healthy riparian buffer. These flood-risk reduction objectives are framed in the 2006 FHMP and are consistent with recommended salmon habitat recovery actions present in the WRIA 10/12 Salmon Habitat Protection and Restoration Strategy (Pierce County 2008).

PERFORMANCE STANDARDS

Monitoring objectives and performance standards are designed to determine project effectiveness (Table 1).

Table 1. Performance standards.

Category	Indicator	Objective	Performance Standards[1]	Adaptive Management
Project Implementation	As-built condition	Project is constructed according to design specifications and regulatory conditions.	As-built condition satisfies design objectives.	Adjustments to meet design specifications made during construction.
Channel Dynamics	Movement	Channel complexity (e.g., sinuosity, formation of multiple channels) will increase.	New channel(s) form outside of the present (pre-project) active channel.	Consider measures to initiate a flow path through appropriate means.
Habitat Benefit	Aquatic habitat	The area of slow-water edge habitat will increase.	Sum of slow-water (<1.5 ft/sec) bar, bank, backwater and side channel area increases by >50%, relative to baseline condition.	Project objective not met.
		The area of floodplain inundation will increase.	Floodplain inundation within the project area will increase after project construction, as measured between February 1 and March 31 utilizing aerial photography.	Consider measures to promote floodplain inundation.
	Wood	Wood loading will increase over baseline condition.	Wood loading (natural and placed) on site meets or exceeds NMFS recommendation for properly functioning condition (>80 pieces/mile; NMFS 1996).	Project objective not met.
	Riparian cover	Installed plants survive.	80% survival[2] at end of Year 1 growing season for all installed trees and shrubs (excluding stakes)[3].	Additional planting or maintenance needed.
		Installed plants, as well as volunteers of desirable native woody species, form a dense canopy cover.	Cover by installed trees and shrubs, including cover by volunteers of desirable native woody species: Year 2 at least 15%, Year 3 at least 20%, Year 5 at least 40%, Year 7 at least 60%, and Year 10 at least 75%.	Additional planting or maintenance needed.
		Biorevetment allows a vegetated riparian buffer to establish between river and setback levee.	Average vegetated riparian buffer width of 75 feet.	Reconsider design approach in similar settings.
	Invasive cover	Invasive plant cover is minimized due to native revegetation and weed control.	Less than 10% invasive cover (non-regulated noxious weeds and weeds of concern) in planted areas (5% for KC Class A noxious weeds, bindweed, and knotweed). Less than 25% reed canary grass on site as a whole.	Additional maintenance needed. If reed canarygrass performance standard exceeded, plant areas with willow (cultural control).
	Wetlands	Wetland area temporarily impacted by construction is restored.	1.08 acres temporary impacts in Wetlands A and B restored to aquatic habitat condition.	To be determined depending on conditions.
Fish use	Habitat preference	Juvenile salmonids preferentially use low velocity edge habitat (specifically backwaters and side channels).	Juvenile salmonid density (or frequency of occurrence) is highest in backwaters and side channels, compared to other edge types.	Revise habitat priorities in future design considerations in Lower White River.
	Habitat capacity	Habitat capacity is increased by increasing low velocity edge habitat.	Habitat capacity at project site – estimated as the product of the average density of juvenile salmonids in edge habitats and the area of edge habitat (by type) at median rearing flows increased by >50% compared to baseline.	Project objective not met
Flood Hazard	Structural stability	Installed elements (ELJs, setback levee, biorevetment) have remained stable over their design life.	No significant damage to engineered structures that would diminish the intended design function.	Implement repairs and/or prevention measures as needed.
	Flood elevations	Flood risks outside of the project area decrease or remain the same, as compared to future conditions without the project.	The project does not directly cause damage to adjacent flood facilities, infrastructure, or private property, as compared to future conditions without the project.	Further flood risk reduction actions may be necessary. Implement repairs or prevention measures as needed.
	Channel migration	Allow natural channel movement within the project area.	Channel migration is contained within the project area.	Implement repairs and/or prevention measures as needed.

[1] Performance assessed over 10-year monitoring period, unless otherwise noted.

[2] Only installed plants count towards achieving the Survival Performance Standard; volunteers do not count.

[3] Plant survival and cover on top of the apex logjams will be assessed when access is feasible.

MONITORING STRATEGY

This monitoring plan will help evaluate the effectiveness of two levee setback projects intended to reduce flood risk and improve natural processes that create and sustain productive aquatic habitat.

MONITORING PURPOSE

An understanding of natural floodplain processes and baseline conditions is essential for planning river and floodplain restoration projects and for evaluating effectiveness (Pess et al. 2005; Ward et al. 2001). Because the science of floodplain restoration is still evolving, restoration actions should be viewed as experimental manipulations linked to explicit hypotheses (Pess et al. 2005). The purpose of this monitoring plan is to evaluate whether two large-scale floodplain reconnection projects on the Lower White River effectively meet the stated project goals and objectives and are able to meet the performance standards.

The purpose of this monitoring plan is to:

1. Ensure the projects match design specifications (Implementation Monitoring),
2. Determine whether levee setback project actions are producing the intended effects on habitat conditions, watershed processes, threatened fishes, and flood risk (Effectiveness Monitoring), and
3. Improve design, construction, and maintenance practices using monitoring results (Adaptive Management).

AUDIENCE

The primary audiences for implementation and effectiveness monitoring results include:

1. King County staff – Results will be shared to inform future project design, construction, and monitoring protocols, as well as project maintenance needs. The reporting format includes presentations, monitoring reports, and access to real-time data.
2. Regulatory agencies – Monitoring results will allow regulatory agencies to determine whether performance standards are being met, as well as inform review of future projects with similar elements. Monitoring reports will be submitted to the US Army Corps of Engineers in Years 1, 2, 3, 4, 5, 7, and 10.
3. Funding agencies and project stakeholders – Monitoring results will provide funding agencies and project stakeholders with the information necessary to determine whether funding agreements are being followed, as well as to evaluate the effectiveness of the

project at meeting funding priorities. The reporting format includes presentations and monitoring reports.

4. Scientific community – This study will add to a growing body of research into the effects of large-scale floodplain reconnection projects on channel processes and habitat conditions, as well as the efficacy of levee setbacks for flood risk reduction in depositional rivers.

MONITORING DESIGN

The project reach will be monitored before and after project implementation to measure changes in physical and biological process as well as to assess the ability of the project to meet its stated performance standards. A control reach immediately upstream between the R Street SE and A Street SE Bridges in Auburn will be used where appropriate to account for variability related to environmental fluctuations (Roni et al. 2005).

MONITORING TASKS AND OBJECTIVES

Indicators, or evaluation metrics, are proposed for each performance standard (Table 2). These indicators are intended to be used for effectiveness analyses (comparisons between time periods) and interpretation of the overall project success.

Table 2. Indicators and monitoring methods for evaluating project effectiveness.

Category	Indicator	Performance Standard	Task	Monitoring Method	Timing (Years)	Output
Project Implementation	As-built condition	As-built condition satisfies design objectives.	1	Manage construction to ensure project satisfies design objectives; Produce record drawings.	Immediately post-construction	Record drawings
Channel Dynamics	Movement	New channel(s) form outside of the present (pre-project) active channel.	2	LiDAR, aerial photography, and field survey	1, 3, 5, 10 (timing may be adjusted based on high flow events)	Mapped channel forms
Habitat Benefit	Aquatic habitat	Sum of slow-water (<1.5 ft/sec) bar, bank, backwater and side channel area increases by >50%, relative to baseline condition.	3	Map slow water areas on channel margins at flows representing 50th, 75, and 90th percentile flows during Jan-Jun	1, 3, 5, 10	Change in edge habitat area relative to baseline
		Floodplain inundation within the project area will increase after project construction, as measured between February 1 and March 31 utilizing aerial photography.	4	Georeferenced aerial photography and field ground-truthing	1, 3, 5, 7, 10; additional photography may be collected during and following high flow events	Georeferenced photograph of inundated area
	Wood	Wood loading (natural and placed) on site meets or exceeds NMFS recommendation for properly functioning condition (>80 pieces/mile; NMFS 1996).	5	Object-based image analysis (based on LiDAR and orthophotos) and field survey	1, 5, 10	Estimates of wood loading
	Riparian cover	80% survival[2] at end of Year 1 growing season for all installed trees and shrubs (excluding stakes)[3].	6	Fixed plots	1, 2, 3, 4, 5, 7, 10	Percent survival of installed plants
		Cover by installed trees and shrubs, including cover by volunteers of desirable native woody species: Year 2 at least 15%, Year 3 at least 20%, Year 5 at least 40%, Year 7 at least 60%, and Year 10 at least 75%.	7	Fixed plots	1, 2, 3, 4, 5, 7, 10	Percent cover of native installed and volunteer woody vegetation (trees and shrubs)
		Average vegetated riparian buffer width of 75 feet.		See task 4	1, 5, 10	Minimum, average, and maximum buffer width
	Invasive cover	Less than 10% invasive cover (non-regulated noxious weeds and weeds of concern) in planted areas (5% for KC Class A noxious weeds, bindweed, and knotweed). Less than 25% reed canary grass on site as a whole.		See task 7	1, 2, 3, 4, 5, 7, 10	Percent cover of invasive plants
	Wetlands	1.08 acres temporary impacts in Wetlands A and B restored to aquatic habitat condition.		See task 4	1	Wetted area
Fish use	Habitat preference	Juvenile salmonid density (or frequency of occurrence) is highest in backwaters and side channels, compared to other edge types.	8	Sample juvenile salmonids in edge habitat during rearing period	1, 3, 5, 10	Relative abundance of juvenile salmonids in discrete habitat types
	Habitat capacity	Habitat capacity at project site – estimated as the product of the average density of juvenile salmonids in edge habitats and the area of edge habitat (by type) at median rearing flows increased by >50% compared to baseline.		See tasks 3 and 10	1, 3, 5, 10	Change in habitat capacity
Flood Hazard	Structural stability	No significant damage to engineered structures that would diminish the intended design function.	9	Inspect during and following flood events and annually during low flow period	During and following flood events; Annually	Documentation, recommendations
	Flood elevations	The project does not directly cause damage to adjacent flood facilities, infrastructure, or private property, as compared to future conditions without the project.	10	See task 9. Also use channel cross sections, LiDAR, orthophotography and hydraulic modeling to monitor channel capacity.	Inspection during and following flood events. Cross sections in years 1, 3, 5, 7, 10.	Documentation, recommendations, analysis of change in bed elevation & channel capacity
	Channel migration	Channel migration is contained within the project area.		See tasks 2, 9, and 10	During and following flood events	Mapped channel forms, documentation, recommendations

MONITORING SCHEDULE

All indicators will be sampled at the project site (Table 3). A control area immediately upstream may be established and monitored for channel dynamics, slow water edge, and fish monitoring.

Table 3. Monitoring schedule.

Task	Objectives	Pre-Construction Baseline	Post-Construction Baseline	Year 1 2017	Year 2 2018	Year 3 2019	Year 4 2020	Year 5 2021	Year 6 2022	Year 7 2023	Year 8 2024	Year 9 2025	Year 10 2026
1	Record Drawings		X										
2	LiDAR/air photos*	X		X		X		X					X
3	Edge habitat	X		X		X		X					X
4	Aerial photography*			X		X		X		X			X
5	Wood loading	X		X				X					X
6	Plant survival			X									
7	Percent vegetative cover			X	X	X	X	X		X			X
8	Fish sampling	X		X		X		X					X
9	Facility inspections*			X	X	X	X	X	X	X	X	X	X
10	Channel cross-sections*	X		X		X		X		X			X

*Additional sampling may be conducted during and following high flow events

MONITORING PROTOCOLS

PROJECT IMPLEMENTATION

Upon completion of the projects, the design drawings will be updated to become record drawings. The information for these record drawings comes from the Contractor's daily record drawings as well as the Project Representative's field records (daily records, photographs, inspection reports, field directives, and possible change orders) and post-construction site survey. Record drawings represent the best information available as to where improvements and changes from the original design have been made during construction due to unanticipated conditions encountered in the field. The record drawings will show sufficient detail to allow location of these improvements and changes for future monitoring or maintenance.

CHANNEL DYNAMICS

The river channel may adjust to restoration with increased channel complexity, manifested by increased channel sinuosity or increased occurrence of multiple channels, or both. Channel complexity strongly affects the physical habitat template for salmonids and riparian forests. Geomorphic processes that result in increased channel complexity include lateral channel movement, changes in planform channel pattern, increases in the rate and frequency of meandering, neck and chute cutoffs, large scale avulsions or reoccupation of old channels resulting in a new main channel or secondary channel (anastamosing). Channel dynamics monitoring will focus on the formation of new channels outside of the present (pre-project) active channel; it will also characterize channel complexity by measuring channel sinuosity

(channel centerline length divided by valley centerline length) and documenting the occurrence of multiple channels.

Channel location, channel pattern and channel features such as gravel bars will be mapped annually by interpreting aerial photos, augmented by field inspection and (less frequent) ground surface elevations from LiDAR. Mapped channel locations will allow documentation of the formation of new channels outside of the present active channel and the occurrence and frequency of multiple channels. Airphoto analysis also will be used to measure changes in the location of the active channel centerline between consecutive years along cross-valley transects spaced at intervals scaled to channel width (Latterell et al. 2008). These measurements will allow calculation of channel sinuosity and quantification of geomorphic processes such as annualized estimates of channel movement, by mechanism.

HABITAT

General Site Conditions and Amphibian Use

Surveyors will note general site and habitat conditions on field datasheets. This should include observed fish and wildlife use (direct observation of live or dead animals or indirect observation of prints, scat, etc.), general patterns of vegetation condition, invasive vegetation, illegal use or dumping, deformation or damage (movement of installed wood, bank erosion, etc.), and anything else considered worth noting. In addition, post-project amphibian breeding surveys will be conducted in Years 1, 5, and 10 to document habitat use by lentic breeding amphibians (Richter and Ostergaard 1999; Thoms et al. 1997). Because the project has the potential to adversely affect lentic breeding amphibians, a project performance standard was not associated with this monitoring effort. Rather, the information will be used to document change in breeding area and use and inform future project considerations in similar settings.

Aquatic Habitat

The primary focus of aquatic habitat surveys will be to determine how the amount, type, and distribution of low-velocity edge habitat (hydraulic refuge) changes with flow before and after restoration. Edge habitats are generally characterized by shallow and low velocity water and fine substrate and have been shown to be important for juvenile salmonids, particularly Chinook (Hillman et al. 1987; Bjornn 1971). This sampling will focus on bars, banks, backwaters and side channels (Beechie et al. 2005). Edge habitat mapping will be conducted at flows representing 50th, 75, and 90th percentile flows during Jan-Jun. Edge habitat will be classified, mapped and measured with two downriver passes; one along the left bank and the other along the right. The margin of the wetted channel will be mapped on foot by GPS. The midstream (waterward) margin of the edge habitat will be located with a flow meter – where water velocity is approximately <1.5 ft/sec- and the slow-water boundary mapped at multiple points by GPS. Points and water margins will be transferred to a GIS and to permit the area, number, and

distribution of low-velocity edges to be quantified for bars, banks, backwaters, and side channels, and then plotted against corresponding discharge levels.

Inundation area will be monitored in the project area using georeferenced aerial photography between February 1 and March 31 of each monitoring year. Total inundated acreage will be calculated in GIS. Field survey using GPS may be necessary for heavily vegetated areas and for ground-truthing in early monitoring years.

Wood

Wood loading will be characterized using field surveys and aerial photo interpretation. Field surveys of large wood will follow methods specified by Montgomery (2008) and Latterell (2012). Aerial photos and object-based image analysis may also be used to replace or supplement field surveys. Logjams will be mapped as a single unit, and large isolated pieces (i.e., E4s and larger; Montgomery 2008) will be mapped separately. In each case, the point will be given several attributes based on photo interpretation. The trapping location will be noted as mainstem, side channel, backwater, floodplain, or wetland. The physical function of jams and pieces will be noted as pool scour, bar formation, bank stabilization, flow splitting, meander geometry, and sediment trapping. The ecological functions will be noted as vegetation regeneration, juvenile salmonid cover, juvenile salmonid rearing habitat, and adult holding habitat. The size of each individual piece will be described using the alphanumeric code from Montgomery (2008), ranging from E4 to G7. The river mile location will also be noted.

Riparian and Invasive Plant Cover

Vegetation monitoring transects will be established in disturbed areas to evaluate the success of planted vegetation and to estimate the rate at which native and invasive trees colonize bare ground. Transects will be established within five strata (four per stratum): naturally-formed gravel bars (GB), constructed depositional bars behind engineered log jams (ELJ), riparian buffer (RB), off-channel forested areas (OC), and levee slopes (LS). Transects will not cross strata. Transects will be established directionally to maximize transect length with a minimum transect distance of 30-m (max 50-m). A photo monitoring point will be established at the beginning and end of each transect, looking back along the transect. Some transects in the active floodplain and channel (GB, ELJ, OC) may become inaccessible as channel complexity increases following construction.

Percent cover trees, shrubs, groundcover will be measured using circular plots with a 3-m radius at three locations, the beginning, middle, and end, of each transect. Percent cover will be estimated using Daubenmire cover classes to ensure repeatability of measurements. Estimates of cover will be categorized into native and invasive plant cover classes.

Tree regeneration will be measured at five locations along the transect within 1-m^2 quadrats. Trees will be identified to genus and classified as seedling versus non-seedling. Invasive species

frequency will be measured in five 4-m^2 quadrats established using the same point as the tree regeneration quadrats. Invasive species will be identified to genus and classified as seedling or non-seedling within these quadrats.

Wetlands

Temporary construction fill in wetlands will be removed following construction. The impacted areas will be monitored in Year 1 to determine whether the area reverted to aquatic habitat condition (flowing or ponded water).

FISH USE

Habitat Preference

The study area has the potential to provide valuable rearing habitat for salmonids which is limited in the Lower White River. Fish monitoring will focus on quantifying changes in the density of juvenile Chinook, steelhead, and coho, and will document use of the site by other species such as bull trout.

Seining will be used as the primary sampling technique in mapped habitat units to determine the relative importance of each habitat type for each species and life stage. If it is not possible to sample all of the habitats at the project site, then a stratified random sample will be selected for surveys proportional to the type of habitats that are available in the study reach. Surveys will target Chinook and steelhead juveniles in particular, and are therefore proposed to occur during the spring and late summer/early fall.

Habitat Capacity

Habitat capacity, estimated as the product of the average density of juvenile salmonids in edge habitats and the area of edge habitat (by type) at the targeted rearing flows, is summed across all habitats available at the project site. The habitat capacity will be calculated for each period when edge mapping and fish sampling occur, and compared with baseline conditions sampled during the same season.

FLOOD HAZARD

Structural Components

Annual facility inspections and post-flood damage inspections will be conducted to identify active or potential problems that may affect the functionality of the structures. The structures to be inspected include the setback levee, portions of the existing levee that will remain, the biorevetment, and the ELJs.

The data collected from inspections will make use of GPS field equipment to capture spatial data as well as data in digital format to improve the speed and efficiency of data transfer to the King County River and Floodplain Management Section's facility inventory database and to allow for

direct mapping of key points of interest in the GIS environment. Facility inspection sheets include the following information types:

- Inspectors, time stamp, flow conditions.
- Extents of inspection.
- Check box describing a particular issue of concern for apparent damage and a text box to allow a detailed description of the damage.
- Geographic location, dimensions, description, severity and photograph of noted damage.
- Follow-up notifications.

The setback levee and the portion of the levee remaining downstream of the BNSF Railway Bridge will be inspected for indications of seepage, erosion, and vegetative cover. The biostabilized portion of the levee remaining downstream of the BNSF Railway Bridge will be inspected to note any scour at the levee tip, the loss of any to rock, damage to the coir lifts in initial years before vegetation is established, and changes in vegetative growth affecting structural integrity as the native plantings mature. The biorevetment and ELJs will be inspected to note erosion of ballast material and any shifting of key logs that might indicate structural issues of concern within the interior or foundation of the structures (e.g., scour, settlement, piping of flow) that would require follow-up inspections. The biorevetment and ELJ inspections will also document changes in vegetative growth on the structures affecting the structural integrity and the accumulation or loss of natural wood accumulations against the structures. If a damage or maintenance issues are identified in any of the inspections, the inspection will identify next steps to evaluate and address the problem further.

Flood Elevations

In-channel monitoring of sediment levels in the Lower White River is conducted regularly to characterize trends in sediment deposition and to document changes in flood conveyance. Monitoring is conducted by resurveying river channel cross sections and comparing the results to previous surveys. The most recent survey was conducted in 2012 between RM 1.8 and 10.6 and included 78 cross sections. Prior monitoring 2011 included 62 cross sections located between river mile 4.5and 10.6. Previous monitoring of some of these cross sections occurred in 2009, 2007, 2001, 1984, 1974, and 1969.

The change in flood elevations resulting from changes in channel conditions is evaluated using hydraulic modeling methods. Flood elevations are evaluated in terms of both the channel capacity (the discharge at which flow begins to overtop one of the banks) and the extent of flooding for the 100-year event (15,500 cfs). The channel conveyance capacity is evaluated using the one-dimensional hydraulic model, HEC-RAS. The extent of flooding for the 100-year event is evaluated using a two-dimensional hydraulic model, typically River FLO-2D.

In-channel monitoring and one-dimensional hydraulic modeling of flood elevations will be conducted biannually or more frequently depending on the occurrence of major flood events and

significant changes in channel location. Although the existing cross section locations can be used in the existing channel, the monitoring of channel conditions in the setback area will require the establishment of new cross sections or the reliance on high-resolution lidar topography and bathymetry, or a combination of the two methods. The results of the channel monitoring will be summarized in a report documenting the changes in sediment levels, channel bed elevation, and changes in channel conveyance capacity and extent of flooding for the 100-year event.

Channel Migration

The rate of channel migration is monitored by comparing the relative change in the position of the active channel over a known period of time. Historical channel migration on the Lower White River has been conducted by tracing the edge of the active channel from historical orthorectified aerial photographs. Channel locations mapped on the ground are also used to augment information obtained from aerial photographs.

The monitoring of channel migration rates will be conducted annually to document the dynamic channel response to the project. Monitoring will use aerial photographs, field mapping of actual channel locations, and observations from annual facility inspections to document channel location and to confirm that channel migration is contained within the project area. Results of the channel migration monitoring will be documented graphically on maps and quantitatively in terms of migration rate (e.g., distance per time).

ADAPTIVE MANAGEMENT

Specific adaptive management strategies are outline in Table 1. The expected outcomes of this monitoring effort are:

- Quantitative evaluation of the effectiveness of levee setback and floodplain reconnection projects on the Lower White River,
- Improved certainty in the outcome of large-scale levee setback projects in mainstem rivers,
- Increased understanding of the effectiveness of levee setback projects as a river system management alternative in sediment-rich rivers,
- Empirical understanding of how fish, habitat, and watershed processes respond to a suite of restoration actions, and
- Increased understanding of the appropriateness of specific monitoring methods for evaluating floodplain reconnection project effectiveness.

In general, if the evidence confirms the monitoring hypotheses, the actions taken and techniques employed will be viewed as successful and worthy of application in future (similar) projects and monitoring studies. If the hypotheses are not confirmed, or the evidence remains very weak, the accumulated knowledge will be used to explain (or speculate) why the desired outcomes were not achieved. Lessons from both ‘successes’ and ‘failures’ are valuable products from this

monitoring effort; these lessons will be summarized in reports and presentations. The results of this monitoring will likely provide valuable lessons and insights that can be applied to similar projects and studies in the future, and to guide adaptive management decisions.

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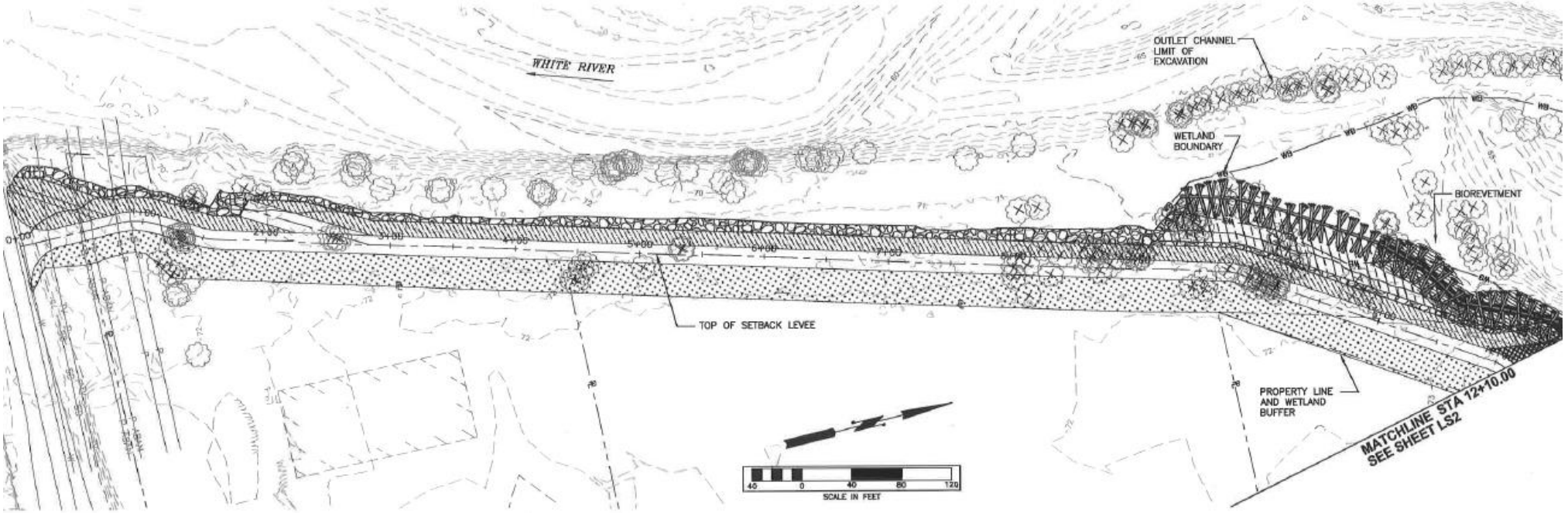
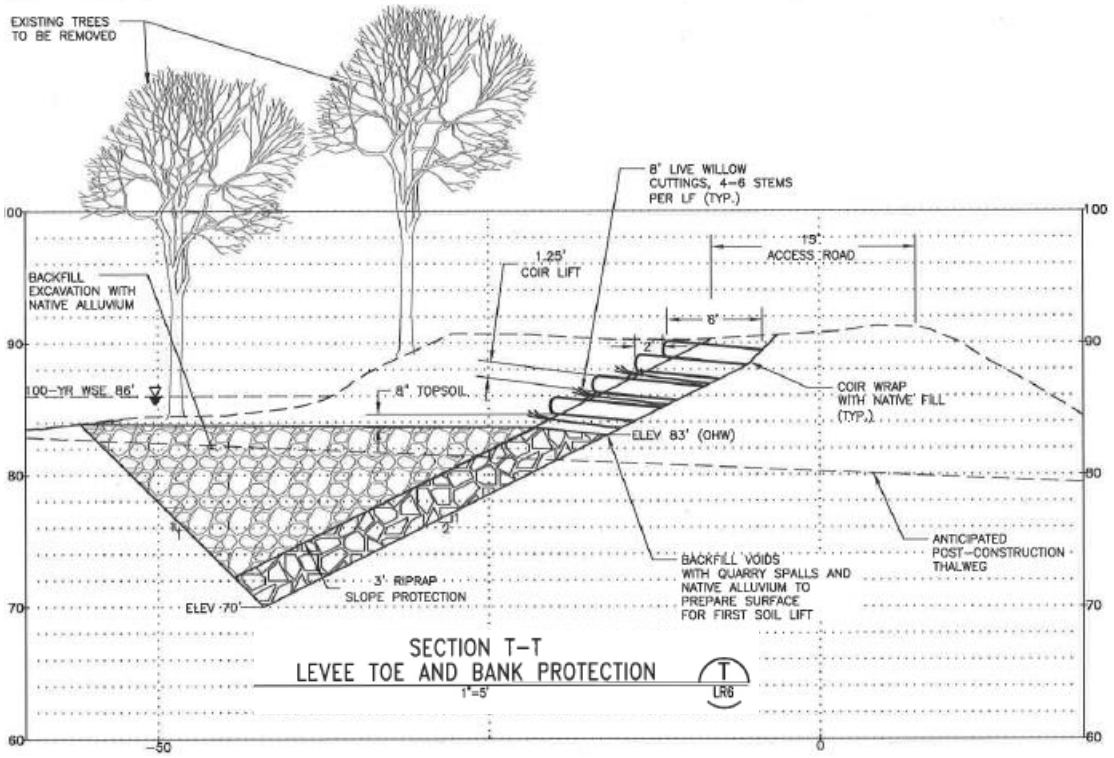
APPENDIX A. PLANTING PLAN





SECTION T-T
LEVEE TOE AND BANK PROTECTION
1"=5'
T
LR6

LEGEND:

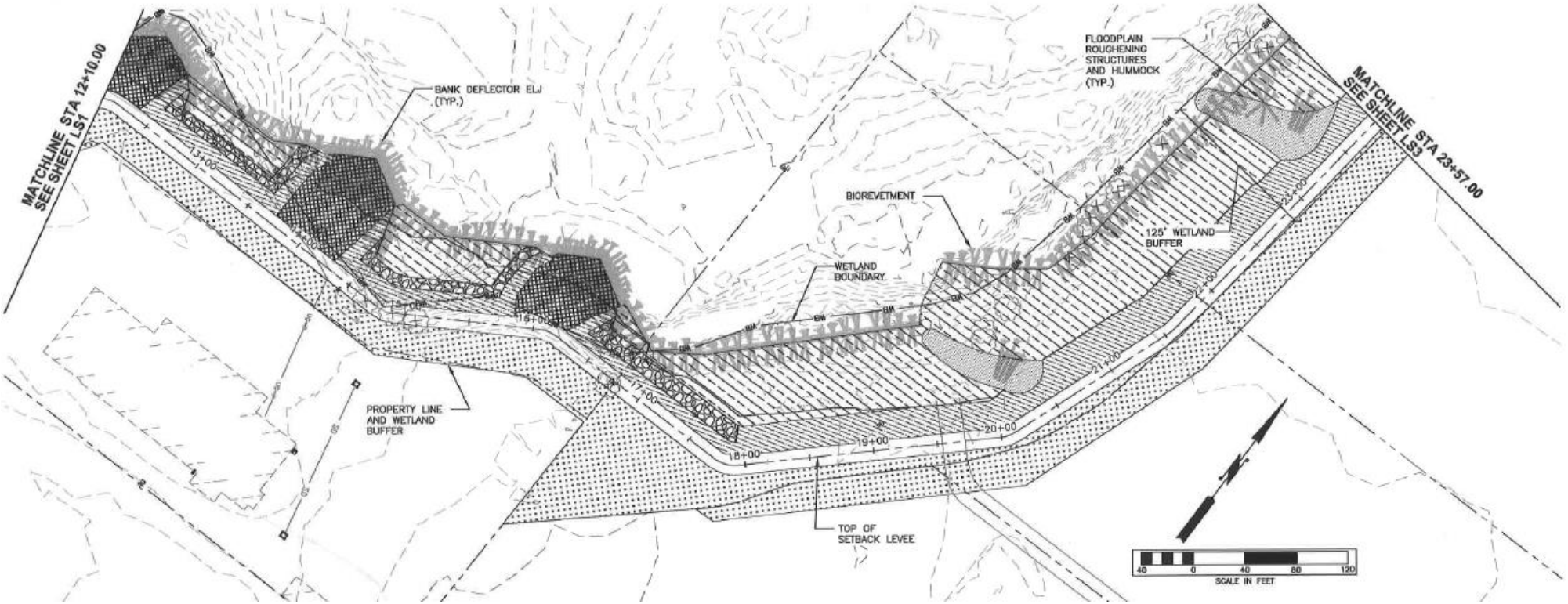
EX. TREE
TO BE PROTECTED

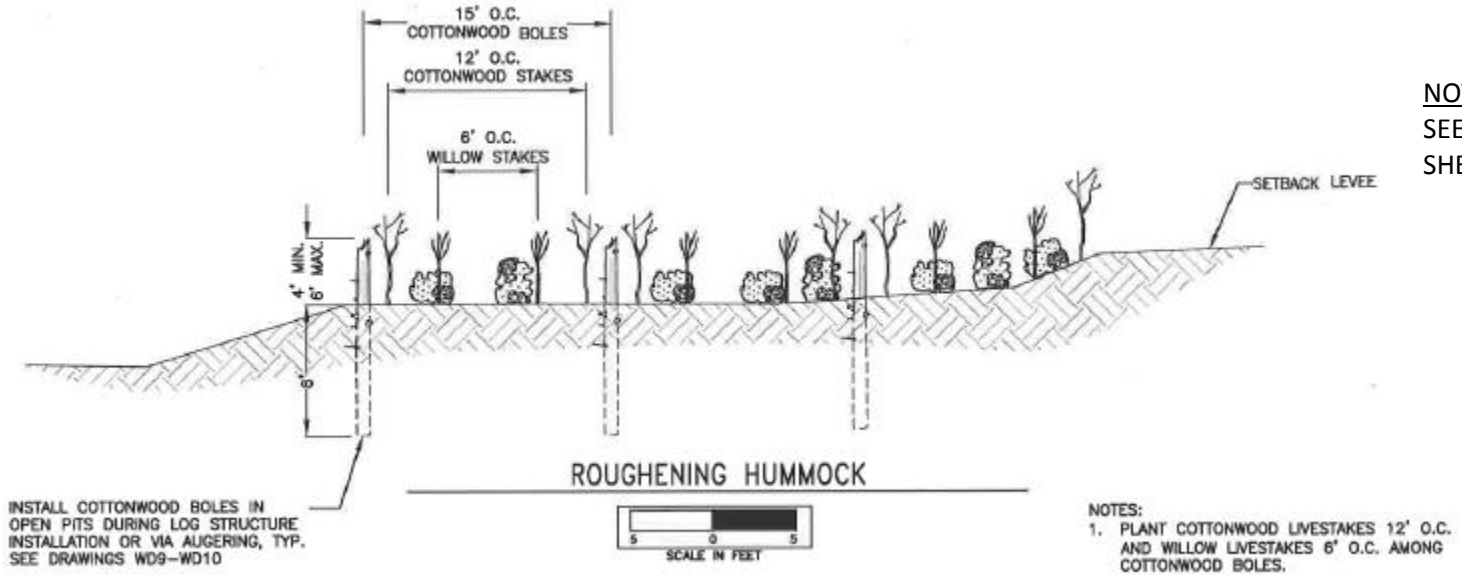
EX. TREE
TO BE REMOVED

NOTES:

1. SEE PLANTING PLAN TABLE AND LEGEND, SHEET 28.
2. SEE SHEET 4 FOR LOCATION OF SECTION T-T.

PLANTING PLAN & DETAILS

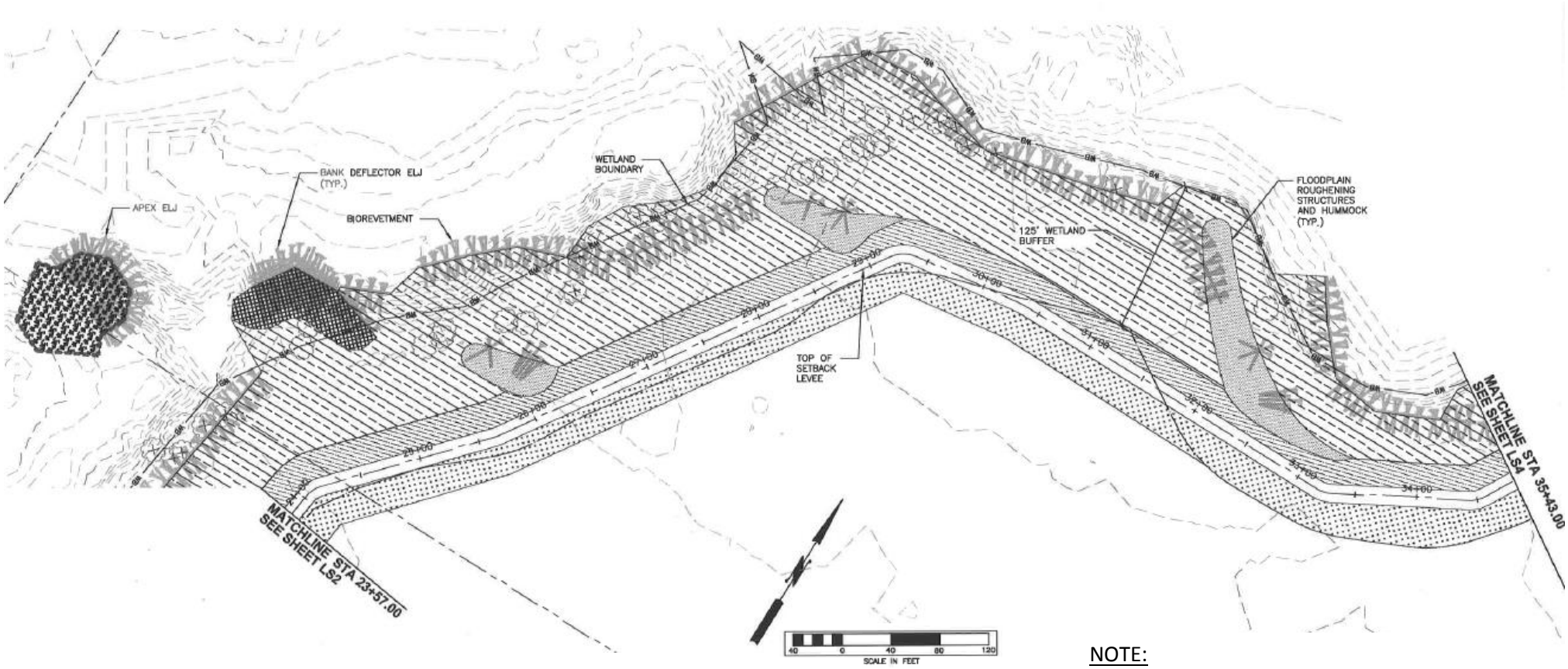




NOTE:
SEE PLANTING PLAN TABLE AND LEGEND, SHEET 28.

NOTES:
1. PLANT COTTONWOOD LIVESTAKES 12' O.C. AND WILLOW LIVESTAKES 6' O.C. AMONG COTTONWOOD BOLES.
2. PLANT SHRUBS 4'–6' O.C. IN CLUSTER GAP MOSAIC AS PER WETLAND BUFFER PLAN DETAIL.

PLANTING PLAN & DETAILS



NOTE:
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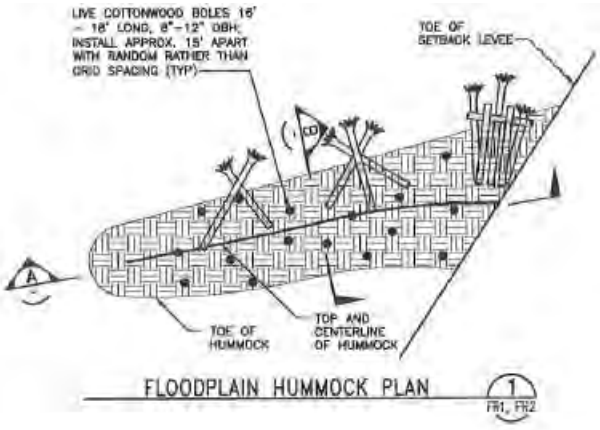

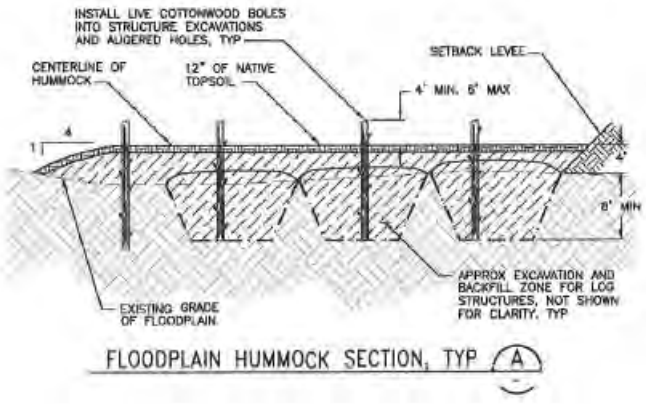

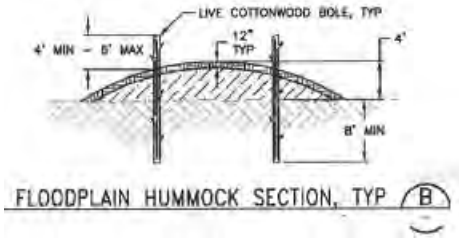

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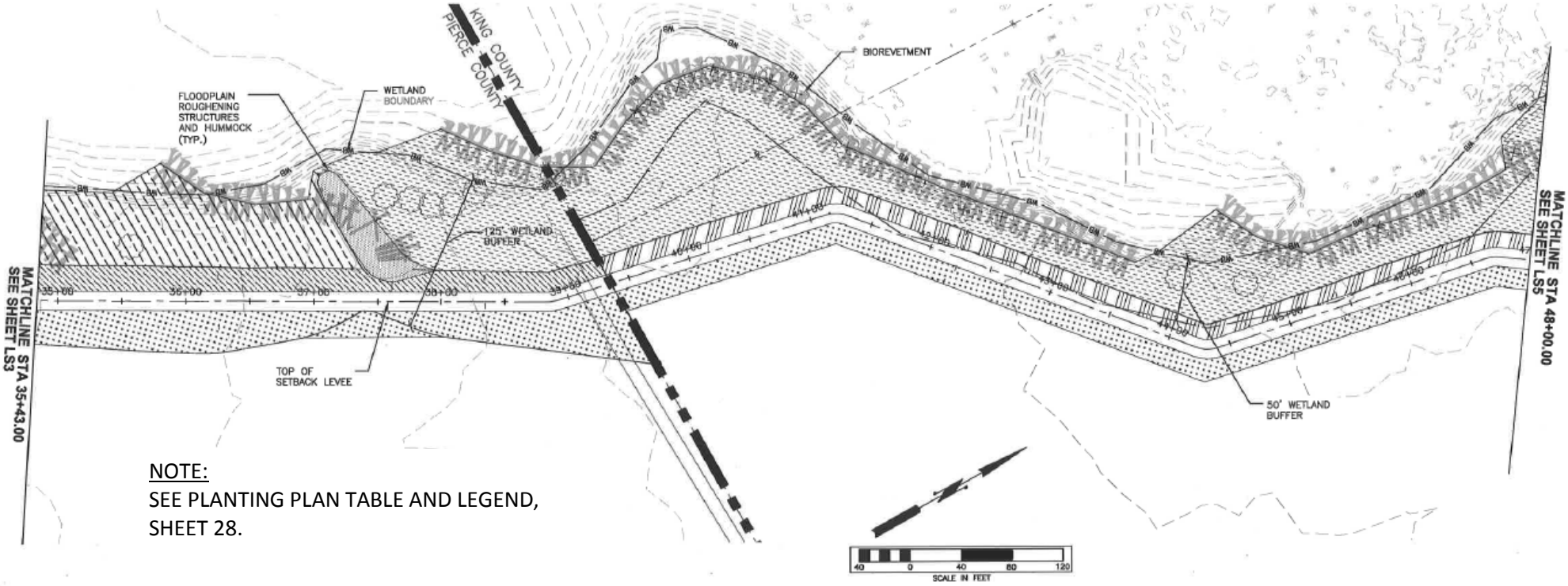
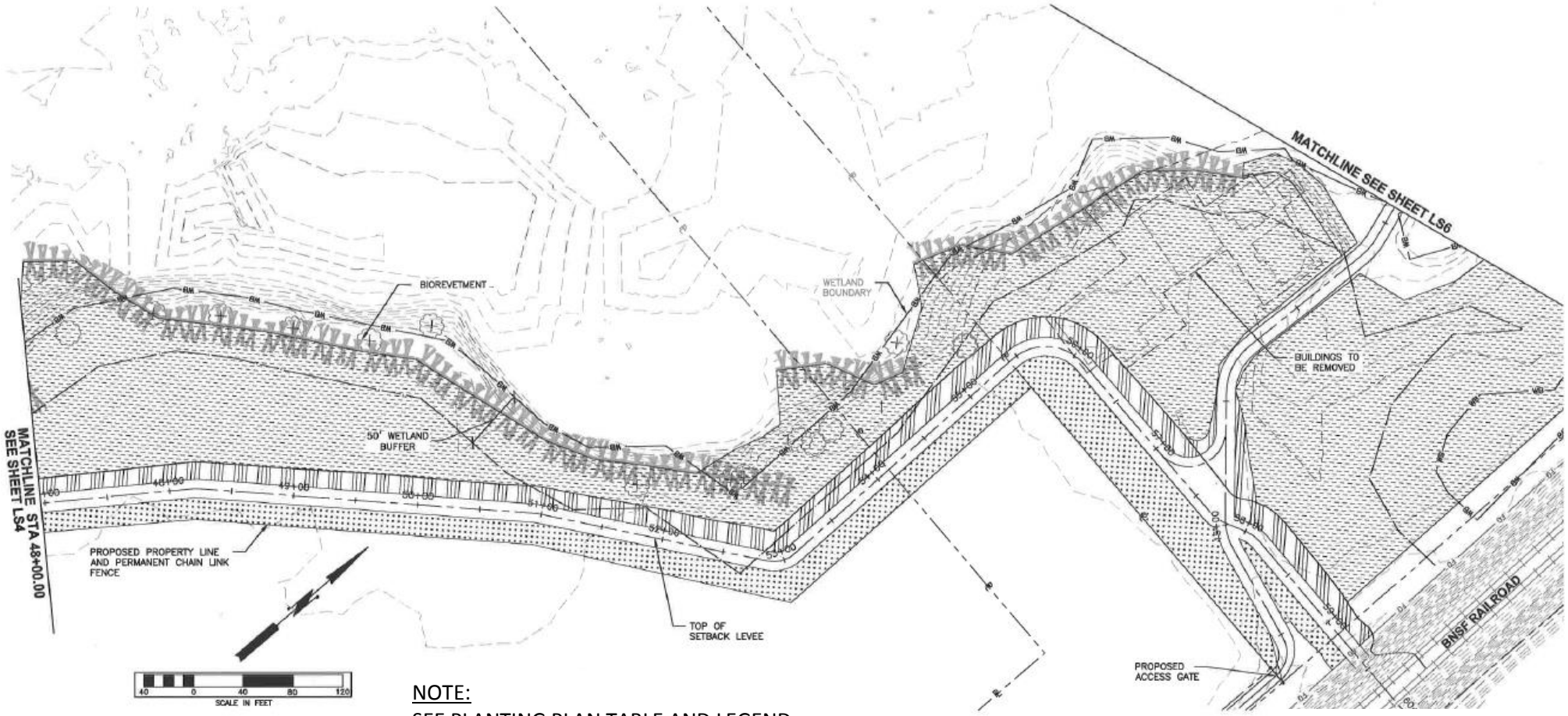


NOTE:
SEE PLANTING PLAN TABLE AND LEGEND, SHEET 28.

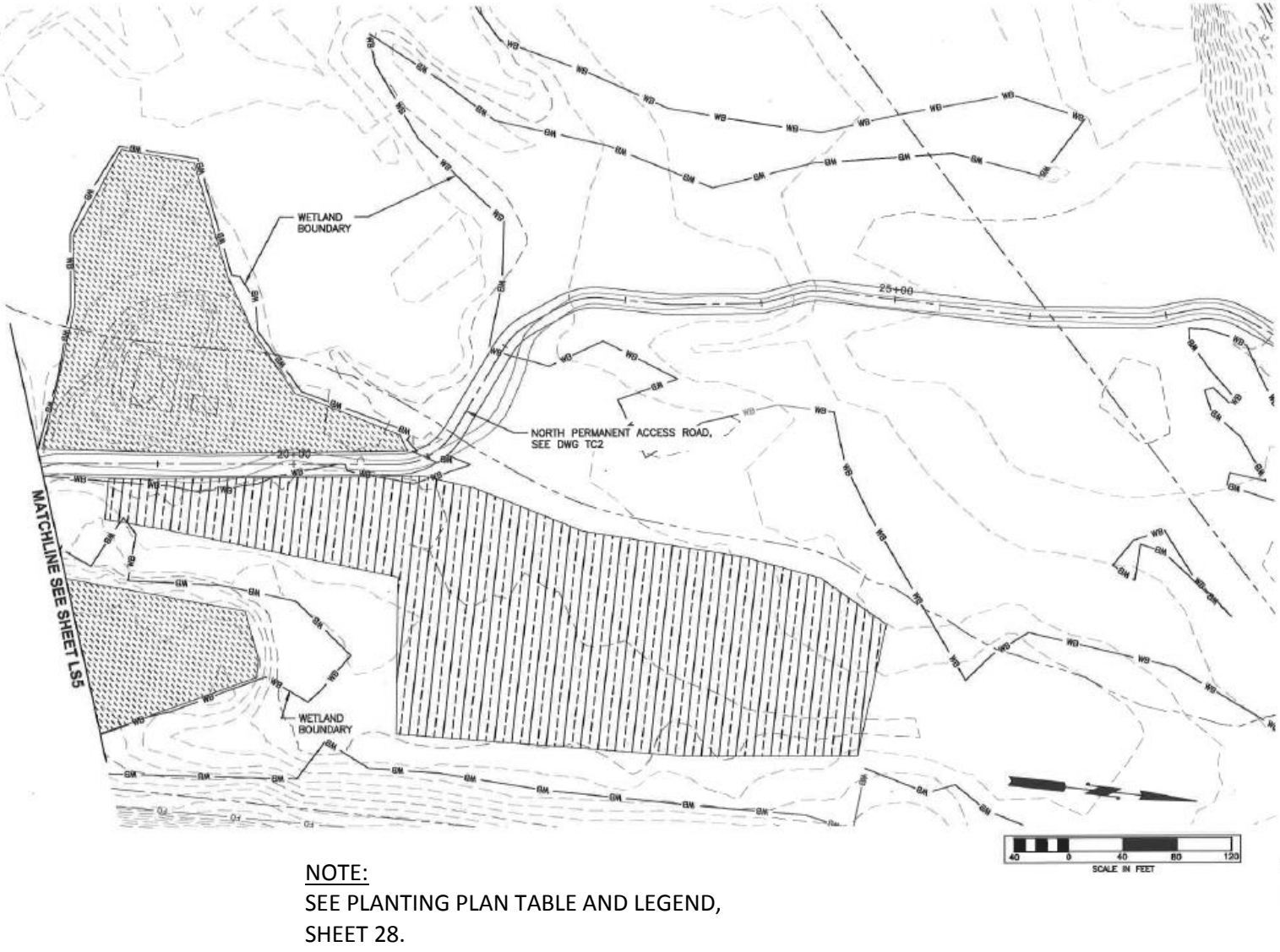
PLANTING PLAN & DETAILS



NOTE:
SEE PLANTING PLAN TABLE AND LEGEND, SHEET 28.

LEGEND:
EX. TREE TO BE PROTECTED
EX. TREE TO BE REMOVED

PLANTING PLAN & DETAILS



NOTE:
SEE PLANTING PLAN TABLE AND LEGEND, SHEET 28.

PLANTING PLAN & DETAILS

Symbol	Scientific Name	Common Name	Wetland Indicator Status	Area (ft²)	% Cover Goal	Spacing (ft o.c.)	Stock Type	Quantity
	WETLAND BUFFER DRY							
	Acer Macrophyllum	Big leaf maple	FACU	247,563	10	10	SD, GAL	248
	Populus trichocarpa	Black cottonwood	FAC	247,563	50	10	LS3	1,238
	Pseudotsuga menziesii	Douglas fir	FACU	247,563	20	10	PL, GAL	495
	Alnus rubra	Red alder	FAC	247,563	20	10	SD, GAL	495
	Rhamnus purshiana	Cascara	FAC	247,563	10	6	SD, GAL	688
	Salix scouleriana	Scouler's willow	FAC	247,563	10	6	SD LS3	688
	Acer circinatum	Vine maple	FAC	247,563	10	6	TR, GAL	688
	Rosa gymnocarpa	Bald-hip rose	FACU	247,563	10	4	SD, GAL	1,547
	Corylus cornuta	Hazelnut	FACU	247,563	10	6	TR, GAL	688
	Oemleria cerasiformis	Indian plum	FACU	247,563	10	6	TR, GAL	688
	Vaccinium parvifolium	Red huckleberry	FACU	247,563	10	6	GAL	688
	Amelanchier alnifolia	Saskatoon	FACU	247,563	10	6	TR, GAL	688
	Symphoricarpos albus	Snowberry	FACU	247,563	10	6	TR, GAL	1,725
	Rubus parviflorus	Thimbleberry	FACU	247,563	10	4	SD, GAL	1,547
	Polystichum munitum	Sword fern	FACU	247,563	10	4	GAL	1,547
	WETLAND BUFFER WET							
	Populus trichocarpa	Black cottonwood	FAC	230,400	70	10	LS3	1,613
	Alnus rubra	Red alder	FAC	230,400	20	10	SD, GAL	461
	Thuja plicata	Western redcedar	FAC	230,400	10	10	PL, GAL	230
	Rhamnus purshiana	Cascara	FAC	230,400	10	6	SD, GAL	640
	Salix hookeriana	Hooker's willow	FACW	230,400	10	6	SD LS3	640
	Salix sitchensis	Sitka willow	FACW	230,400	10	6	SD LS3	640
	Acer circinatum	Vine maple	FAC	230,400	10	6	TR, GAL	640
	Rosa nutkana	Nootka rose	FAC	230,400	10	4	SD, GAL	1,441
	Cornus sericea	Red twig dogwood	FACW	230,400	20	6	TR, GAL	1,280
	Rubus spectabilis	Salmonberry	FAC	230,400	10	4	TR, GAL	1,441
	Athyrium filix-femina	Lady fern	FAC	230,400	10	4	GAL	1,441
	WATERWARD LEVEE SLOPE DRY Plant big leaf maple & Doug fir alternately 25' o.c. in undulating line on mid-lower slope position. First 5' of slope adjacent to road seed with red fescue. Next 5' plant sword fern and fringe cup.							
	Acer circinatum	Vine maple	FAC	30,304	10	6	GAL	84
	Acer Macrophyllum	Big leaf maple	FACU	2,252 LF	10	25' L	GAL	45
	Cornus sericea	Red twig dogwood	FACW	30,304	20	6	GAL	168
	Corylus cornuta	Hazelnut	FACU	30,304	10	6	GAL	84
	Festuca rubra	Red fescue	FAC	30,304	5	14 lbs/ac	SEED	30
	Holodiscus discolor	Oceanspray	FACU	30,304	10	6	GAL	84
	Oemleria cerasiformis	Indian plum	FACU	30,304	10	6	GAL	84
	Polystichum munitum	Sword fern	FACU	30,304	10	4	GAL	189
	Pseudotsuga menziesii	Douglas fir	FACU	2,252 LF	10	25' L	GAL	45
	Rhamnus purshiana	Cascara	FAC	30,304	10	6	GAL	84
	Rosa gymnocarpa	Bald-hip rose	FACU	30,304	10	4	GAL	189
	Rubus parviflorus	Thimbleberry	FACU	30,304	15	4	GAL	284
	Symphoricarpos albus	Snowberry	FACU	30,304	25	6	GAL	210
	Tellima grandiflora	Fringe cup	FACU	30,304	5	4	POT	95
	WATERWARD LEVEE SLOPE WET Plant Western redcedar 25' o.c. in undulating line on mid lower slope. Seed first 5' of slope along road with red fescue. Plant next 5' with lady fern and piggy-back plant.							
	Acer circinatum	Vine maple	FAC	67,881	10	6	GAL	189
	Alnus rubra	Red alder	FAC	67,881	20	12	GAL	94
	Athyrium filix-femina	Lady fern	FAC	67,881	10	4	GAL	424
	Cornus sericea	Red twig dogwood	FACW	67,881	25	6	GAL	471
	Corylus cornuta	Hazelnut	FACU	67,881	10	6	GAL	189
	Festuca rubra	Red fescue	FAC	67,881	5	14 lbs/ac	SEED	22
	Oemleria cerasiformis	Indian plum	FACU	67,881	10	6	GAL	189
	Rosa nutkana	Nootka rose	FAC	67,881	10	4	GAL	424
	Rubus spectabilis	Salmonberry	FAC	67,881	10	4	GAL	424
	Salix hookeriana	Hooker's willow	FACW	67,881	10	6	LS3	189
	Salix sitchensis	Sitka willow	FACW	67,881	10	6	LS3	189
	Sambucus racemosa	Red elderberry	FACU	67,881	10	6	GAL	189
	Symphoricarpos albus	Snowberry	FACU	67,881	25	6	GAL	471
	Thuja plicata	Western redcedar	FAC	3,856	10	25' L	GAL	154
	Tolmiea menziesii	Piggy back plant	FAC	67,881	5	4	POT	212

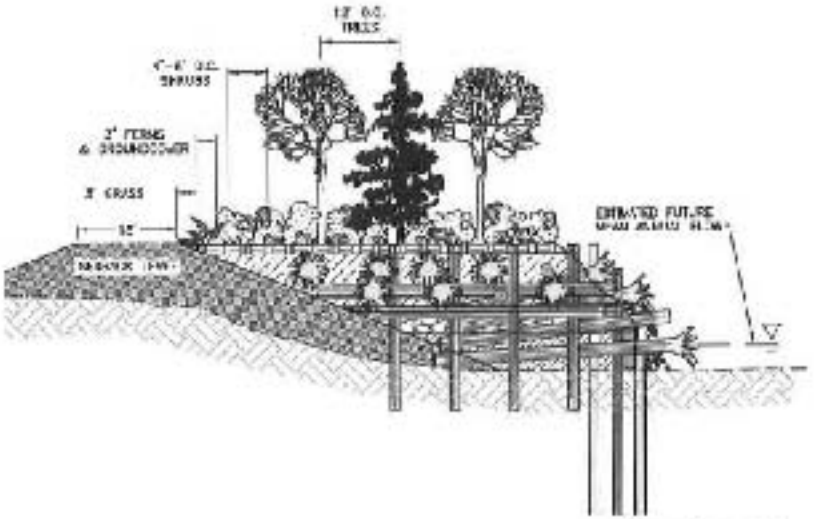
Symbol	Scientific Name	Common Name	Wetland Indicator Status	Area (ft²)	% Cover Goal	Spacing (ft o.c.)	Stock Type	Quantity
	LANDWARD LEVEE SLOPE - Plant shore pine in straight line 25' o.c. in mid-slope position only. First 5' of slope adjacent to road seed with red fescue. Next 5' to be planted to sword fern and fringe cup only.							
	Amelanchier alnifolia	Saskatoon	FACU	152,879	30	6	GAL	479
	Corylus cornuta	Hazelnut	FACU	152,879	25	6	GAL	1,067
	Festuca rubra	Red fescue	FAC	152,879	5	14 lbs/ac	SEED	49
	Holodiscus discolor	Oceanspray	FACU	152,879	40	6	GAL	1,698
	Pinus contorta var. *con.*	Shore pine	FAC	1,080 LF	25	25' L	GAL	240
	Polystichum munitum	Sword fern	FACU	152,879	30	4	GAL	958
	Symphoricarpos albus	Snowberry	FACU	152,879	25	6	GAL	1,067
	Tellima grandiflora	Fringe cup	FACU	152,879	5	4	POT	479
	BANK DEFLECTOR ELJs							
	Acer circinatum	Vine maple	FAC	15,497	30	6	GAL	43
	Acer Macrophyllum	Big-leaf maple	FACU	15,497	30	12	GAL	32
	Alnus rubra	Red alder	FAC	15,497	30	12	GAL	32
	Corylus cornuta	Hazelnut	FACU	15,497	20	6	GAL	86
	Oemleria cerasiformis	Indian plum	FACU	15,497	25	6	GAL	69
	Polystichum munitum	Sword fern	FACU	15,497	30	4	GAL	106
	Pseudotsuga menziesii	Douglas fir	FACU	15,497	25	12	GAL	27
	Rhamnus purshiana	Cascara	FAC	15,497	30	6	GAL	83
	Rosa gymnocarpa	Bald-hip rose	FACU	15,497	20	4	GAL	194
	Symphoricarpos albus	Snowberry	FACU	15,497	20	6	GAL	86
	Thuja plicata	Western redcedar	FAC	15,497	15	12	GAL	16
	APEX ELJs							
	Upper 1/2 of Apex ELJs							
	Acer circinatum	Vine maple	FAC	7,448	20	6	GAL	41
	Alnus rubra	Red alder	FAC	7,448	25	12	GAL	13
	Corylus cornuta	Hazelnut	FACU	7,448	30	6	GAL	21
	Oemleria cerasiformis	Indian plum	FACU	7,448	10	6	GAL	21
	Rosa gymnocarpa	Bald-hip rose	FACU	7,448	30	4	GAL	47
	Rubus parviflorus	Thimbleberry	FACU	7,448	30	4	GAL	93
	Sambucus racemosa	Red elderberry	FACU	7,448	30	6	GAL	21
	Symphoricarpos albus	Snowberry	FACU	7,448	20	6	GAL	41
	Thuja plicata	Western redcedar	FAC	7,448	25	12	GAL	13
	Vaccinium parvifolium	Red huckleberry	FACU	7,448	30	6	GAL	21
	Lower 1/2 of Apex ELJs							
	Cornus sericea	Red twig dogwood	FACW	7,448	30	6	GAL	21
	Populus trichocarpa	Black cottonwood	FAC	7,448	100	12	LS3	52
	Rhamnus purshiana	Cascara	FAC	7,448	30	6	GAL	21
	Rosa nutkana	Nootka rose	FAC	7,448	10	4	GAL	47
	Rubus spectabilis	Salmonberry	FAC	7,448	20	4	GAL	93
	Salix hookeriana	Hooker's willow	FACW	7,448	20	6	LS3	41
	Salix sitchensis	Sitka willow	FACW	7,448	20	6	LS3	41
	ROUGHENING HUMMOCKS							
	Acer circinatum	Vine maple	FAC	15,794	10	6	GAL	57
	Athyrium filix-femina	Lady fern	FAC	15,794	30	4	GAL	117
	Cornus sericea	Red twig dogwood	FACW	15,794	20	6	GAL	102
	Polystichum munitum	Sword fern	FACU	15,794	30	4	GAL	117
	Populus trichocarpa	Black cottonwood	FAC	15,794	100	12	LS3	131
	Rhamnus purshiana	Cascara	FAC	15,794	10	6	GAL	57
	Rosa nutkana	Nootka rose	FAC	15,794	30	4	GAL	117
	Rubus spectabilis	Salmonberry	FAC	15,794	30	4	GAL	117
	Salix hookeriana	Hooker's willow	FACW	15,794	20	6	LS3	104
	Salix sitchensis	Sitka willow	FACW	15,794	20	6	LS3	101
	ROCK FACED LEVEE							
	Lower 1/2 of Rock Faced Levee - Install 6-8' 1-2" willow live stakes 2' o.c. in single layer in 2" topsoil immediately above rock layer of levee per design drawings.							
	Salix scouleriana	Scouler's willow	FAC	1,719	100	2'	LS3	[illegible]

SEE PLANTING NOTES, SHEET 29

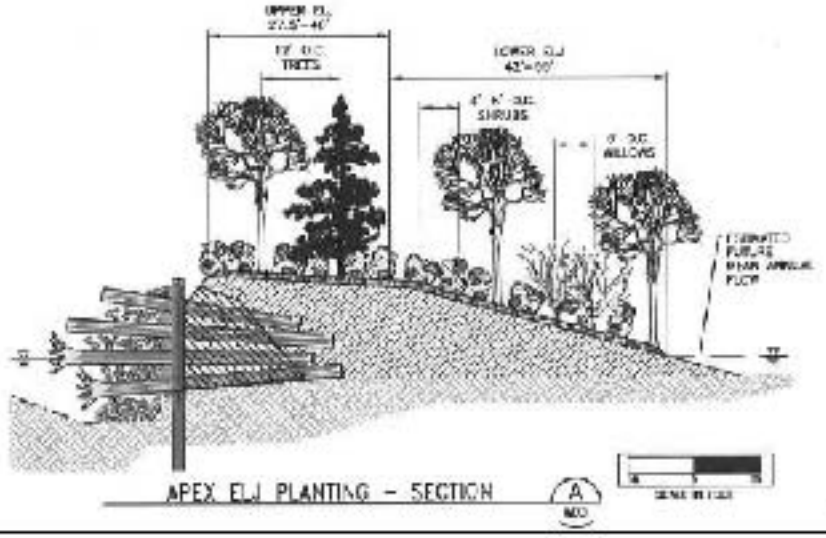
PLANTING PLAN & DETAILS

NOTES:

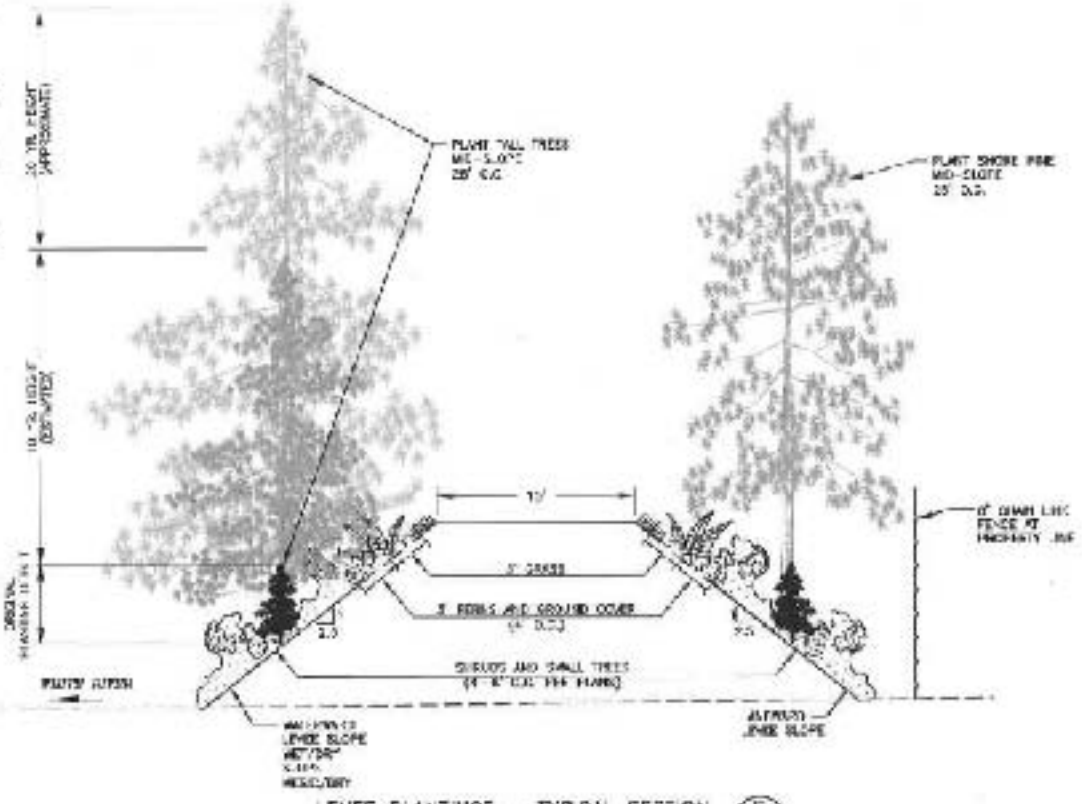
1. SPACING IN FT O.C. UNLESS LINEAR FT AS INDICATED BY "L". TREES TO BE PLANTED 10 OR 12 FEET O.C. FROM OTHER TREES IN PLANTING UNIT AS INDICATED. SHRUBS TO BE PLANTED 4 OR 6 FEET FROM OTHER SHRUBS AS INDICATED. QUANTITIES ARE BASED ON PERCENT COVER GOALS FOR EACH SPECIES AS OPPOSED TO SPACING.
2. ALTERNATIVE A INCLUDES MAINLY PLANTING CONTAINERS EXCEPT FOR WILLOW AND BLACK COTTONWOOD, WHICH WILL BE LIVESTAKES.
3. SD=SEEDLING, TR=TRANSPLANT, LS3=3' LIVE STAKE, LS6=6' LIVE STAKE, PL=PLUG, GAL=1-GALLON CONTAINER, POT= 4" POT, SEED=POUND OF SEED
4. WHERE TWO STOCK TYPES ARE INDICATED, SPLIT QUANTITIES HALF AND HALF FOR EACH TYPE.



BANK DEFLECTOR ELJ PLANTING-SECTION X



APEX ELJ PLANTING - SECTION A



LEVEE PLANTINGS - TYPICAL SECTION F

GENERAL PLANTING NOTES:

1. BIOREVETMENT WILL BE PLANTED WITH TALL SHRUBS (WILLOWS & DOGWOOD) ALONG THE EDGE OF THE STRUCTURE IN GAPS BETWEEN LOGS.
2. THE WETLAND BUFFER WET/DRY WILL BE PLANTED WITH A MIX OF TREES AND SHRUBS. SEE WETLAND BUFFER WET/DRY TYP. DETAIL, THIS SHEET.
3. THE LEVEE TOP/ACCESS ROAD WILL BE COVERED WITH GRAVEL.
4. LEVEE BACK SLOPES WILL BE PLANTED WITH SHRUBS AND SELECT TREE SPECIES.
5. APPLY COMPOST IN THE LEVEL PLANTING AREAS AND 18" TOPSOIL ON LEVEE SIDE SLOPES AS SHOWN ON PLANS.

PLANTING NOTES:

1. PLANT TREES AT VARIABLE SPACING AVERAGING 10' O.C.
2. PLANT SHRUBS BETWEEN TREES IN CLUSTER-GAP MOSAIC.
3. SHRUBS TO BE SPACED 1'-2' APART IN CLUSTERS OF THREE, APPROXIMATELY 7'-9' APART.
4. EACH CLUSTER TO CONTAIN AT LEAST TWO DIFFERENT SPECIES.

PLANTING PLAN & DETAILS