# BASIS OF DESIGN REPORT

## WHITE RIVER AT COUNTYLINE LEVEE SETBACK PROJECT

Prepared for
King County
Department of Natural Resources and
Parks, Water and Land Resources Division

Prepared by
Herrera Environmental Consultants, Inc.

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**Note:**
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Prepared for
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
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# INTRODUCTION

This report presents the basis for the 60% design of the White River at Countyline Levee Setback Project proposed by King County in the cities of Pacific and Sumner and in unincorporated Pierce County. The project site is located on the left (east) bank of the White River between river mile (RM) 5.00 and RM 6.33, which corresponds to the 8th Street E and A Street SE bridges, respectively. The Countyline project provides significant flood protection and salmon habitat benefits by reconnecting the river channel to its floodplain. By providing increased area for flood flows, the Countyline project will significantly reduce the level of flood risk to over 200 residential and commercial properties located in the City of Pacific. The project design accounts for the continued sediment aggradation occurring in this reach of the White River, a very sediment-rich river originating from the glaciers of Mount Rainier. After 15 years following construction, the flood protection benefits of the Countyline project are estimated to reduce flood risks for more than 700 residential and 26 commercial properties in King County.

The Countyline Levee Setback project includes the following design elements:

- Removing most of an existing levee
- Constructing a setback levee
- Constructing engineered log structures (ELSs) including a biorevetment structure (hereafter referred to as the biorevetment) adjacent to the setback levee to prevent migration of the river toward the setback levee
- Constructing several engineered logjams (ELJs) within the setback floodplain area and at selected locations in conjunction with the biorevetment to encourage complex flow patterns and to enhance aquatic habitat
- Restoring a riparian buffer by planting native shrubs and trees between the setback levee and the biorevetment

The goals and objectives of the project are as follows:

- **Goal 1**: Restore riverine processes and functions to the lower White River and its floodplain within the project area (inside the proposed levees) in order to enhance salmonid rearing habitat, in particular for spring and fall Chinook, coho, and steelhead.
    - **Objective 1.1**: Allow natural channel movement within the project area by removing and setting back the existing levee along the left bank.
    - **Objective 1.2**: Encourage the formation of off-channel rearing habitat (pool complexes and side-channels), 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.

  - **Objective 1.3**: 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.
  - **Objective 1.4**: 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 and geomorphic hazards outside of the project area from this restoration project and, if possible, reduce existing hazards.
  - **Objective 2.1**: Design the project to ensure flood and geomorphic hazards (on private property and associated with public infrastructure) outside of the project area do not increase due to the project.
  - **Objective 2.2**: 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.
  - **Objective 2.3**: Avoid or minimize the need for sediment management actions.

- **Goal 3**: Design and construct a project that best meets the project goals and objectives using the most cost-effective means.
  - **Objective 3.1**: Evaluate individual and collective project components based on cost-effectiveness, and whether they achieve the goals and objectives for salmonid habitat (primarily) and flood hazards.
  - **Objective 3.2**: Avoid or minimize the need for remedial actions (habitat restoration or construction to avoid or repair damage to public facilities) by incorporating self-sustaining habitat restoration and flood hazard reduction components in the design.
  - **Objective 3.3**: Work with adjacent landowners to negotiate acquisitions or conservation easements.
  - **Objective 3.4**: Work with all stakeholders, including the City of Pacific, City of Sumner, Pierce County, Washington Department of Fish and Wildlife (WDFW), the Puyallup Tribe of Indians, and the Muckleshoot Indian Tribe throughout project development to foster project support and a clear understanding of any needs or issues.

This report includes summaries of various technical assessments and analyses completed in support of the project. More detailed information on most of these topics is presented in appendices. Specifically, this report includes summaries of the following:

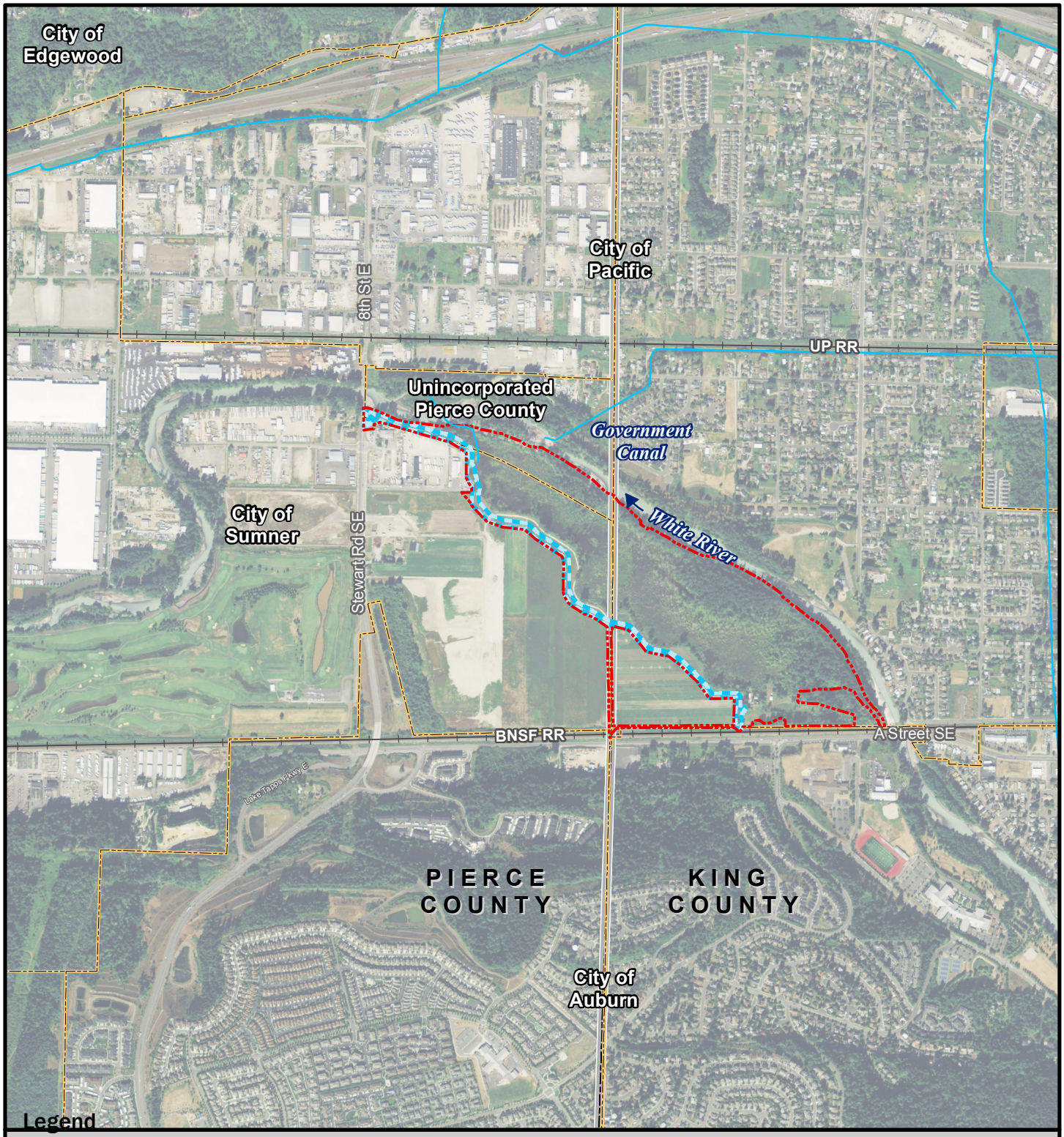
1. Existing site conditions influencing the proposed project configuration and design, including geologic, geotechnical, geomorphic, hydraulic, and habitat conditions
2. Constraints and opportunities with regard to flood hazards, habitat, wood recruitment, public safety, constructability, and costs
3. Project concept alternatives that were developed and evaluated, and the basis for selection of the preferred alternative for design advancement
4. Hydraulic modeling of proposed project conditions and comparison to existing conditions, and associated analysis of expected changes to existing flood hazards
5. Expected geomorphic responses in the river channel and floodplain following construction of the proposed project
6. Engineering analyses that define the design details for the setback levee, biorevetment, and ELJs that best meet the project goals and objectives

# EXISTING CONDITIONS

The existing land use in the project area and the limits of the proposed project are shown in Figure 1. The project site parallels the White River for a distance of about 1.33 miles between the A Street SE and 8th Street E bridges. Land use within and immediately adjacent to the project site is mostly wetlands and other open space, with one residential property located toward the northeast side of the site, agricultural fields on the east side of the site, and light industrial operations bordering the south side of the site. Over half of the agricultural land on the east side of the site has been zoned by the City of Sumner for light industrial uses, with a majority of this area currently undergoing development activities.

The existing Countyline Levee and Revetment on the east (left, facing downstream) bank of the river channel at the project site is nearly 100 years old. These adjoining flood control features were constructed after the White River was channelized and permanently diverted away from the Green River and into the Stuck River channel, which then flows into the Puyallup River five miles downstream. The White River naturally carries a high sediment load and transports large volumes of gravel and cobbles as bedload due to its origin in glaciers of Mount Rainier and due to the relatively steep gradient of the channel from its headwaters to the project site area. The project site is located within a reach of the river where suspended sediments and bedload transported from upstream deposit in the channel and the adjacent floodplain. The Stuck River channel at and near the site area was dredged repeatedly to contain White River flows in the decades that followed the diversion of flow from entering the Green River. Since dredging practices ceased in the 1980s, the river has continued to aggrade, reducing its flood flow conveyance capacity between the banks. Flows now overtop the levee on the left bank near the county line (at river mile [RM] 5.5) when discharge reaches 3,500 cubic feet per second (cfs) (Figure 2), corresponding to a flow that typically occurs several times per year. Overtopping flows enter the lower part of the wetland in the historical floodplain and return to the main river channel over a low spot along the revetment access road (currently a constructed ford where a blocked culvert is located).

The Countyline Levee does not meet current flood risk reduction standards and is eroding near the county boundary line. The lower (landward, southeastern) wetland edge, which is contained by an earthen berm constructed by private landowners after the January 2009 flood, overtops when discharge reaches about 7,500 cfs, sending flows down 142nd Street and over Stewart Road SE (8th Street E). This corresponds to less than a 2-year recurrence (50% annual chance of exceedance) flow. As described in detail later in this report, hydraulic modeling of the 100-year flood event (15,500 cfs; the 1% annual chance of exceedance flow) with existing topography indicates that one-third of the total flow (about 5,000 cfs) would move through this area (i.e., along 142nd Street toward and over Stewart Road SE). This overbank flood hazard poses significant risks to Stewart Road SE, which is a local commercial and commuter corridor between State Route 167 and the Lakeland Hills development (in the City of Auburn) and Lake Tapps (in the City of Bonney Lake), as well as existing commercial




Legend

- Stream
- Project site
- Proposed setback levee
- City boundary
- County boundary
- Railroad

**Figure 1.**
**White River at Countyline Project Site and Vicinity Map.**

N

0 750 1,500 3,000 Feet

USDA, Aerial (2013); King County GIS Center (2013); Pierce County GIS Center (2010)

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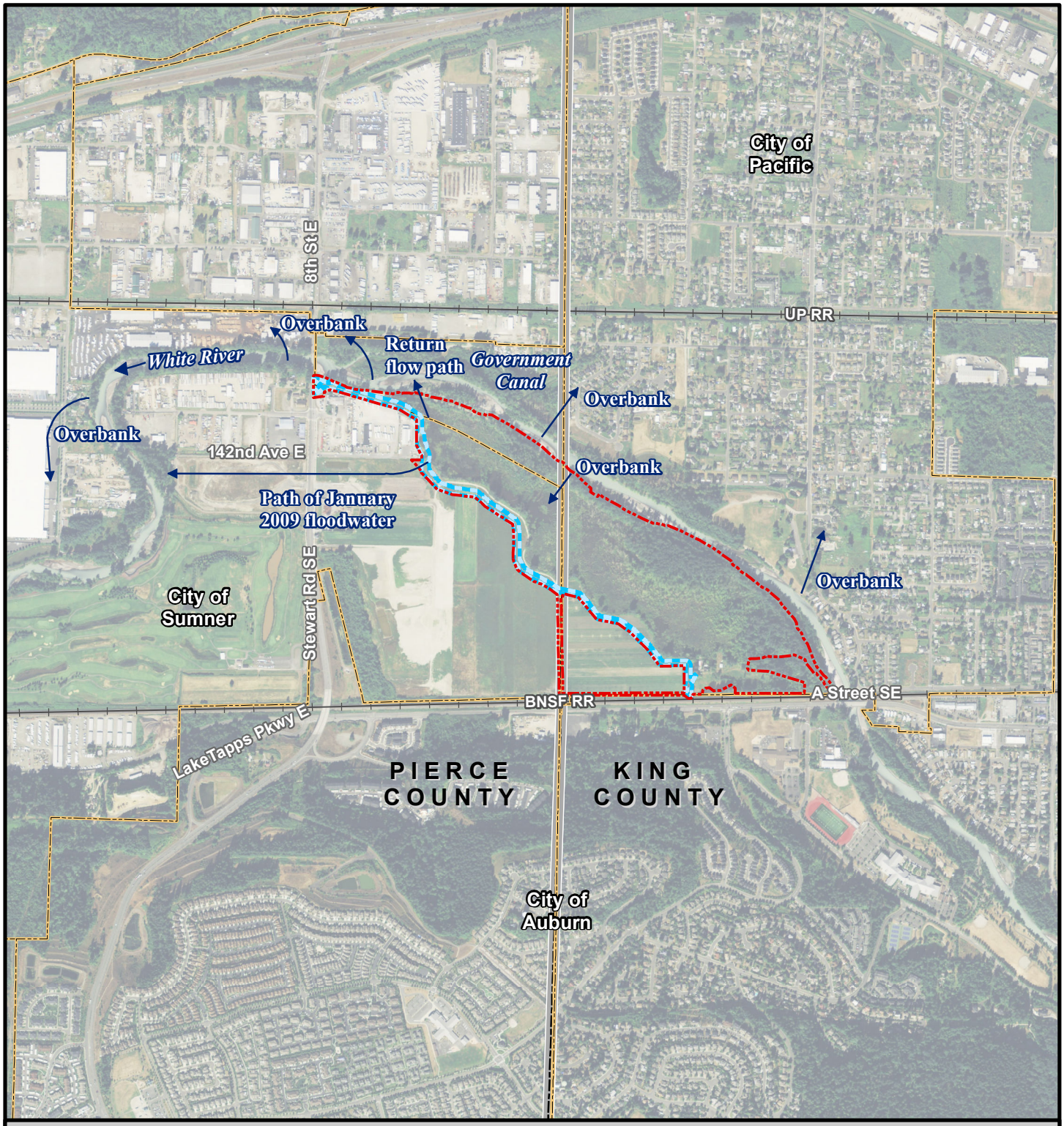


## Legend

- Project site
- Flow direction
- City boundary
- Proposed setback levee
- County boundary
- Railroad

**Figure 2.**
**Existing Flood Flow Patterns.**

N

0 750 1,500 3,000 Feet

USDA, Aerial (2013); King County GIS Center (2013); Pierce County GIS Center (2010)

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and industrial development and planned commercial and residential land uses on the south side of Stewart Road SE.

The lower White River has been the subject of numerous studies carried out by King County and the US Geological Survey (USGS) to characterize historical and existing sediment deposition patterns. Monitoring of sediment deposition and 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 cubic yards of sediment (approximately 70 percent gravel and 30 percent sand) is deposited each year in the river channel between the A Street SE and 8th Street E bridges. Additionally, approximately 75 percent of the bedload passing beneath the A Street Bridge each year is deposited in the 1.33-mile project reach. Over the past 27 years, since river dredging operations ceased in the mid-1980s, the White River has aggraded an average of 5 feet within the project reach. The extensive aggradation has reduced the flood-carrying capacity of the channel in this reach by half since the mid-1980s and by two-thirds compared to the original 1914 channel design.

Hydraulic model results indicate that without the Countyline project, the White River channel will fill with sediment at the King-Pierce County boundary line in approximately 15 years (assuming the same historical rate of sediment aggradation). Triggered by a channel plugged with sediment, the river would avulse through the path of least resistance, which includes the existing left bank levee, wetland, agricultural fields, and onto Stewart Road SE, a major traffic corridor located southeast of the project site. The property damage, threat to human safety and the lack of vehicular access due to closure of Stewart Road SE resulting from an avulsion would be significant.

## Geology, Soils, and Groundwater

The valleys of the White and Green rivers are underlain by Late Pleistocene and Holocene alluvium deposited in a glacial trough scoured out by the Puget ice sheet (USGS 1995). Up until approximately 5,600 years ago, the coastline of Puget Sound extended inland to the present-day location of Auburn. The collapse of the Mount Rainier Summit approximately 5,600 years ago released 3.8 cubic kilometers (0.91 cubic miles) of volcanic material that swept down the White River valley as a series of lahars (known as the Osceola mudflow) that reached present-day Port of Tacoma and Kent. Smaller, subsequent lahars generated from Mount Rainier, mass wasting debris, and alluvium supplied by the White River filled in the White River and Green River valleys to the Port of Tacoma and to Elliot Bay near Seattle, respectively. Sediments underlying the White and Green river valleys therefore include peat, mass wasting debris, mudflow sediments, and fluvial and deltaic sediments.

The project area is located on the southern edge of the White River alluvial fan laid down over the past 5,000 years by the reworking of lahar sediment stored in the White River canyon and recent glacial sediments supplied by Mount Rainier. The alluvial fan formed as a result of sediment deposition at the abrupt reduction in channel slope that coincides with the former coastline of Puget Sound. The river in the project site area was known as the Stuck River, an overflow outlet distributary channel of the White River. Prior to the major flood in 1906, the bulk of the White River water and sediment exited the White River canyon at what is now approximately RM 8 and flowed north to join the Green River near Auburn (Appendix B).

During the 1906 flood, the main flow of the White River avulsed to the old Stuck River channel. The construction of the "Auburn Wall" in 1915 made the change permanent. Additional information on the historical characteristics of the Stuck River is contained in the *Geomorphic Assessment, White River at Countyline Levee Setback Project* provided in Appendix B.

Alluvium found in the valley of the White River, designated as "Qal" on geologic maps, is a geologic unit considered to be an important aquifer. Few wells fully penetrate the Qal unit in the study area, so the thickness of the unit generally is not known. Near the steep slopes of each valley, Qal is interbedded with and sometimes overlain by mass-wasting debris (USGS 1995). The liquefaction potential of the area is indicated as "moderate to high" in the most recent liquefaction susceptibility mapping (Palmer et al. 2004).

Soils within the project site are sands, silts, and silty sands with layers of fine pervious sands in the subsurface. Groundwater was encountered in all of the borings drilled for this project, at depths ranging from 1.6 to 6 feet below the ground surface at the time of drilling (see Appendix H). Groundwater levels fluctuate in response to the seasons, rainfall levels, and water levels in the White River. Groundwater beneath the upstream portion of the setback levee area is influenced by the White River upstream of the project site through deeper pervious sand and gravel layers. Groundwater in the southern portion of the setback levee area is also influenced by flow through pervious layers in the alluvial fan and responds to the rise and fall of the river when the river overtops into the wetland and flows along the southern edge of the wetland. Groundwater levels in piezometers installed along the southern edge of the wetland have been measured higher than the ground surface. Standing water has been routinely observed in the agricultural area east of the site during non-rainy periods, further indicating that the shallow groundwater level is often at or near the ground surface in much of the project site.

## Geomorphology

Appendix B summarizes the existing geomorphic conditions at the project site. Currently, the river is threatening to avulse through the left bank floodplain wetland near the county boundary line as a result of the mainstem channel aggrading to an extent that left bank overflow occurs with increasing frequency. This increases the risk of flows overtopping Stewart Road SE, and returning to the existing main channel near the former Sumner Meadows Golf Course. Under non-flood conditions, water in the left bank floodplain wetland returns to the river at the southwest edge of the project site (Figure 2), mostly as hyporheic flow. During flood conditions, as occurred in January 2009, water overtopped the low bank at the southeast corner of the wetland and flowed over Stewart Road SE. *Ad hoc* earthen berms have been placed by property owners to prevent further flow from exiting the wetland and flowing through fields to the southeast and across Stewart Road SE, though these small berms could overtop and are unlikely to withstand floodwaters during a large flood event.

The potential avulsion would be triggered by ongoing sediment deposition in the river channel upstream, downstream, and within the project site. As detailed in Herrera (2010), the entire reach between A Street SE and 8th Street E has been aggrading significantly since dredging

stopped in the 1980s. For instance, up to 6 feet of deposition has occurred in the channel at the 8th Street E Bridge since the cessation of dredging in the 1980s (Appendix C).

Overall aquatic habitat conditions are moderate to poor because the channel is confined by levees and revetments on both banks, particularly along the segment of the channel extending several thousand feet downstream of A Street SE. While large wood (LW) deposits onto gravel bars and remains within the main channel throughout the reach between A Street SE and 8th Street E, the confinement of the channel tends to flush most LW downstream during floods, with some of this wood accumulating on the 8th Street E Bridge piers and other in-channel obstructions downstream.

## Hydraulics

The hydraulic modeling used to support engineering design of the Countyline project is different than other available hydraulic modeling completed for the purposes of flood studies prepared for the Federal Emergency Management Agency (FEMA) flood insurance program. The hydraulic modeling used to support engineering analyses and project design development utilized the topographic surface obtained from bathymetric survey and lidar collected by King County in 2011. When compared to the input data used in the King County (2009) Draft Flood Insurance Study prepared for FEMA purposes, this 2011 data reveals a large amount of recent in-channel sediment aggradation, which in some cases has raised the channel bed surface several feet higher. The modeling for the King County 2009 Draft Flood Insurance Study was based upon survey data collected in 2007 and 2008, but the hydraulic model of existing conditions used for Countyline project analysis and design purposes was calibrated to high water mark elevations from the January 2009 flood event. Because of reduced in-channel flow conveyance capacity due to the increased channel bed surface elevations, and because of the different hydraulic model types (described below), the estimated water surface elevations resulting from the project design modeling, presented and discussed herein, are generally higher (sometimes by several feet) in the project area and surrounding areas than those shown on the 2009 Draft Flood Insurance Study maps produced by King County.

In addition to the differences associated with the 2011 topographic surface, the hydraulic model used for the Countyline project analysis and design (developed with the RiverFLO-2D software program) is a two-dimensional model capable of simulating flow throughout the floodplain with greater accuracy than the one-dimensional model created with the HEC-RAS software program for the King County (2009) Draft Flood Insurance Study. HEC-RAS can only simulate flow perpendicular to individual topographic cross-sections that are determined by the user and entered into the model. Two-dimensional modeling is a superior tool for assessing existing conditions at the project site because it explicitly calculates the relative amounts of flow in flow splits near the county boundary line and at other locations, particularly at the potential avulsion pathway over Stewart Road SE, east of the 8th Street E Bridge, rather than flow conditions at specific cross-section locations imposed by the model user. The one-dimensional HEC-RAS model is limited in its applicability to accurately simulate the dynamics of multiple split flows, whereas RiverFLO-2D can produce estimates of water surface elevations that more realistically portray these types of flow patterns through the duration of a simulated flood event.

A RiverFLO-2D model of existing site conditions was developed and refined several times (Appendix D). These updates included expanding the model domain, adding breaklines to resolve detailed topography and to properly simulate flow near critical points (such as over the left bank levee immediately downstream of the A Street Bridge and in the vicinity of Government Canal), and adding input data to define hydraulic structures (such as culverts) and buildings.

The final existing conditions model simulation is summarized in Appendix E. The final hydraulic model simulation demonstrates that widespread flooding can occur under existing conditions, including large areas of developed land in the City of Pacific on the opposite (west) side of the river from the project site, without temporary flood-protection measures in place. Significant flooding is also predicted to occur over Stewart Road SE in the same general area as occurred in January 2009 (centered approximately 1,000 feet east of the 8th Street E Bridge). The model of the 100-year recurrence flood event indicates that extensive flooding would persist south of the project site over both banks of the river. On the right bank, the hydraulic connection of the river to Government Canal near the county boundary line allows flood waters to inundate areas along Butte Avenue. The downstream extent of this area is hydraulically disconnected from the river due to topographic barriers imposed by dredge spoil mounds east of Butte Avenue, the Union Pacific Railroad embankment to the west, and the 8th Street E road prism to the south. Without a path for flow to return to the river, the depth of flooding is exacerbated in this area. On the left bank, flows overtopping the *ad hoc* earthen berm at the south end of the wetland in the 100-year flood event would inundate the area east of 142nd Avenue SE, cross Stewart Road SE, and return to the main channel near the meander at RM 4.4, approximately one-half mile downstream of the 8th Street E Bridge. Flooding over both banks is expected to be significantly higher in elevation and more extensive than what is shown in the 1987 FEMA Flood Insurance Rate Map (FIRM), which the City of Sumner uses for floodplain development regulation, and slightly higher than the water surface elevations estimated per the King County (2009) Draft Flood Insurance Study that the City of Pacific uses as best available flood data for floodplain development regulation.

## Fish and Wildlife Habitat

Juvenile and adult anadromous and resident fish migrate through the mainstem White River during certain times of the year. Salmonid presence in the Lower White River include Chinook, coho, chum, sockeye, and pink salmon, steelhead and cutthroat trout, and bull trout. Levees and riprap revetments constructed on both banks of the river have shortened the river length, reduced access to side channels and floodplain wetlands, reduced the quality of riparian habitat for fish and other aquatic species, reduced the recruitment of large wood to the river, and altered the character of sediment transport and deposition. Consequently, aquatic habitat within the White River is simple and consists of fast water, with few pools or off-channel habitat for rearing. These conditions provide poor habitat for juvenile salmon, making the river less productive for many species at critical life stages. The loss of rearing habitat has been identified as the main limiting factor in the Lower White River (Kerwin 1999; Pierce County 2012).

The project area also comprises a portion of the Pacific Flyway used by waterfowl and other migratory bird species. Wildlife observed or known to be on or near the project site at various

times throughout the year include hawks, great-blue heron, bald eagle, songbirds, belted kingfisher, merganser, dipper, beaver, otter, vole, mouse, salmon, trout, char, whitefish, sculpin, dace, Northwestern salamander (egg masses), long-toed salamander (egg masses), pacific tree frog, American bullfrog, and Northern red-legged frog (adult).

Five wetlands and a small stream are present within the portion of the project area to be reconnected to the White River floodplain (wetlands A, B, C, D and E; and Stream A). Wetland A is a 0.16-acre riverine flow-through wetland extending along the upstream portion of the left bank. Vegetation consists mostly of red alder (*Alnus rubra*) and Sitka willow (*Salix sitchensis*). Wetland B is a 77-acre, mixed-class depressional outflow wetland that covers most of the low ground between the existing levee and adjacent agricultural lands. It contains palustrine forested, palustrine scrub-shrub, and palustrine open-water wetland classes. Black cottonwood (*Populus trichocarpa*) and red alder dominate the canopy, salmonberry (*Rubus spectabilis*) and red-osier dogwood (*Cornus sericea*) dominate the shrub layer, and grass dominates the herbaceous layer. Wetlands C, D, and E are small depressional wetlands located at the far north end of the forested area between the existing levee, the railroad, and a residential property. Stream A is a small (Type Np: non fish-bearing, perennial) stream that flows for about 600 lineal feet between Wetland B and Wetland C. Other tree, shrub, and emergent plant species present in the project area include Douglas-fir (*Pseudotsuga menziesii*), Western red cedar (*Tsuga heterophylla*), snowberry (*Symphoricarpos alba*), cattail (*Typha latifolia*), creeping buttercup (*Ranunculus repens*), skunk cabbage (*Lysichiton americanus*), Himalayan blackberry (*Rubus discolor*), and reed canarygrass (*Phalaris arundinacea*).

The project site is heavily vegetated along the existing left bank levee and within the forested portions of the left bank floodplain wetlands. The Countyline Levee has prevented channel migration for nearly 100 years, allowing trees to mature on the banks of the levee and to persist in much of Wetland B. Sedimentation and persistent and increased frequency of ponding (caused by rising groundwater levels related to the sedimentation) in the deeper areas of the wetland has either prevented establishment of dense forest stands or has caused tree mortality. As a result, there are several snags (mostly cottonwood) at the downstream end of the wetland.

Results of baseline project monitoring indicate that juvenile salmonids in the project reach choose side-channel and backwater habitat over fast-moving water bar and bank habitats. The proposed project will increase the amount of slow-water edge habitat significantly over the currently armored and channelized condition.

## Recreational Use

The White River is used for several types of recreational activities in the project site vicinity including fishing, casual floating, canoeing, and kayaking. Recreational use in the Lower White River is relatively low compared to other King County rivers due to the cold water temperature, rocky substrate, and high turbidity of the glacially fed system. The project will change the course of the river through the project site, and as such will affect these recreational uses over time. A Public Safety Management Plan will be prepared by King County in accordance with the Department of Natural Resources and Parks policies and

procedures for capital improvement projects involving large wood placement. The plan will characterize existing public safety hazards and risks, the potential change in these risks as a result of the project, and how any new risks will be mitigated with adaptive management actions. The plan will also present a management approach that integrates coordination among multiple jurisdictions and regulatory agencies having roles and responsibilities along the White River. The plan will provide a framework for monitoring and adaptive management, and will be updated after construction to address any new public safety concerns as conditions change.

# Constraints and Opportunities

Project constraints include various physical, economic, regulatory, public safety, and cultural issues that present potential barriers to achieving the project goals and objectives. Opportunities include features that would result in greater project benefits, eliminate a project constraint, or allow the project goals to be met within the identified constraints. The various constraints and opportunities identified for this project are described in the following sections.

## Constraints

Project constraints limit the development, extent, and efficacy of the flood risk reduction and salmon recovery benefits that can be accomplished with the Countyline project, or else force a design change to accommodate the constraint. The effectiveness of the project in achieving its goals and objectives is limited by the constraints identified below.

### *Physical (Habitat, Geomorphic, and Geologic)*

- The project area encompasses a large forested wetland in the area of a former channel that will likely be re-activated under proposed conditions. Construction of ELSs in the wetland will disturb portions of the wetland and will require the placement of permanent fill in the wetland within the footprint of the structures. To minimize wetland impacts, the construction access routes for the ELSs need to be constrained. The temporary wetland impacts will be mitigated by the off-channel habitat created by the project.
- The large wetland encompasses several areas that are perennially inundated, while other areas have groundwater within 1 to 2 feet of the ground surface based on monitoring data collected by King County. Access into the wetland to construct the ELSs will be constrained by water levels and the extent of vegetation. Anchoring of the ELSs will be constrained by the characteristics of the alluvial soils underlying the wetland soils, with loose soils allowing pile driving, and dense, coarser substrate likely requiring pre-drilling for pile installation.
- The project will eliminate overbank flow on the left bank floodplain and will route all flood water to the 8th Street E bridge crossing. Historical sediment deposition in the channel, sub-standard freeboard beneath the 8th Street E Bridge, floodplain development on both banks, and the Stewart Road SE/8th Street E road prism form an artificial constriction at the downstream extent of the project reach that complicates design efforts to minimize off-site flood impacts.

### *Infrastructure, Property, and Public Safety*

- Hydraulic modeling results indicate that increased occurrence and depth of flooding cannot be avoided on private property located at the northeast area of the site, thus requiring acquisition of the affected property.

- The artificial constriction and sub-standard freeboard conditions at the 8th Street E Bridge cause hazardous conditions that are compounded by the potential for accumulations of large wood on the two in-water bridge piers, thereby resulting in flood risks under both existing and future conditions. Proximal and upstream wood recruitment, onsite wood accumulation, wood export from the project site, and resultant hazards at the 8th Street E Bridge evaluated by King County (2011) during design development indicate that wood flux at the bridge is likely to increase the first few years after construction, and then decrease below existing rates. The project should be designed to minimize wood export from the project site, and a plan for wood management at the bridge should be prepared to address any residual risks that exceed the existing risks at the bridge.

- Private property bordering the east side of the site must be protected from flooding, bank erosion, and channel migration with the construction of the proposed setback levee and ELSs. In order to minimize wetland impacts, construction costs, and mitigation requirements, the proposed structures should be constructed outside of the wetland boundary to the extent possible.

- The wetland is currently bordered by public and private property. Land rights needed for the project include property acquisition in fee and permanent easements for project construction and site management after construction, as well as temporary rights of entry for data collection before construction.

- Coordination with numerous project stakeholders will be necessary for project success. Stakeholders include landowners, Pierce County, City of Pacific, City of Sumner, Muckleshoot Indian Tribe, Puyallup Tribe of Indians, Salmon Recovery Funding Board, recreational users, the Commencement Bay Natural Resource Damage Assessment & Restoration Program Trustees, and local, state, and federal permitting agencies.

- Project planning will need to consider river recreational use, and King County will need to prepare a Public Safety Management Plan as described above to monitor and manage public safety hazards and risks. Project planning will also need to follow established King County procedures and be compliant with all regulatory requirements for considering public safety when placing large wood or modifying any naturally occurring wood in King County rivers.

### *Project Funding, Schedule, Permitting, and Regulatory Issues*

- The construction cost for the 60% design of the Countyline project is currently estimated to be $9,600,000 (2013 dollars), including tax and 15 percent contingency. This amount does not include the estimated costs for any necessary property acquisitions or construction management and inspection.

- The setback levee and biorevetment must be in place prior to the removal of the existing levee and onset of the first ensuing flood season. Construction of the setback levee and biorevetment is estimated to require approximately 3 to 6 months depending on work production rates and the allowable construction timing for in-

water work dictated by project permits. As a result, two separate construction phases (carried out over two summer construction seasons) will be necessary: one to construct the setback levee and biorevetment, and one to remove the existing levee. Construction of ELJs in the wetland can be completed during either construction period.

- Several local, state, and federal permits and regulatory approvals will be required for the project. Review times for permit applications may affect the project construction schedule. The following permits and approvals may be necessary:
  - Permits and approvals at the local level are required from the cities of Sumner and Pacific and from Pierce County. Such permits may include a Floodplain Development Permit, Shoreline Permit, Clearing and Grading Permit, Critical Areas review, and compliance with compensatory storage requirements for fill placed in the floodplain in relation to the setback levee.
  - At the state level, a Hydraulic Project Approval (HPA) will be necessary from WDFW for work waterward of the ordinary high water mark (OHWM) of the river and wetlands. The Washington State Department of Ecology (Ecology) will require a Clean Water Act Section 401 Water Quality Certification for work occurring in wetlands. In addition, a National Pollutant Discharge Elimination System (NPDES) permit will be required by Ecology because there will be more than 1 acre of earth disturbance associated with construction activity. An Aquatic Use Authorization from the Washington Department of Natural Resources (WDNR) will not be necessary for work along the shores of the White River because the river is not within WDNR jurisdiction.
  - At the federal level, a Clean Water Act Section 404 Permit from the US Army Corps of Engineers (USACE) is required for work waterward of the OHWM of the river and within regulated wetlands. Necessary approvals associated with the USACE permit include compliance with the Endangered Species Act (ESA) and Section 106 of the National Historic Preservation Act (NHPA).
  - A Conditional Letter of Map Revision (CLOMR) will be required from FEMA due to modifications of the area of the site that will be inundated in a 100-year flood event as compared with the FEMA Flood Insurance Rate Map that is published for the site area. FEMA is updating the Levee Analysis and Mapping Procedure (LAMP) for non-accredited levees and is not reviewing CLOMR applications at the time of this writing. King County will work with FEMA, the Washington State Department of Ecology, Pierce County, and the cities of Pacific and Sumner to update the Flood Insurance Rate Maps when the LAMP is finalized.

## Opportunities

Multiple opportunities were identified during design development as integral to achieving the project goals and objectives within the constraints summarized above.

- Large ELJs can be positioned within the wetland in locations where a channel is anticipated to form, thereby providing opportunities for long-term accumulations and storage of naturally-occurring large wood. Following removal of the existing levee, a channel avulsion into the wetland may occur at several locations; therefore, these ELJ types can be designed and positioned to allow flow to impinge upon the structure from a range of angles and to encourage formation of side channels. These ELJ types can also be placed to deflect flow away from the setback levee and to split flows near the downstream end of the project. These hydraulic effects will dissipate energy as the flow re-enters the existing White River channel.

- Removal of the existing levee alone (without constructing ELJs in the wetland) will provide salmonids access to the off-channel habitat within the wetland and accomplish several of King County's habitat objectives. Disturbances and costs associated with ELJ construction in the wetland can be reduced by installing a lesser number of ELJs than originally conceived, with ELJs only sited in select locations to maintain or reduce geomorphic hazards due to the project. These ELJs will also provide additional fish habitat and meet King County's habitat objectives for the project.

- The constructability of ELJs within the wetland can be improved if water levels can be lowered to within a foot or two above the ground surface prior to construction. The water surface elevations of the river and wetland during the proposed construction period need to be compared to assess the influence of groundwater seepage and to determine the feasibility of this proposal. Regardless of when the ELJs in the wetland are built, removal of the downstream portion of the existing levee and construction of the wetland outlet channel will naturally allow water to flow from the wetland back into the White River when water levels in the river are lower than in the wetland, thereby lowering water levels in the wetland during construction. Therefore, sequencing of structure construction, levee removal, and some lowering of surface water levels in the wetland can be planned to improve the log structure constructability and to minimize structure costs and temporary wetland habitat impacts.

- Removing a large portion of the existing levee and establishing access to ELJ construction sites in the wetland will require removing a large quantity of trees and shrubs. Some of this woody material can be incorporated into the ELJs, biorevetment, or floodplain roughening to reduce the need for imported woody material, which in turn reduces construction costs.

- Additional reductions in construction costs can be realized by using levee removal spoils as backfill material in the ELSs. This material is likely ideal for this function because of the anticipated course gradation, which improves structure longevity and structural deformation factors of safety. Levee removal spoils can also be used for the outer layer of the setback levee that will be constructed over the inner, fine-grained core of the levee. Riprap removed from the existing levee face can be used in construction of the riprap toe protection on the southern portion of the setback levee.

# Concept Alternatives Development and Evaluation

## Range of Alternatives Considered

Several concepts for flood risk reduction were considered by King County for this site, including sediment dredging in the river channel, a setback levee, and raising the existing left bank levee. Based upon a study by the US Geological Survey (USGS 2010), dredging would provide only short-term benefits, and much less flood reduction benefits than a setback levee can provide. To obtain federal permits for river dredging where endangered salmonid species are present, as is the case in the lower White River, it must be shown that no other feasible alternatives (like setting back a levee) exist. Dredging would require extensive habitat mitigation in the lower White River or Puyallup River Basin, likely in relation to each dredging operation, which would have to occur repeatedly into the future given the prevailing sediment loading and deposition at the site. Since salmonid rearing habitat is a limiting factor in the lower White River, mitigation dollars would likely be spent on a levee setback project elsewhere.

Raising the existing left bank levee at the project site was determined to be infeasible because the concomitant sediment aggradation would require new roadway and railroad bridge construction upstream of the raised levee section and would raise flood elevations both within the project reach and upstream of the site, triggering the need to raise levees on both banks for a distance extending several miles upstream. These actions would also face significant challenges with permitting and incur substantive mitigation costs. The overall cost of this option would be considerably greater than the proposed setback levee option.

Based on this initial analysis of alternatives, the levee setback option was selected as the preferred approach for cost, feasibility, and permittability reasons. In addition, it would provide beneficial attributes for aquatic and riparian habitat in an area of historical floodplain that has been disconnected from the river channel for nearly a century.

An analysis of potential project alternatives for the Countyline Levee Setback project was conducted in 2008 to support development of the 30% design plans. The analysis (King County 2012) evaluated four alternatives: complete levee removal with and without a setback levee, and a notched levee removal with and without a setback levee. All four of the alternatives included a biorevetment and vegetated buffer along the eastern project boundary and interior engineered logjams (ELJs). Each alternative was ranked according to an analysis of project benefits and risk with respect to performance criteria. Alternative 2 (complete levee removal with a setback levee) ranked highest and was used as the basis for further development of the project design.

The 30% design for the alignment of the setback levee and the location and number of ELJs in the setback floodplain was subsequently modified to address future flood elevations predicted

by the updated hydraulic modeling and to address challenges with constructing large ELJs in open water in the large wetland. The following section provides a detailed description of the major components of the proposed project at the 60% design level.

# Proposed Project Configuration

The project is expected to be constructed over two years. Four apex ELJs, four deflector ELJs, and segments of a biorevetment will be constructed within the large floodplain wetland. The ELJ construction will occur before the existing levee is completely removed, and therefore may not be subject to permitted, in-water work windows for fish. The remainder of the biorevetment, setback levee, and floodplain roughening structures will be constructed in upland areas, parts of which are within the regulated wetland buffer. Portions of the existing levee removal and water management for this work will occur below the OHWM and will therefore be subject to permitted, in-water work windows for fish protection.

Water management methods will be used to divert clean flow, isolate work areas, pump turbid construction water for treatment, establish infiltration areas, manage construction water storage and discharge, and avoid impacts on water quality. Water pumped from excavations will be pumped to approved infiltration areas or on-site storage tanks. The existing levee will remain intact during the winter season between construction years one and two to maintain the existing level of flood protection.

Construction year one will include construction of most interior project elements, including access roads, a significant portion of the setback levee, the biorevetment, floodplain roughening structures, ELJs, revegetation of the wetland buffer, and relocation of utilities. Year one work may also include limited excavation of the landward edge of the existing levee prism (for re-use as backfill material for the ELJs and biorevetment), removal of an existing culvert, and residential structure demolition. Construction of ELJs may span two consecutive construction years.

Construction year two will include completion of any ELJ and setback levee construction not completed in year one, removal of the existing levee and riprap revetment, culvert removal and construction of the outlet channel, revegetation of the wetland buffer, and restoration activities needed to complete the work. Construction of individual project components is described below.

## Setback Levee and Biorevetment

The setback levee will extend 6,000 lineal feet from the upstream tie-in point at the BNSF railway embankment to the downstream tie-in point located on the north side of the eastern approach to the 8th Street E Bridge. Levee side slopes will be graded at 2.5H:1V (horizontal to vertical). The levee will range in height from 6 to 12 feet above the existing grade. The levee height includes 3 feet of freeboard above the anticipated water surface elevation in the 100-year flood event should it occur immediately after construction, plus an additional 2 to 3 feet of reserve freeboard to accommodate future anticipated sediment aggradation over the service life of the project. The footprint for the setback levee is located primarily within existing agricultural fields and will be prepared by first stripping off any

vegetation. The upper 1 foot of soil will be removed and weed-free soil will be stockpiled on-site for later reuse as topsoil. A levee core consisting of fine-grained (low-permeability) material will be placed and compacted in 6- to 8-inch lifts. The remaining levee prism, also placed and compacted in 6- to 8-inch lifts, will consist of on-site alluvium obtained from the excavation of the existing levee or from imported, pit-run material. Twelve to 18 inches of topsoil obtained from both on-site and imported sources will be placed on the waterward slope of the levee, and 12 inches of topsoil will be placed on the landward slope of the levee. Four inches of imported road base will be placed on the top of the levee as surfacing for a 15-foot-wide gravel access road/trail. The levee slopes will be planted with native vegetation.

The biorevetment, wetland buffer, and floodplain roughening hummocks will protect the setback levee from channel migration and erosion by deflecting high-energy flows back into the reconnected floodplain and by reducing flow velocities along the face of the setback levee. More detail on the biorevetment and other log structures included in the design is provided in the *Basis of Engineering Design* section later in this report. The southern extent of the setback levee lacking a significant vegetated buffer will include buried riprap toe protection to prevent scour during flood events from undermining the toe. The riprap will only extend up to an elevation corresponding to the post-construction, 100-year water surface elevation. The remaining 5 to 6 feet of the levee side slope will be covered with topsoil and planted with native vegetation in accordance with the planting plan.

## Existing Levee Removal

Most of the existing left bank levee prism will be removed down to the elevation of the OHWM between RM 5.2 and 6.1. Portions of the levee will remain undisturbed to preserve clusters of trees. Approximately 5.8 acres of the existing levee will be cleared of vegetation before excavation. This includes the gravel access road, invasive vegetation, native vegetation, and trees growing on the existing levee. About 31,500 cubic yards of native alluvium and 3,000 cubic yards of riprap will be excavated with trackhoes and loaded onto dump trucks for removal and reuse on-site as is feasible. Non-native levee material (primarily riprap) will be stockpiled for reuse as is feasible in construction of the bank protection along portions of the setback levee. Native material will be used as backfill for ELJs and other project components in a way that does not restrict floodplain capacity and that minimizes the potential for juvenile fish stranding. In-water work areas will be isolated using turbidity curtains and/or bulk bags to protect water quality.

## Northern Levee Terminus Resurfacing and Biostabilization

Approximately 300 lineal feet of bioengineered bank protection is proposed at the tip of the northern end of the existing Countyline Levee adjoining the BNSF railway embankment that will remain after construction. The bioengineered bank protection is necessary to stabilize the levee in this area, direct flows into the reconnected floodplain area at a fixed location, and prevent potential upstream impacts, such as “nick point” propagation and associated bed scour at the BNSF and A Street bridge abutments and footings. This northern levee terminus bank protection is also necessary to prevent channel migration and potential cross-stream impacts that could be caused by toe scour along the BNSF railway embankment immediately

south of the A Street Bridge. The waterward slope at the tip of the remaining levee section will be excavated to elevation 70 feet (NAVD88) to key in the riprap toe protection. A 3-foot-thick layer of riprap facing will be placed from elevation 70 feet up to elevation 83 feet (corresponding roughly to existing ground and the OHWM), and the excavation will be backfilled with native alluvium to near existing ground. The new slope of the levee above OHWM will be biostabilized with coir-wrapped soil lifts and live willow cuttings (8 feet long, four to six stems per lineal foot). Approximately 850 lineal feet of the remaining levee adjacent to the BNSF bridge abutment will be raised and resurfaced with on-site surplus materials or imported pit-run material to prevent overtopping during the 100-year event.

## Northern Access Road

About 1,350 lineal feet of the existing primitive road to the northern portion of the levee will be resurfaced with native alluvium to accommodate construction equipment. A temporary water crossing in Wetland B will be established during construction.

## Southern Outlet Channel

The existing 18-inch-diameter culvert and ford in the access road that conveys left bank floodplain wetland outflows back into the river channel, as well as the southern portion of the left bank levee, will be removed to restore channel connectivity through this area. The ground surface in this area will be graded to an elevation of 66 feet (NAVD88) to allow water to drain freely back into the river and to avoid the potential for fish stranding during low flows before higher winter flows rework this area and establish a natural channel.

## Planting

Revegetation and enhancement of 17.8 acres of wetland and riparian and wetland buffer is included in the project design. About 5,700 trees and 32,000 shrubs and groundcover plants will be planted in wetland buffers, in wetland areas currently maintained as pasture, and in upland areas. Additionally, willow stakes will be installed along the biorevetment to provide overhanging shade in the near-term while other tree plantings mature. Cottonwood boles will be integrated in the biorevetment to promote new cottonwood growth that will provide shade over the long term. About 100 trees and more than 500 native shrubs will be planted on the constructed bars and upper surfaces of the apex ELJs. The levee removal area and construction access route to the ELJs will not be vegetated because they are expected to immediately revert to active channel conditions.

# Hydraulic Modeling and Analysis of Proposed Project Conditions

## Modeling Approach

Initially it was thought that a mobile-bed hydraulic model, using the RiverFLO-2D software program, would dynamically predict both bed surface and water surface elevations. Early hydraulic model calibrations to simulate the January 2009 flood event were of high quality, though there was a slight dependence of the results on the grid spacing forming the computational mesh resolution in the model and the "build" version of RiverFLO-2D (Herrera 2011). Therefore, a single model version (99g) was selected to be the version used throughout the preliminary hydraulic analysis simulations with a variable grid resolution corresponding to approximately 33,000 elements (see Appendix D), though more elements were added as complexity was added to the model in later simulations.

Early results of the sediment transport component of the mobile-bed hydraulic model indicated that it could not replicate known geomorphic behavior accurately enough for engineering design purposes (Appendix D). Therefore, it was decided that an iterative approach to predicting geomorphic change would be most appropriate to simulate the flooding characteristics in the future rather than relying upon simulated geomorphic conditions. The process by which future conditions topographic surfaces were created (representing conditions with and without project construction, accounting for ongoing sediment accumulation in the river channel and left bank floodplain) is described in detail in Appendix F. Once the floodplain surface creation approach was developed, the approach to the hydraulic modeling could be developed. This approach and preliminary results of some of the limited-domain scenarios are described in Appendix G. The limited model domain (the geographic area contained within the computational mesh, described further below) extended approximately from RM 4.4 to RM 6.6. The final hydraulic model simulations, based upon an expanded domain extending downstream of the 8th Street E Bridge to RM 2.5 and further west and east into the cities of Pacific and Sumner, were performed with Version 3 of RiverFLO-2D at a comparable grid resolution to the earlier calibrated simulations. Details of the final model simulations are presented in Appendix E.

## Model Scenarios

Many model scenarios were developed throughout the course of the design process. These simulations are summarized in Table 1 of Appendix E. In several cases, these model results had flow filling the floodplain to the edge of the model domain (i.e., flow encountered the model boundary, which effectively acts as a vertical wall). Some other of these simulations had unacceptably high (greater than 5 percent) conservation of mass errors. Details about why these errors occurred and why in many cases the conservation errors did not affect the results from an engineering design perspective are included in Appendices D and I. Most of the

conservation errors in the limited-domain model only impacted the model results downstream (south of) 8th Street E / Stewart Road SE, where significant flow left the downstream model boundary in the floodplain instead of in the channel. Since the limited-domain scenarios were generally used for the engineering design of project components (e.g., setback levee and ELJs) within the project site and far from the model domain boundaries, they were deemed sufficient for those purposes.

Final modeling of post-construction conditions for the preferred alternative compared with the model results for existing conditions is presented in Appendix E. The difference between these two model scenarios illustrates the immediate post-construction changes in flood elevations that are expected. These changes are discussed in detail below.

## Model Refinements Based on Earlier Simulations

The model was continuously updated throughout the modeling phase of the project. These updates corrected various flow anomalies encountered during preliminary modeling runs and culminated in the final hydraulic model results described in Appendix E. These corrections included the following:

- Refinement of the left bank levee definition within the model throughout its length
- Refinement of the 8th Street E fill prism and road surface definition on both sides of the bridge
- Inclusion of the Butte Avenue culverts over Government Canal on the west side of the river and the 8th Street E culverts that convey a small unnamed creek across the street on the east side of the bridge near the January 2009 overtopping point
- Refined breaklines along Butte Avenue, the BNSF railway prism, a terrace along the left bank of the river near the 8th Street E Bridge, and a revetment along the right bank of the river in the vicinity of the City of Pacific Park to better define the geometry of these features

### *Computational Domain*

The computational domain consists of the topographic surface and hydraulic characteristics of that surface. The domain initially was limited to extend from RM 4.4 to RM 6.6 and out to higher portions of the floodplain on each bank (see Figure 1 of Appendix E for details). From the early model results, it was found that a significant amount of flow overtopped and exited the model outside the active channel (Appendix G). In the southeast end of the computational domain, this generated conservation of mass errors greater than 5 percent. These errors are discussed in detail below and in Appendices G and E. A battery of tests was performed to ensure that these simulations were sufficiently accurate away from the edges of the domain for the purposes of engineering design.

To provide precise and complete simulation of hydraulic impacts of the project, the domain needed to be extended because some changes in post-project water surface elevations were observed where the model results were less accurate and beyond the initial model domain (i.e., near the downstream model boundary). In the expanded model domain, the

downstream boundary condition was extended to approximately RM 2.5 (about 2.4 miles downstream of the 8th Street E Bridge), and the lateral boundaries were extended to the Union Pacific and BNSF railroad prisms on the west and east sides of the river, respectively. In the final model simulations, the flood flow did not contact the model domain boundaries anywhere downstream of the A Street Bridge. The final model results (computed with Version 3 of RiverFLO-2D) also indicated that conservation of mass errors were less than 5 percent, thus achieving an acceptable level of accuracy.

### *Downstream Boundary Conditions*

The downstream boundary conditions were refined throughout the modeling as it was discovered that a key issue is the return of floodwaters to the main channel after crossing over 8th Street E / Stewart Road SE. In the initial model domain simulations, there were two downstream boundary conditions: one for the mainstem channel, and one for the left bank floodplain. The in-channel boundary condition was set by a rating curve (i.e., river stage as a function of discharge) developed by King County for the HEC-RAS model used in the Draft 2009 White River flood study (King County 2009) for flood insurance study purposes, whereas a fixed elevation boundary condition was defined in the left bank floodplain. The final, expanded model domain extended the downstream boundary condition almost 2.5 miles downstream of the project site, assuring that the boundary condition would not affect the simulation of flood flows through the project site and across Stewart Road SE and back into the river. The downstream boundary condition in the expanded domain was set based upon HEC-RAS model results and at a location where the floodplain is relatively narrow. As a result of the refinements to the boundary conditions, the final model results completely resolved the simulation of flood inundation extents, including those areas where the overbank flow across Stewart Road SE returns to the main channel in the vicinity of the former Sumner Meadows Golf Course.

### *Upstream Boundary Conditions*

The upstream boundary conditions were consistent throughout all of the modeling. They consisted of a single distributed flow input 1,300 feet upstream of the A Street Bridge. The input hydrographs for a range of flows are described in Appendix D.

## Final Hydraulic Modeling Results

Results of the final hydraulic model comparison are provided in Appendix E. In summary, the results illustrate that the primary flood response of the project will be to divert large amounts of floodwater into the left bank floodplain wetland, reducing floodwater surface elevations by up to 5 feet from the A Street Bridge to where floodwaters return to the main channel downstream of the county boundary line. The diversion of this water into the lower left bank floodplain wetland will likely generate a headcut emanating near the diversion point, corresponding to the upstream end of the removed levee segment near RM 6.1. This is discussed in greater detail in the next section.

The primary off-site impact of the project is associated with the elimination of split flow over Stewart Road SE and forcing all flow under the 8th Street E Bridge. The net result of the confinement of this flow to the 8th Street E Bridge crossing will be to increase water surface

elevations, flow velocities, and scour depths in the vicinity of the 8th Street E Bridge. These impacts are expected be temporary with the project, as they would occur in the future without the project due to ongoing sediment deposition in the channel. The project is not expected to increase the extent of existing flooding or inundate properties that do not currently flood. While the scour depth at the bridge piers could increase during flood events (see Appendix C), modeling that accounted for the expanded channel depth in the vicinity of the bridge piers indicated that the increases in conveyance brought about by the scour will not compensate entirely for the additional flow, and thus the peak water surface elevation during flood events will increase at the bridge and extend downstream of it (Appendix E). Because of the artificial floodplain constriction created by the bridge crossing and road prism for 8th Street E, the existing flow velocities under the bridge are relatively high during flood events, but the difference in peak flow velocities between existing and proposed conditions is relatively small and is not expected to compromise the bridge. The bridge is also being considered for replacement by the City of Sumner and will be designed to accommodate the increased flows described in Appendix E. The geomorphic implications of this impact are discussed in the next section.

Other off-site impacts will indirectly result due to the redirection of flood flows under the 8th Street E Bridge. They include: increased floodwater surface elevations on the right bank in the vicinity of Butte Avenue and increased flood depths and flow velocities along the right bank downstream of the 8th Street E Bridge to where floodwaters return to the main channel in existing conditions (RM 4.0). There are patchy areas of increases and decreases in simulated flood depths and peak flow velocities in areas downstream of the 8th Street E Bridge on the left bank as well. However, these differences arise largely from the redirection of flow, not from an increase in flood flow volumes in the proposed conditions. Flooding under existing conditions along the left bank properties in this area may pose greater risk now than following project construction because of the risk of an avulsion, in which a significant fraction of the flow of the White River would cross over Stewart Road SE and place properties and infrastructure in this path at great risk. In the proposed conditions, flood flow inundation of these properties south of Stewart Road SE will consistently occur from the west via overtopping of the main channel bank.

# EXPECTED GEOMORPHIC RESPONSE FOLLOWING PROJECT CONSTRUCTION

General geomorphic ramifications of the proposed project are summarized in Appendix B. This includes the potential abandonment of the main channel and the reestablishment of a new channel or network of channels within the wetland of the left bank floodplain. Estimates of the geometry of the new channels are based upon the quantity and location of flow simulated in the final hydraulic model of immediate post-construction conditions. Realignment of approximately half of the river flow into the reconnected floodplain is expected after the first winter following project construction. This will produce a new set of channels that are impossible to predict precisely, except to say that the channels and floodwaters will be contained within the project area, west of the setback levee alignment. These changes could have limited impacts on adjacent infrastructure. The impacts on adjacent infrastructure and measures to reduce these impacts are summarized below.

- **Remaining King County left bank levee and revetment** – Approximately 1,200 feet of the north end of the left bank levee will be left in place to prevent channel migration into the BNSF railway prism and in-channel erosion from concentrating near the BNSF and A Street bridges. The greatest risk of erosion within the site is to the south end of the levee segment that will remain. The hydraulic model results indicate high-flow velocities (in excess of 10 feet per second) in this area. To address this risk, the downstream 300 feet of the remaining portion of the existing levee will be stabilized with a buried rock revetment and bioengineered bank protection. Approximately 850 lineal feet of the remaining left bank levee at its upstream end will be raised and resurfaced to prevent overtopping during the 100-year flood event occurring after future sediment deposition. Under existing conditions, overtopping at this location may occur during a 2-year flood event.

- **BNSF and A Street bridges** – Initially it was thought that removal of the existing levee might initiate a head cut near the point where flow enters the (lower) left bank wetland at the south end of the remaining revetment, raising concerns of scour at the bridges. However, the final hydraulic modeling shows that flow velocities should not increase anywhere close to these bridges. Therefore, changes in channel bed elevation at the bridges can be expected to occur slowly over several flood events, and then only if a head cut from the wetland inlet propagates upstream to the bridge crossings. Additionally, the depth of the head cut erosion at the bridges would need to be significantly larger than the several feet of sediment deposited in the existing channel since the mid-1980s when dredging ceased. Therefore, it is probable that there will be no impact from the project at these upstream bridges. This is supported by the sediment transport modeling that was performed early in design development (Appendix D).

- **Pierce County's existing Left Bank Flood Protection Facility** – The revetment along the left bank between the county boundary line and the 8th Street E bridge is located in unincorporated Pierce County on property owned by Pierce County. Approximately 1,200 lineal feet of this rock revetment will remain in place after construction and will be maintained by Pierce County as part of their inventory of flood-protection facilities. The facility, in combination with revegetation of the adjacent riparian buffer, will provide erosion protection for the new setback levee. Although flood flows and velocities along this facility will increase compared to what they are estimated to be in the existing conditions model, they will not be greater than they were historically due to known variability in the channel location and width (Appendix B). Consequently, this facility is not expected to be adversely impacted by the Countyline project.

- **8th Street E Bridge** – The 8th Street E Bridge is currently at risk of debris accumulation on the two in-water piers and lower bridge chord due to inadequate freeboard in the 100-year flood event. The project-induced elimination of split flow over 8th Street E and redirection of all flood flows to the bridge crossing is expected to reduce the existing freeboard by approximately 1 foot. The City of Sumner is planning to replace the bridge, but not before the Countyline project is constructed. King County will address the temporary increase in risk to the bridge by preparing a Public Safety Management Plan that will outline coordination among multiple jurisdictions and local agencies for monitoring, adaptive management, and emergency response.

  Redirecting all of the flow to the bridge crossing during major flood events could also increase scour at the two in-water bridge piers. Because of this, a separate scour analysis was done specific to the bridge (see Appendix C). The results of this analysis predict an increase in the scour depth that is not expected to impact the bridge because of the large quantity of accumulated sediment at the bridge due to historical deposition, and because the maximum expected scour depth will be several feet above the elevation of the pile caps of the two in-water piers (Appendix B). The new bridge foundation and the low chord elevation of the new bridge deck could be designed to accommodate estimated scour depths and floodwater surface elevations based upon the information documented in appendices to this report.

- **Existing King County right bank revetments** – King County maintains several revetments and temporary flood-protection measures on the right bank between the A Street bridge and the King-Pierce County boundary line. Reduction in flood water surface elevations in this area due to the Countyline project will reduce hydraulic stresses on these revetments. Because of the expected rerouting of floodwaters to the left bank floodplain, it is possible that debris could accumulate in the existing main channel near Pacific City Park and downstream of this point. If this occurs, there is a potential for debris to initiate significant variability in the erosion of the main channel, thereby affecting revetments on the right bank. However, these changes will be local and subdued by the diversion of a significant percentage of floodwater to the left bank floodplain.

# Basis of Engineering Design

This section documents the basis of engineering design for the setback levee and the engineered log structures (ELSs), including the biorevetment and ELJ structures. The assessments of fish habitat conditions, geological and geotechnical conditions, geomorphic conditions and hazards, and the hydraulic modeling results described in previous sections of this report directly informed the design of these structures. A memorandum summarizing the detailed analysis and calculations completed in support of the setback levee is provided in Appendix H. A memorandum summarizing the design and engineering analysis completed in support of the ELSs is provided in Appendix I. The 60% design plans and details showing the proposed setback levee construction, the existing levee removal, the ELSs, the project revegetation plans, and all associated erosion and sediment control measures are included in Appendix J.

## Setback Levee

The proposed setback levee was designed using soils information from drilled borehole investigations and lab data provided by King County. The results of the setback levee design and analyses, and compilation of subsurface data used to support the design is included in Appendix H. The water level used for the levee design was the future 100-year flood peak water surface elevation corresponding to the project design service life (Scenario S1d, see Appendix E). The design of the proposed levee included the following geotechnical analyses:

- Settlement
- Stability
- Seepage

Models used for these analyses are common models for their specific purposes in accordance with USACE design procedures. Modeling procedures and results obtained were in accordance with applicable USACE levee design guidelines, and considered both static and seismic risk conditions.

The minimum factors of safety (FS) for static conditions required by the USACE are shown in Table 1. All levee sections analyzed were determined to be stable for both static and seismic cases. The rapid drawdown case was also analyzed assuming the flood level at maximum elevation and dropping at 0.5 feet per hour.

USACE seepage guidelines state that levee sections with average vertical exit gradients less than 0.5 at the levee toe are not susceptible to piping failure and thus do not require seepage cutoff or other design measures to drain seepage flow. Calculated seepage values were all within the guidelines for exit pressures; however, existing high groundwater conditions, that are evident at the project site even during drier summer months, will not be alleviated by construction of the setback levee. Some minor seepage through the levee foundation

materials may occur during extreme flood events and cause groundwater levels to rise at the toe of the levee. However, the slightly higher groundwater levels would be far less of a concern than the extensive flooding of the area that would occur without the setback levee. Due to existing groundwater conditions, the design of roads and structures behind (east and south of) the setback levee will need to consider additional measures to address shallow groundwater conditions. Although the construction of the setback levee will not alleviate the shallow groundwater conditions, it will block high water levels in the river during a flood event that would otherwise inundate some off-site areas.

**Table 1. Minimum Factors of Safety Required by the USACE (2000) for Levees under Static Conditions.**

| Design Condition | Minimum F.S. |
|---|---|
| Rapid Drawdown | 1.0 to 1.2 [a] |
| Long Term (Steady Seepage) | 1.4 [b] |

[a] Sudden drawdown analysis. F.S. = 1.0 applies to pool levels prior to drawdown conditions where these water levels are unlikely to persist for long periods preceding drawdown. F.S. = 1.2 applies to pool level likely to persist for long periods prior to drawdown.

[b] For existing slopes where either sliding or large deformation has occurred previously and analyses have been performed to establish design shear strengths, lower factors of safety may be used. In such cases probabilistic analyses may be useful in supporting the use of lower factors of safety for design.

Settlement along the setback levee length should not be a concern because the majority of the estimated settlement will occur during construction. Long-term settlement of up to 6 inches may occur in areas of thicker peat layers underlying the setback levee. Some settlement is normal for embankment fills.

A groundwater analysis using monitoring well data compared water levels in the White River with well log data (see Appendix E that is appended to Appendix H). Well log data indicates that the groundwater levels are influenced by the White River at some distance upstream of the project site through deep pervious layers of sand and/or gravel. Some data indicate higher groundwater in wells than the surrounding ground level or the adjacent water levels in the White River, indicative of subsurface water pressures emanating from upstream of the site.

Two different configurations were analyzed for the proposed setback levee (see Appendix H), called Section 1 and Section 2 in the project analyses. The first configuration, Section 1, is a typical levee section of fill that will be used for all areas of the levee except for the portion of the levee at the southwest edge of the large wetland complex (Section 2). Three different core sections were analyzed for this first configuration (Section 1, Section 3a, and Section 3b) to maximize the use of on-site alluvium removed from the existing levee along the river. These sections are shown on Figures 4 and Figure 5 in Appendix H and are described as follows:

- **Section 1** - Impervious fill (25 percent fines), full section with 2.5 (Horizontal):1 (Vertical) side slopes (typical section at A, C, and D, see Figure 4 in Appendix H). A minimum depth of 12 inches of topsoil would be placed on the back (inland) side of the levee to support new plantings.

- **Section 3a** – Smaller impervious fill core with 2.5H:1V side slopes, covered with 18 inches of alluvium and 18 inches of topsoil at 2.5H:1V slopes (alternate section at A, C, and D, see Figure 5 in Appendix H).
- **Section 3b** – Smaller impervious fill core with 1H:1V side slopes, covered with alluvium (variable thickness) and 18 inches of topsoil at 2.5H:1V slope (alternate section at A, C, and D, see Figure 5 in Appendix H).

The second configuration applies to the portion of the levee along the southwest edge of the large wetland complex. At the draft 60% stage of design completion, when this analysis was performed, the levee section in this unique area (Section 2, see Figure 4 in Appendix H) had a 3-foot-thick riprap armoring layer extending from the toe to the top of the riverward side of the levee and a log structure at the toe. The core of this section is similar to Section 1 described above except for the riprap armoring on the river side. The final 60% design plans for this portion of the levee changed somewhat, replacing riprap at the top of the levee slope with topsoil.

## Engineered Log Structures

Large and small apex ELJs, bank deflector ELJs, the biorevetment, and floodplain roughening structures are included in the project design plans (Figure 3). All of these ELSs were designed based on the project habitat and flood risk reduction goals and objectives, the hydraulic modeling and geomorphic changes previously summarized, geotechnical data developed in support of this project, and the design of the setback levee. The biorevetment and ELJs were designed to remain stable for all anticipated future conditions during the design flow event of 15,500 cfs, which corresponds to the 100-year recurrence interval flow. The primary design objectives of the ELSs include diffusing and deflecting flow away from the biorevetment and setback levee; providing stable foundations to accumulate and retain naturally occurring large wood; providing aquatic habitat complexity through side-channel formation, scour pool formation and bank stabilization; and providing large-scale hydraulic roughness within the wetland to slow flow velocities and encourage sediment deposition in the wetland. The ELSs will also be heavily planted with native riparian tree and shrub species as part of the project revegetation efforts previously described, further enhancing habitat.

### *Structure Descriptions*

All ELS types, except the floodplain roughening structures, consist of a matrix of multiple layers of interlocking and horizontally oriented large “key” logs (with and without attached rootwads) and smaller racking logs and slash (small branches and twigs). The key logs will be secured in place by vertical timber piles deeply embedded below the anticipated scour depth and by ballast material placed over and around the key logs within the interior core of the structure. The key logs will protrude from the waterward face of the structure and function to accumulate naturally occurring wood, to deflect flow around the waterward sides of the structure, and to secure smaller racking logs and slash material that is added during construction. The smaller racking logs and slash are intended to absorb the erosive energy of impinging flow and retain the log ballast material. Log ballast in the structures will include bank and channel alluvium derived locally from excavations during ELS construction and coarse alluvium spoils produced during existing levee removal.

### *Large Apex ELJ Structure*

One large apex ELJ (ELJ 4, Figure 3) will be constructed in the wetted portion of the wetland. The primary function of ELJ 4 will be to interact with flow that is deflected away from the biorevetment and setback levee by a bank deflector ELJ (ELJ 5), and deflect this flow westward into the interior of the wetland and away from the biorevetment and setback levee. ELJ 4 will be approximately 17 feet tall above the bottom of the wetland, 90 feet wide, and will be anchored with 28 timber piles deeply embedded into the alluvial soils that underlie the shallow wetland soils.

### *Small Apex ELJ Structure*

Three small apex ELJs (ELJs 1, 2, and 3, Figure 3) will be constructed in the wetted portion of the north end of the wetland near the upstream terminus of the levee removal extents. The primary function of ELJs 1, 2, and 3 is to enhance aquatic and riparian habitat by directly interacting with flow as it enters a relic channel in the wetland from the northwest and by splitting flow into multiple channels, thereby creating a diversity of channel complexes that will encourage gravel bar and mid-channel island formation. ELJs 1, 2, and 3 will each be approximately 16 feet tall above the bottom of the wetland, will be 55 feet wide, and will be anchored with 13 timber piles deeply embedded into the alluvial soils that underlie the shallow wetland soils.

### *Bank Deflector ELJ Structure*

Four bank deflector ELJs (ELJs 5, 6, 7, and 8, Figure 3) will be constructed along the western edge of the terrace bordering the wetland area and will be situated between units of the biorevetment (described below). The primary function of ELJs 5, 6, 7, and 8 is to deflect flow away from the setback levee and back towards the middle of the wetland, thereby preventing flow from becoming fixed in position along the levee and biorevetment. ELJs 5, 6, 7, and 8 will each be approximately 18 feet tall, will span approximately 82 feet along the bank, and will be anchored with 27 deeply embedded timber piles.

### *Biorevetment*

The biorevetment will be constructed along the entire length of the eastern edge of the wetland area (Figure 3). It will consist of 108 units constructed end-to-end to create a long and semi-continuous, roughened wall. Each unit will be approximately 10 feet tall, will span 40 feet along the edge of the terrace, and will be anchored with four timber piles deeply embedded into the terrace and wetland soils. The primary function of the biorevetment is to maintain a permanent physical buffer between the setback levee and the existing wetland boundary by providing continuous protection from erosive flows along the new left bank of the floodplain.

### *Floodplain Roughening*

The floodplain roughening features consist of multiple small log structures constructed on the upstream faces of low earthen berms (hummocks) that will extend from the toe of the setback levee across the wetland buffer to the biorevetment. Numerous live cottonwood boles will also be installed on the berms to accelerate native plant recolonization. These structures will increase overall floodplain hydraulic roughness to reduce flow velocities on the floodplain and along the setback levee.

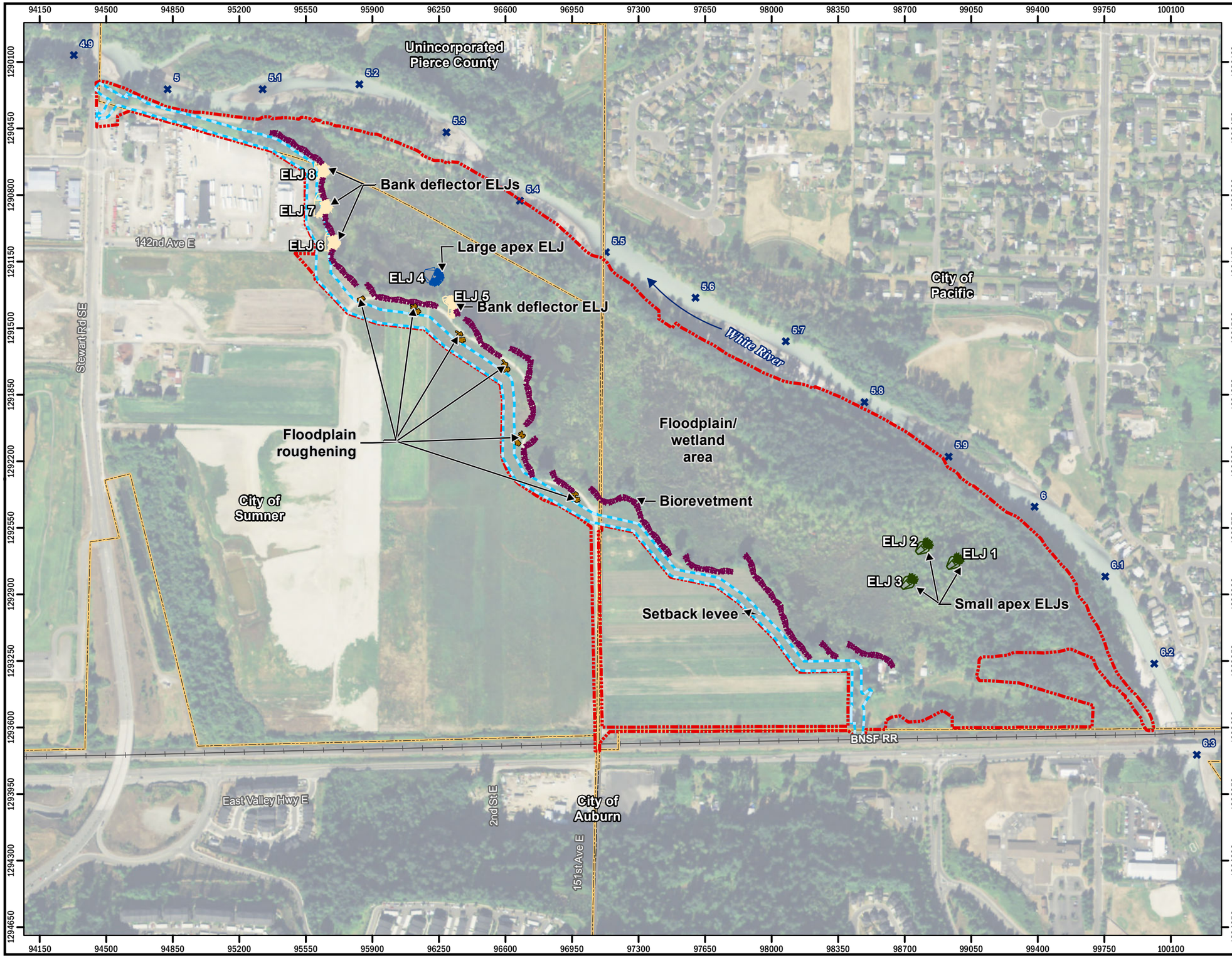


Figure 3.
White River at Countyline Levee Setback Project Site with Proposed Locations of Engineered Log Structures.

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)

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HERRERA

February 2014
Basis of Design Report - White River at Countyline Levee Setback Project

## *Summary of Design Calculations*

Design calculations were completed to ensure the ELSs are stable during the design flow event. The results of the various calculations are summarized below. Detailed descriptions of the calculations including design assumptions, criteria, and methods established to complete the calculations are presented in Appendix I.

### *Scour Analysis*

A scour analysis was completed to determine the depth of soil that could potentially be eroded away from the portion of the timber piles below the bottom of the structure when subjected to the design flow event. The results of the scour analyses summarized in Table 2 were used as input for the pile analysis described below.

**Table 2. Average Maximum Probable Scour Estimated for the ELJs and Biorevetment.**

| Large Apex ELJ (feet) | Small Apex ELJ (feet) | Bank Deflector ELJ (feet) | Biorevetment (feet) |
|---|---|---|---|
| 19 | 17 | 18 | 12 |

### *Pile Analysis for ELJs and Biorevetment*

A pile analysis was completed for the ELJs and biorevetment to determine the depth that the timber piles must be embedded below the channel bed to remain stable when subjected to the maximum probable scour and the resulting hydraulic drag applied to the structures during the design flow event. The analysis included calculating and comparing the maximum load a pile could withstand (factored resistance) to the actual load that it would be subjected to during the design flow event (factored load). Results of the pile analysis are summarized in Table 3.

**Table 3. Results of the Pile Analysis for the ELJs and Biorevetment.**

| Pile Design Component | Ratio of Factored Resistance to Factored Load | | | |
|---|---|---|---|---|
| | Large Apex ELJ | Small Apex ELJ | Bank Deflector ELJ | Biorevetment |
| Minimum Requirement for Bending and Shear | 1.0 | 1.0 | 0.9 (Main Structure)<br>1.00 (Side Structure | 1.0 |
| Calculated Ratio for Bending | 1.23 | 1.46 | 0.92 (Main Structure)<br>3.80 (Side Structure | 1.02 |
| Calculated Ratio for Shear | 12.94 | 12.89 | 1.67 (Main Structure)<br>7.96 (Side Structure) | 6.28 |
| **Pile Design Requirements** | | | | |
| Number of Piles Per ELS | 28 | 13 | 27 (Main Structure)<br>4 (Side Structure) | 4 |
| Pile Embedment Depth Below Existing Grade | 38 feet | 30 feet | 28 feet | 30 feet |

### *Analysis of Large Wood Accumulation on the Apex ELJs*

An additional pile analysis was completed for the apex ELJs to assess their stability if they were to accumulate naturally occurring large wood. Large wood extending beyond the periphery of the as-built structure, although possible (but unlikely), would increase the projected surface area of the ELJs (in the direction of flow), thus increasing the hydraulic drag on the structures and the stresses on the piles. Results of the additional pile analysis are summarized in Table 4. The ELJs could safely accommodate an additional 20-foot wide increase in their projected surface area, but a 40-foot wide increase in their projected surface area could cause the ratio of factored resistance to factored load to be less than 1.0. However, because accumulated wood would extend farther upstream from the pile, the resulting scour moves away from the piles and thus increases their embedment depth. As this occurs the pile's resistance to bending stresses increases, thereby increasing the ratio to above 1.0. Furthermore, large wood generally does not tend to accumulate much beyond the periphery of ELJs because either the pieces break apart, or they are shed off the structure during flow conditions that cause them to be re-mobilized. This characteristic also helps to maintain the ratio above 1.0. Therefore, large wood accumulations of up to 20 feet or more that create a complete obstruction to flow across the width of the apex ELJs are not anticipated to occur. The number of piles and recommended embedment depths listed in Table 3 are sufficient to maintain stability under the potential future loads on the ELJs.

**Table 4. Results of Pile Analysis for Apex ELJs with Additional Natural Wood Loading.**

| ELJ Condition | Ratio of Factored Resistance to Factored Load for Bending | |
|---|---|---|
| | Large Apex ELJ | Small Apex ELJ |
| As-built design conditions without naturally-occurring wood loading | 1.23 | 1.46 |
| As-built design with 20 foot-wide increase in projected surface area | 1.21 | 1.24 |
| As-built design with 40 foot-wide increase in projected surface area | 0.99 | 0.95 |

### *Buoyancy Analysis*

A buoyancy analysis was completed to determine the minimum thickness of log ballast material (i.e., alluvium from the existing levee or locally excavated to construct the ELS) that needs to be placed over the top (final) layer of logs in the ELSs to overcome the buoyant forces applied to the wood material when it is submerged. The results of the buoyancy analysis are summarized in Table 5.

**Table 5. Results of ELS Buoyancy Analysis.**

| ELS Type | Minimum Depth (feet) of Ballast Needed on Top Layer of Logs to Resist Buoyancy for a Factor of Safety = 2.0 |
|---|---|
| Large Apex ELJ | 4.6 |
| Small Apex ELJ | 3.5 |
| Bank Deflector ELJ | 4.0 |
| Biorevetment | 4.5 |
| Floodplain Roughening Types 1, 2 and 3 | 3.0 |

### *Pile Pullout and Cable/Chain Strength Analysis*

Logs for the large apex ELJ will be secured (lashed) to the timber piles using 1/2-inch diameter high strength steel cable or 3/8-inch diameter, hot-dipped galvanized steel chain. A pile pullout calculation was completed to ensure the friction between the embedded portion of the log and the surrounding earth is sufficient to resist the buoyant forces exerted on the piles (due to the lashing) when the structure is submerged. The result of this calculation indicates that a minimum of 16 of the 28 piles in the large apex ELJ must be fastened with cable or chain to achieve a factor of safety (FS) of 3.0. Given the unique configuration of the key logs and piles in the large apex ELJ, 26 of the 28 piles will be fastened to provide a consistent level of protection against the structure from destabilizing if some of the ballast is eroded. Doing so also increases the FS value for pullout resistance.

A calculation was also completed to ensure the cable or chain fastening the logs in the large apex ELJ to its piles will be strong enough to resist failure when transferring the structure's buoyant forces to the piles. The result is provided in Table 6 and shows that the minimum FS value for cable and chain failure is 10.4 when all 26 piles are lashed.

**Table 6. Results of the Cable/Chain Strength Analysis for the Large Apex ELJ.**

| Cable/Chain Breaking Strength (pounds) | Cable/Chain Type and Size | Number of Piles to be Fastened | Calculated Factor of Safety Value |
|---|---|---|---|
| Cable: 26,600 | Cable: IWRC 6x19 galvanized EIPS1/2-inch diameter | 26 | 10.4 |
| Chain: 20,000 | Chain: 3/8-inch diameter, grade 43, galvanized | 26 | 10.4 |

## *Pile Installation Recommendations*

King County completed a geotechnical and engineering analysis to assess the feasibility of driving timber piles for the ELJs and biorevetment. The results of that analysis, which is described in more detail in Appendix I, indicate that it should be possible to continuously drive the piles for the biorevetment to their required embedment depth without overstressing them. Therefore, traditional pile driving methods will be used to install the biorevetment piles.

King County's results indicated that piles for the ELJs would likely be overstressed when attempting to drive them to their required embedment depth. This is due to the presence of dense to very dense gravels, sands and cobbles and occasional boulders observed in the deep borings completed as part of King County's geotechnical investigation. Therefore, traditional pile driving methods will not be used for the ELJs. Instead, the pile installation contractor should be prepared to pre-drill each pile location to within 2 feet of the planned pile tip embedment depth prior to driving. The diameter of the pre-drill hole should be approximately the diameter of the pile tip or slightly larger. Pre-drilling at every pile location may not be necessary, but it will likely be required at enough locations (i.e., potentially 50 percent or more of the piles for each structure) that planning to pre-drill each pile is

prudent. The ELJ piles should also have steel tips/points for protecting their wooden tips during driving.

If the piles cannot be installed to within 80 to 90 percent of their intended embedment depth (either by driving or pre-drilling and driving), then the piles will need to be installed via casing and drilling whereby a shaft is drilled through the alluvium to the pile tip elevation using temporary steel telescoping casing, installing the pile into the shaft and then backfilling the shaft with drill spoils. An alternative to casing and drilling will be to install additional piles with a higher tip elevation to compensate for not reaching the intended embedment depth. The number of additional piles needed would be determined during construction on a case-by-case basis and would depend on how many piles do not reach the intended embedment depth and by how much.

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# APPENDIX A

# Concept Development and Pre-Design for Engineered Logjam and Biorevetment Structures

# APPENDIX B

# Geomorphic Assessment

# APPENDIX C

# 8th Street E Bridge Scour Analysis

King County

# Memorandum

| | |
|---|---|
| **Date:** | August 20, 2013 |
| **To:** | Project File |
| | |
| **From:** | Chris Brummer |
| **Project No./Name:** | FL9001 / 1112049 Countyline Levee Setback Project |
| **Subject:** | 8th Street East Bridge Scour Analysis |

## Introduction

This memorandum describes the methods and results of a scour analysis performed for the 8th Street East (Stewart Road SE) Bridge located on the Lower White River at river mile (RM) 5.0 in the City of Sumner. This scour analysis was performed to evaluate potential increases in the scour depth at the bridge piers resulting from the construction of the Countyline Levee Setback project proposed upstream of the bridge on the left bank of the Lower White River. The scour analysis was also performed to refine estimates of the channel bathymetry used in the hydraulic modeling performed in support of the Countyline project design and to evaluate whether the anticipated scour at the bridge piers influences the water-surface elevation predicted by the hydraulic model.

## Background

The 8th Street East Bridge was constructed in 1952 by Pierce County and is currently owned and maintained by the City of Sumner. The bridge is 232 feet long and includes two in-water piers, each supported by a pile group and concrete pile cap. A profile of the bridge extracted from the 1952 construction drawings is shown in Figure 1.

The elevations shown in Figure 1 are in feet relative to the National Geodetic Vertical Datum of 1929 (NGVD 29) and must be increased by 3.5 feet to convert to the North American Vertical Datum of 1988 (NAVD 88), which is the datum used throughout this memorandum. The "anticipated high water" elevation of 62.0 feet NGVD 29 (65.5 feet NAVD 88) shown in Figure 1 corresponds to a design flow of 19,000 cubic feet per second (cfs) based on the stage-discharge relationship developed at the bridge location for channel conditions as existed in 1949. Since 1952 and since the cessation of river channel dredging operations in the late 1980s, the average channel-bed elevation at the bridge crossing has risen approximately 6 feet. Incidentally, the elevation of the top of the existing gravel bar at the bridge crossing (as shown in Figure 2) is within 1 foot of the 1949 "anticipated high water" elevation. The results of recent, two-dimensional hydraulic modeling of the modern 100-year recurrence interval flow of 15,532 cfs indicate a water-surface elevation of 71.5 feet at the bridge crossing (Herrera 2013).

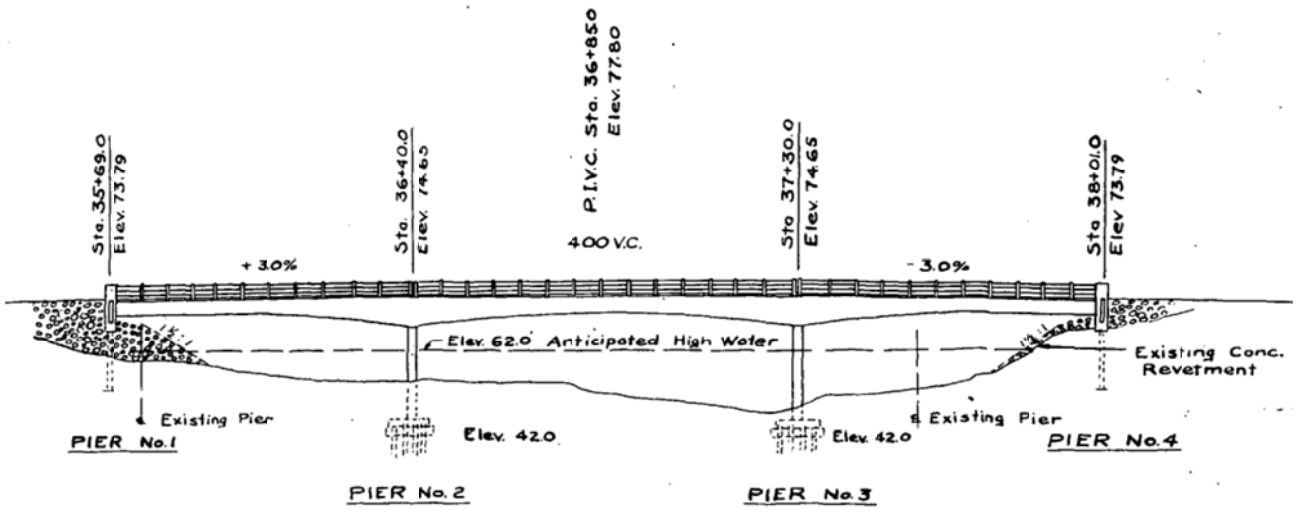


**Figure 1.** Bridge profile (looking upstream) extracted from the 1952 construction drawings. Elevations are relative to NGVD 29; see text below for additional explanation.

**Figure 2.** Photograph of the 8th Street East Bridge under existing conditions (July 25, 2011), looking downstream (compare to Figure 1) and showing accumulations of large wood on the upstream faces of the bridge piers.

The concrete pier caps for piers 2 and 3 were constructed at an elevation of 45.5 feet, which is 6 feet below the historical thalweg elevation of 51.5 feet shown on the 1952 construction drawings and 8.5 feet below the existing (2012) thalweg elevation of 54 feet. Scour below this depth could reduce the friction length of the piles and increase the risk of pile buckling, pier settling, and tilting (Lagasse et al. 2010).

The two in-water bridge piers are prone to the accumulation of woody debris, as shown in Figure 2. Documentation provided by Pierce County (the prior bridge owner) indicates that wood was removed from the bridge crossing on at least two occasions (e.g., 1992 and 1999). Woody debris increases the effective pier width and can increase the calculated scour depth (Lagasse et al. 2010).

Two major utilities are suspended beneath the bridge. They include an 18-inch diameter water main on the downstream-facing side of the upstream concrete arch girders (with the pipe and support brackets suspended below portions of the arch girders) and a 4-inch diameter natural gas main on the downstream-facing side of the downstream concrete arch girders.

The Countyline Levee Setback project is located upstream of the bridge crossing and will involve the removal of significant portions of the existing left bank levee and the construction of a new setback levee along the eastern margin of a 77-acre wetland complex in the historical floodplain that will have a southern tie-in point at the eastern approach to the bridge. Under existing conditions, only two-thirds of the 100-year recurrence interval flow passes under the 8th Street East Bridge. The remaining one-third of flow overtops the southeastern wetland boundary, flows south along 142nd Avenue, and overtops the 8th Street East (Stewart Road SE) roadway east of the bridge (Herrera 2013). The new setback levee will eliminate this split flow and direct the entire 100-year flow under the 8th Street East Bridge.

## Methods

The maximum probable scour depth was calculated at both in-water piers for four flow conditions or simulations defined by previous geomorphic response scenarios and hydraulic modeling completed by Herrera (2013) for the Countyline Levee Setback project. They include:

1. existing (2011) conditions (designated simulation S4a),
2. conditions immediately following construction (S1a),
3. future, no-action conditions after 15 years of continued sediment aggradation (S4c), and
4. future conditions 15 years after construction (S1c).

Hydraulic data (flow depth and velocity) for all simulations were extracted from the two-dimensional hydraulic models developed for the Countyline project. All calculations assumed flow conditions for the modern 100-year recurrence interval event (peak flow of 15,532 cfs).

The maximum probable scour depth at the bridge piers was calculated using the methodology presented in the Hydraulic Engineering Circular No. 18 (HEC-18) published by the U.S. Federal Highway Administration (Richardson and Davis. 2001). The HEC-18 method used in this analysis is based on the Colorado State University (CSU) Equation for live-bed scour with a correction factor ($K_4$) for armoring:

$$\frac{y_s}{a} = 2.0\, K_1\, K_2\, K_3\, K_4 \left(\frac{y_1}{a}\right)^{0.35} Fr_1^{0.43}$$

where

$y_s$ = scour depth (feet)

a = pier width (2 feet)

$y_1$ = flow depth upstream of pier (based on 2-D hydraulic model, in feet)

$K_1$ = correction factor for pier nose shape (1.0 for rounded)

$K_2$ = correction factor for angle of attack of flow (2.74 for pier length of 29 feet and angle of attack of 15 degrees)

$K_3$ = correction factor for bed condition (1.1 for plane bed)

$K_4$ = correction factor for armoring (0.60, based on critical velocity to mobilize median-size and 99$^{th}$ percentile-size bed material)

$Fr_1$ = Froude number upstream of the pier = $V_1/(gy_1)^{1/2}$

$V_1$ = mean velocity of flow upstream of the pier (feet/sec)

g = acceleration of gravity (32.2 feet/sec$^2$)

The pier width of 21 inches shown on the 1952 construction drawings was rounded up to 2 feet for the scour analysis. The pier length (29 feet) used in the analysis to determine the $K_2$ correction factor is the dimension shown on the 1952 construction drawings. In addition to determining the scour depth, the lateral and streamwise extents of scour at both in-water piers were determined using the methods described by Lagasse et al. (2010). The lateral and upstream extents of scour were calculated by assuming a scour hole with 2H:1V (horizontal to vertical) slopes extending up from the sides and upstream face of each pier. The downstream scour extents assumed a scour hole with 4H:1V slopes extending downstream of the downstream end of each pier.

The accumulation of woody debris on the bridge piers was not considered because wood loading is expected to occur with or without the project and because the primary goal of this analysis is to evaluate the relative change in scour depth resulting from the change in hydraulics at the bridge due to the project. Although the project may result in an initial increase in wood flux as channels form in the reconnected forested floodplain, the project reach is expected to eventually trap more wood in the near future than it does under existing conditions, thereby reducing the potential for future wood loading on the bridge piers after construction. Additionally, wood recruitment from the floodplain and transport downstream is highly dependent on the frequency, magnitude, and duration of future flow conditions, which is uncertain.

## Results

The results of the scour analysis are presented Table 1. Because the bed elevation is different for each flow simulation in Table 1 (due to anticipated sediment aggradation), the elevation of the scour hole relative to the elevation of the pile cap (45.5 feet) is more informative than is the relative scour depth. Under existing conditions (with approximately two-thirds of the flow passing under the bridge), the maximum probable scour depth for the 100-year flow event is estimated to be 6.33 to 6.59 feet, which results in a minimum separation of 10.4 feet above the pile caps. Following project construction, with the passage of all of the 100-year flow under the bridge, the maximum probable scour depth is anticipated to increase by about 2 to 3 feet to a scour depth of 8.34 to 9.34 feet, which would result in a minimum separation of 7 feet above the pile cap. The relative scour depth is expected to decrease by about 2 feet in 15 years if the project is not constructed because of sediment aggradation at the bridge and because additional flow would split from the main channel as the river bed upstream continues to fill with sediment. This outcome also assumes unobstructed flow through the current avulsion path (along 142nd Avenue SE), which has been invalidated by fill placed after the 2011 survey was collected for the hydraulic model. Fifteen years after construction, the scour depth is expected to increase slightly by 1 to 2 feet relative to existing conditions and result in a scour hole during the 100-year event that is a minimum of 8.2 feet above the pile cap. The increase in scour depth (relative to existing conditions) is due to an increase in flow velocity (as more flow is directed under the bridge) and the flow constriction caused by ongoing sediment aggradation in the vicinity of the bridge.

## Conclusions

Although the Countyline project will increase the flow rate under the 8th Street East Bridge relative to existing conditions, the post-project flow rate will be less than the historical flow conveyance capacity during the period when the channel was subject to regular maintenance dredging. In fact, the greatest historical flow at the bridge crossing (15,200 cfs in 1986, when channel conveyance was considerably greater than it is today) is within 300 cfs of the current estimated 100-year flow of 15,532 cfs. Additionally, the maximum probable scour depth after construction as determined in this analysis will be within a minimum of 7 feet above the elevation of the pile caps. Thus, the project is not expected to threaten the structural integrity of the bridge piers.

## References

Herrera. 2013. Final Hydraulic Modeling Results Technical Memorandum. Prepared for King County Department of Natural Resources and Parks, Water and Land Resources Division, River and Floodplain Management Section, by Herrera Environmental Consultants, Inc., Seattle, Washington. June 14, 2013 Draft.

Lagasse, P.F., P.E. Clopper, L.W. Zevenbergen, W.J. Spitz, and L.G. Girard. 2010. National Cooperative Highway Research Program (NCHRP) Report 653. Effects of Debris on Bridge Pier Scour. Transportation Research Board, Washington, D.C.

Richardson, E.V. and S.R. Davis. 2001. Evaluating Scour at Bridges, 4th Edition. U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular 18, Publication FHWA NHI 01-001, 378 p.

**Table 1. Results of Pier Scour Analysis at the 8th Street bridge, Countyline Levee Setback Project**

| Variable | Units | HEC-18 [CSU Equation (Richardson et al. 1975) with K4 correction] | | | | | | | | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S4a (No-action, year 0) | | S1a (with project, year 0) | | S4c (No-action, 15 years) | | S1c (with project, 15 years) | | |
| | | Pier No. 2[1] | Pier No. 3 | Pier No. 2 | Pier No. 3 | Pier No. 2 | Pier No. 3 | Pier No. 2 | Pier No. 3 | |
| $y_1$ | ft | 9.62 | 7.30 | 11.50 | 7.86 | 4.89 | 4.98 | 10.55 | 6.33 | Flow depth upstream of pier |
| $V_1$ | ft/s | 6.30 | 6.53 | 9.43 | 11.04 | 4.31 | 4.42 | 10.41 | 12.20 | Mean flow velocity upstream of pier |
| a | ft | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | Pier width |
| L | ft | 29.0 | 29.0 | 29.0 | 29.0 | 29.0 | 29.0 | 29.0 | 29.0 | Pier length |
| θ | degrees | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | Angle of attack |
| g | $ft/s^2$ | 32.2 | 32.2 | 32.2 | 32.2 | 32.2 | 32.2 | 32.2 | 32.2 | Acceleration of gravity |
| $D_{50}$ | mm | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | Median grain size |
| $D_{95}$ | mm | 100 | 100 | 100 | 100 | 88 | 88 | 100 | 100 | 95th percentile grain size |
| $K_1$ | dimensionless | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | Correction factor for pier nose shape |
| $K_3$ | dimensionless | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | Correction factor for bed condition |
| $K_2$ | dimensionless | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | Correction factor for angle of attack |
| Fr | dimensionless | 0.36 | 0.43 | 0.49 | 0.69 | 0.34 | 0.35 | 0.56 | 0.85 | Froude Number |
| $V_{cD50}$ | ft/s | 6.10 | 5.83 | 6.28 | 5.90 | 5.45 | 5.47 | 6.19 | 5.69 | Critical velocity for incipient motion for D50 |
| $V_{cD95}$ | ft/s | 8.65 | 8.65 | 8.65 | 8.65 | 8.29 | 8.29 | 8.65 | 8.65 | Critical velocity for incipient motion for D95 |
| $V_{icD50}$ | ft/s | 3.24 | 3.10 | 3.34 | 3.14 | 2.90 | 5.47 | 3.29 | 3.02 | Approach velocity required to initiate scour |
| $V_{icD95}$ | ft/s | 5.07 | 5.07 | 5.07 | 5.07 | 4.82 | 4.82 | 5.07 | 5.07 | Approach velocity required to initiate scour |
| $V_R$ | dimensionless | 2.96 | 4.52 | 5.01 | 9.54 | 2.25 | 2.36 | 6.32 | 14.80 | Velocity-intensity ratio |
| $K_4$ | dimensionless | 0.47 | 0.50 | 0.51 | 0.56 | 0.45 | 0.45 | 0.53 | 0.60 | Correction factor for "armoring" |
| **$y_s$** | **ft** | **6.33** | **6.59** | **8.34** | **9.34** | **4.71** | **4.80** | **8.91** | **10.11** | **Scour depth** |
| $y_s'$ | ft | 55.9 | 57.9 | 52.5 | 55.1 | 62.0 | 61.9 | 53.7 | 56.64 | Elevation at max. scour depth (NAVD 88)[2, 3] |
| delta | ft | 10.4 | 12.4 | 7.0 | 9.6 | 16.5 | 16.4 | 8.2 | 11.1 | Height of scour hole above pile cap[3] |
| $x_s$ | ft | 14.7 | 15.2 | 18.7 | 20.7 | 11.4 | 11.6 | 19.8 | 22.2 | lateral and upstream extents (2:1 slopes)[4, 5] |
| $z_s$ | ft | 54.3 | 55.4 | 62.4 | 66.4 | 47.8 | 48.2 | 64.6 | 69.4 | downstream extent (4:1 slopes)[4, 5] |

**Notes:**

Calculations based on HEC-18, CSU Equation (Richardson et al. 1975) with K4 correction

1. Pier numbering is from west to east.
2. Calculated from bed elevation minus scour depth.
3. Pile cap is at elevation 45.5 ft (NAVD 88) per 1952 construction drawings.
4. Based on Lagasse et al. 2010. NCHRP Report 653, Effects of Debris on Bridge Pier Scour.
5. lateral and downstream scour include bridge pier dimensions.

# APPENDIX D

# Hydraulic and Sediment Transport Modeling Technical Memorandum

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# APPENDIX E

# Final Hydraulic Modeling Results Technical Memorandum

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# APPENDIX F

# Floodplain Geomorphic Surface Development Approach Technical Memorandum

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# APPENDIX G

# Hydraulic Modeling Approach and Initial Modeling Results Technical Memorandum

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# APPENDIX H

# Seepage, Stability, Design and Construction Considerations

# FINAL
# Technical Memorandum

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| | | | |
|---|---|---|---|
| **To:** | Herrera Environmental Consultants Inc. | **CC:** | |
| **From:** | Rod DenHerder, P.E., Martin McCabe, P.E. | **Date:** | September 30, 2013 |
| **RE:** | White River Countyline Levee Setback Project<br>Seepage, Stability, Design and Construction Recommendations | | |

In partial fulfillment of Task 400.3 of the Herrera contract with King County for analysis and design of the proposed White River Countyline Levee Setback project (Contract #E00187E10), this technical memorandum outlines the approach, analytical methods, and results of geotechnical-related evaluations for the setback levee. This memo furthermore presents recommendations regarding geotechnical design and construction aspects of the project.

## 1.0 PROJECT DESCRIPTION

### 1.1 SETBACK LEVEE ALIGNMENT

The White River at Countyline Levee Setback (Countyline) project is a salmon recovery and flood risk reduction project located on the left (east) bank of the White River between river mile (RM) 5.00 and RM 6.33. Implementation of the Countyline project will reconnect approximately 124 acres of forested wetland and historical floodplain to the main stem of the White River by removing most of an existing left bank levee and constructing a new setback levee and biorevetment along the eastern edge of the project boundary. The site location is shown on Figure 1. The proposed setback levee alignment and locations of subsurface investigation borings are shown on Figure 2. Figure 2 also shows the locations of Sections AA', BB', CC', and DD' that are discussed repeatedly in this memo, as representative locations for the geotechnical analyses conducted.

### 1.2 SETBACK LEVEE CROSS SECTION

URS and King County agreed upon the following proposed general levee configuration for the cross sections evaluated in detail:

- Levee top width 15 feet.
- Levee side slopes 2.5H:1V (horizontal to vertical).
- River-side water level is 3 feet below the levee crest.

The proposed levee consists of a zoned embankment consisting of the following materials:

- Core – low permeability fill material.
- Shell – native alluvium surrounding the core.
- Outer surface - topsoil.
- Top – gravel driving surface.

## 2.0 SCOPE OF SERVICES

The scope of services for the analyses presented in this memo is described in the December 6, 2010 Professional Services Agreement signed between Herrera Environmental Consultants and URS Corporation, which includes providing geotechnical services for levee setback seepage analysis. Specific elements of this scope of services are:

- Compare river stages to measured groundwater level data to assess the linkage between river water level and the groundwater elevation response to it, using river stage data from the USGS gauging station at the A Street Bridge in Auburn and groundwater data loggers deployed by King County in the wetland on-site.
- Characterize the general foundation conditions along the setback levee alignment and provide concept level and design-level geotechnical analysis of the proposed levee, and provide construction recommendations addressing compaction; preload requirements; and potential modes of failure, including slope stability, settlement, levee underseepage, and seismic considerations in general accordance with the following: US Army Corps of Engineers (USACE) Design and Construction of Levees Manual EM 1110-2-1913, dated April 30, 2000, USACE Slope Stability Manual EM 1110-2-1902, dated October 31, 2003, and ETL 1110-2-569 Design Guidance for Levee Underseepage, dated May 1, 2005.
- Prepare a geotechnical analysis technical memorandum (this memo) that documents water level monitoring in wells along the setback levee alignment, addresses the static stability and settlement of the new setback levee, the need for seepage cutoff within and below the new levee, erosion protection of the new levee, use of on-site soils (if available) for construction of the new levee, and seepage cutoff key (if required).
- Provide geotechnical analyses using SLOPE/W and SEEP/W, including design recommendations, for up to two setback levee footprints and up to 3 levee cross-section configurations prepared by King County.

## 3.0 SITE CONDITIONS

### 3.1 SURFACE DESCRIPTION

The proposed setback levee site is on the perimeter of active farmland with a small area of commercial/industrial property along the southern 1,500 lineal feet of the setback alignment. The ground surface in the setback levee project area is relatively flat and gently sloping upward from the southwest to the northeast end, with a mean surface elevation of approximately 70 to 80 feet (NAVD 88). The setback floodplain area west of the setback levee alignment encompasses approximately 124 acres of forested wetland and upland wetland buffer.

## 3.2 GEOLOGIC SETTING

The valley of the White River is underlain by Holocene alluvium (USGS, 1995). During the Holocene Epoch, erosion and deposition occurred primarily along major river valleys and marine embayments. Holocene deposits include peat, mass wasting debris, mudflow sediments generated on the volcanic peaks of the Cascade Range, and fluvial and deltaic sediments. Alluvium found in the valley of the White River is designated as geologic unit "Qal", and this unit is considered to be an important aquifer. Few wells fully penetrate the Qal unit in the study area, so the thickness of the unit generally is not known. Near the steep slopes of each valley, Qal is interbedded with and sometimes overlain by mass-wasting debris (USGS, 1995). The liquefaction potential of the area is indicated as "moderate to high" in the most recent liquefaction susceptibility mapping (Palmer et al, 2004).

The project area is part of the alluvial fan laid down over the past 5,000 years by the erosion and deposition of lahar (volcaniclastic mudflow, such as the 5,700-year-old Osceola mudflow) sediment deposited in the White River canyon. The river was historically considered the Stuck River, an overflow distributary channel of the White River. Prior to a major flood in 1906, most of the White River water and sediment exited the White River canyon near RM 8 and flowed north to join the present-day Green River near Auburn (Herrera, 2012). During the 1906 flood, the main flow of the White River was diverted down the old Stuck River channel. The construction of the Auburn Wall in 1915 made the change permanent.

## 3.3 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were investigated by King County by drilling 16 soil borings, excavating six test pits and excavating three shallow surface scrapings on the waterward face of the existing levee, performing laboratory testing of selected soil samples, and performing conductivity testing at two wells at the locations indicated on Figure 2. A list of the borings and a brief summary of soil layers encountered are presented in Table 2 below. It should be noted that when a water level monitoring well was installed in the boring, an additional name was assigned to the boring to reflect the presence of the well. For example a monitoring well was installed in boring KCB-2, so the boring is also designated as KCMW-2. Boring logs and laboratory data are provided in Appendix A, and are also in Appendix A of the *County Line to A Street Geotechnical Investigation* memo prepared by the King County Department of Transportation (2012).

<u>STRATIGRAPHY</u>

The general stratigraphy along the proposed setback levee alignment as indicated by the subsurface descriptions in the boring logs is roughly illustrated on Figure 3. The figure reflects the substantial variation of subsurface conditions in this alluvial fan setting and may not accurately portray the stratigraphy at locations between borings. About one foot of cultivated sandy topsoil was encountered at the surface along the proposed setback levee alignment at borings KCB-1 and KCB-2 and in borings KCB-4 to KCB-9. Uncontrolled fill (mixed natural and man-made materials without obvious compaction controls) and road fill were encountered at the surface in borings KCB-16 and KCB-3 in thicknesses of about 11 feet and 1 foot, respectively. In general, the native stratigraphy below the topsoil or fill surface is poorly graded fine to medium sand to silty sand interbedded with silt and scattered lenses of peat and organics. In the upper 25 feet, the granular material zones tend to be medium dense to occasionally loose, while the fine grained material zones (silt, clay, and peat) tend to be medium stiff to soft.

GROUNDWATER

Groundwater was encountered in all of the borings drilled for this project at depths ranging from 1.6 to 6 feet below the ground surface (see Figure 3 and Appendix A). Water level measurements from six (6) shallow groundwater monitoring wells installed for this project were provided by King County. Of the six groundwater wells installed for the project, four are located in the wetland area on the landward side of the existing levee, and two are located in borings drilled on the floodplain surface above the wetland along the alignment of the proposed setback levee. The locations of the wells (Figure E-1) and the associated water level data are included in Appendix E. A summary of the wells is shown in Table 1.

Groundwater levels generally follow the slope of the river and alluvial fan surface and are higher in the northeast and lower in the southwest (see Figures 3 and E-2). The time-series plots for the wells shown on Figure E-2 illustrate that the upper wetland in the vicinity of groundwater wells GW1, GW2, and GW3 is hydraulically disconnected from the river (USGS gage #12100496 – White River near Auburn, WA, located at the A Street bridge crossing). King County personnel have reportedly observed static water levels in the wetland several feet lower than the river stage even when the river level is near the top of the existing left bank levee. In contrast, groundwater at GW4, KCMW-2, and KCMW-4 in the lower portion of the wetland is hydraulically connected to the river and responds to water entering the wetland near the county line (for flows greater than 3,500 cfs) and returning back to the river near GW4. The two-foot drop in water levels at GW4 between September and October 2011 corresponds to repair work performed on the culvert at the wetland outlet, whereby a beaver dam was dismantled, the culvert unclogged, and a ford cut in the access road. Reconstruction of the beaver dam restored groundwater levels at GW4 by spring 2012.

**Table 1: Summary of Groundwater Well Measurements**

| | **GROUNDWATER WELLS** | | | | | |
|---|---|---|---|---|---|---|
| | GW1 | GW2 | GW3 | GW4 | KCMW-2 | KCMW-4 |
| Ground Elevation | unknown | unknown | unknown | unknown | 70.2 | 73.3 |
| Sensor Elevation (ft) | 72.15 | 68.15 | 66.19 | 71.57 | 59.32 | 61.99 |
| Start Date | 5/22/11 | 5/22/11 | 5/22/11 | 5/22/11 | 11/17/11 | 11/17/11 |
| End Date | 5/23/12 | 5/23/12 | 5/23/12 | 5/23/12 | 5/9/12 | 5/9/12 |
| Highest Water Surface Elevation (ft) | 75.63 | 74.02 | 73.53 | 72.14 | 70.77 | 72.89 |
| Lowest Water Surface Elevation (ft) | 72.15 | 68.15 | 66.19 | 71.57 | 66.53 | 69.94 |

Figure E-2 and Table 1 also show that groundwater levels measured in KCM-2 were higher than the ground surface at the well location during peaks in the White River hydrograph. This indicates groundwater movement originating from upland areas on the alluvial fan in addition to the shallow groundwater connection with the river described above. This interpretation is consistent with saturated ground observed by King County personnel in the fields near KCM-2 during periods of low river levels in July 2012.

LABORATORY TESTING

To aid in classifying the subsurface materials and to estimate general material characteristics, laboratory tests were performed on selected representative samples. The following tests were performed by the King County Materials Laboratory: moisture content, grain size distribution, fines content and Atterberg limits. The results of the laboratory testing are presented in Appendix A and on the boring logs.

## 4.0 METHODS AND RESULTS

### 4.1 SOIL PROFILES AND SOIL PARAMETERS FOR DESIGN

Figure 3 shows a conceptual stratigraphic profile along the proposed setback levee alignment based on an interpretation of the boring logs. The estimated material parameters for each of the soil strata encountered at the site are provided in Table 2 for use in the levee seepage and stability analyses. The values provided in the table have been estimated using a combination of field and laboratory data together with published data on similar materials. It should be noted that in most cases the values listed in Table 2 are intended to represent average or slightly conservative field conditions.

The estimated material parameters for the proposed setback levee core fill material are also listed in Table 2. Topsoil is not specifically listed but the value for permeability used in the seepage modeling was 0.02 centimeters per second (cm/sec). The permeability value of 0.10 cm/sec was used to model alluvium.

Natural variations in stratigraphy and soil parameters are expected throughout the site, and thus the values listed in Table 2 may not be strictly representative of all locations. The definitions of the soil types used in Table 2 are listed in ASTM D-2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System).

**Table 2: Summary of Characteristics and Estimated Material Properties**

| Section * or Boring No. | Fill or Stratum Modeled ** | Top Depth (ft) | Thick-ness (ft) | Raw SPT (blows per foot) | Unit Weight (lbs/ft$^3$) | Friction Angle (degrees) | Cohesion (lbs/ft$^2$) | Perm-eability (cm/s) |
|---|---|---|---|---|---|---|---|---|
| 2 | Riprap | n/a | n/a | n/a | 140 | 40 | 0 | 0.200 |
| 1, 2 | Core Fill (25% fines) | n/a | n/a | n/a | 130 | 35 | 50 | 0.003 |
| | Core Fill (20% fines) | n/a | n/a | n/a | 130 | 37 | 0 | 0.020 |
| 3a, 3b | Narrow Core Fill (25% fines) | n/a | n/a | n/a | 130 | 35 | 50 | 0.003 |
| KCB-1 | Existing. Fill (SP) | 0 | 4 | 18 | 128 | 33 | 0 | 0.003 |
| | ML,PT | 4 | 2.5 | 6 | 110 | 28 | 50 | 0.00001 |
| | SP-SM | 6.5 | 10.5 | 7-31 | 125 | 35 | 0 | 0.0003 |
| | ML | 17 | 4 | 10-23 | 115 | 30 | 50 | 0.00001 |
| KCB-2 / KCMW-2 | ML,OR | 0 | 4 | 2 | 110 | 28 | 50 | 0.00001 |
| | SM | 4 | 1.5 | 14 | 125 | 35 | 0 | 0.0003 |
| | ML | 5.5 | 6.5 | 14-19 | 115 | 30 | 50 | 0.00001 |
| | ML-PT | 12 | 2 | 2 | 110 | 28 | 50 | 0.00001 |
| | SP-SM | 14 | 14 | 21-29 | 130 | 35 | 0 | 0.0003 |
| KCB-3 | Road Fill (SM) | 0 | 1.5 | | 128 | 33 | 0 | 0.0003 |
| | ML,PT | 1.5 | 5.5 | 3-4 | 110 | 28 | 50 | 0.00001 |
| | SP-SM | 7 | 2.5 | 8 | 125 | 32 | 0 | 0.0003 |
| | ML | 9.5 | 2 | 3 | 110 | 28 | 50 | 0.00001 |
| | SP-SM | 11.5 | 10 | 13-28 | 130 | 35 | 0 | 0.0003 |
| KCB-6 | ML,PT | 0 | 4 | 9 | 110 | 28 | 50 | 0.00001 |
| | SP-SM | 4 | 13 | 7-31 | 125 | 35 | 0 | 0.0003 |
| | ML,PT | 17 | 8.5 | 4-8 | 110 | 28 | 50 | 0.00001 |
| KCB-7 | SM | 0 | 4 | 8 | 128 | 33 | 0 | 0.0003 |
| | ML | 4 | 5 | 13-15 | 115 | 30 | 50 | 0.00001 |
| | SP | 9 | 3.5 | 11-18 | 125 | 35 | 0 | 0.003 |
| | ML | 12.5 | 2 | 5-17 | 115 | 30 | 50 | 0.00001 |
| | SP | 14.5 | 5 | 11 | 125 | 35 | 0 | 0.003 |
| KCB-9 | SM | 0 | 9 | 4-16 | 128 | 33 | 0 | 0.0003 |
| | ML,PT | 9 | 3 | 3 | 110 | 28 | 50 | 0.00001 |
| | SP | 12 | 5 | 12-21 | 125 | 35 | 0 | 0.003 |
| | ML | 17 | 1 | 3 | 110 | 28 | 50 | 0.00001 |
| | SM | 18 | 3 | 8 | 125 | 32 | 0 | 0.0003 |

* Sections as shown on Figures 4 and 5

** 20% or 25 % fines is that percentage of fill material that passes the #200 sieve

SPT – standard penetration test

## 4.2 LEVEE CROSS SECTIONS

Several different setback levee cross-section configurations were modeled (simulated). Section 1 and Section 2 are shown on Figure 4. Sections 3a and 3b are preferred by King County and are shown on Figure 5.

Section 1 was analyzed at locations AA', CC', and DD' shown on Figure 2. Section 1 was assumed applicable for all portions of the setback levee except where the levee encroaches into the wetland. This section consists entirely of imported low permeability material with a top width of 15 feet and 2.5H:1V side slopes (Figure 4).

Section 2 is located in the area where the levee encroaches on the wetland as shown at cross-section BB' on Figure 2 (approximately Station 12+00 to 16+50 as shown on the 60% Plans). Section 2 is shown on Figure 4 and is similar to Section 1 except that it has a 3-foot layer of heavy loose riprap with a filter layer on the riverward side and an engineered logjam with wood piles built into the levee toe on the river side.

Sections 3a and 3b have a smaller impermeable core, and were evaluated at locations AA' and DD' shown on Figure 2. These sections include an outer shell of gravelly material representative of on-site alluvium. Section 3a consists of a core of imported low permeability material with the top at the future 100-year recurrence interval water surface elevation, 2.5H:1V side slopes, and on-site alluvium for the outer shell around the core ranging in thickness from 18 inches on the slopes to 3 feet on the top of the levee. The shell is covered with 18 inches of topsoil on both slopes of the levee. Section 3b is similar to Section 3a, with a narrower core constructed to the same height as section 3a but with 1H:1V side slopes. On-site alluvium was assumed for the outer shell around the core ranging in thickness from 3 feet on the top of the levee to approximately 5 feet on the side slopes. Both slopes of the levee in Section 3b are covered with 18 inches of topsoil.

## 4.3 SEEPAGE ANALYSES

Seepage analyses were performed using the computer program SEEP/W (2007) to obtain pore water pressures in the soil elements for both steady state and transient state flow conditions. The steady state pore pressures are used for the evaluation of exit hydraulic gradients at the toe of the levee for long-term conditions. Similarly, the transient pore pressures are used to evaluate hydraulic gradients for rapid drawdown conditions. The pore pressure values were also used in the slope stability analyses using SLOPE/W (2007).

SEEP/W is a commercially available (Geo-Slope International Ltd) finite element software product for analyzing groundwater seepage and excess pore-water pressure dissipation problems within porous materials such as soil and rock. SEEP/W provides analyses and results that comply with the USACE guidelines in EM 1110-2-1913 and ETL 1110-2-569. SEEP/W can model both saturated and unsaturated flow, a feature that greatly broadens the range of problems that can be analyzed. In addition to traditional steady-state saturated flow analysis, the saturated/unsaturated formulation of SEEP/W makes it possible to analyze seepage as a function of time and to consider such processes as the infiltration of precipitation.

The seepage models were developed for the proposed setback levee using soil conditions encountered at borings KCB-1, KCB-2/KCMW-2, KCB-7 and KCB-9, and assumed material properties for the imported material to be used in the proposed levee. These borings were considered the most critical for seepage considerations because of the presence of relatively higher permeability materials directly beneath the ground surface under the proposed embankment compared to the other borings. Seepage analyses were conducted for the steady state condition and for a transient rapid drawdown condition. A total head boundary condition was applied for the seepage model cases discussed below.

URS used available King County hydraulic modeling data showing the timing of flood water rise and fall (see Appendix B) to develop a rapid drawdown rate for the seepage analysis. A drawdown rate of 0.42 feet per hour (ft/hr) was calculated from the drawdown curves provided by the County for the future conditions scenario. This value was conservatively rounded up to 0.50 ft/hr for the seepage analysis.

The phreatic surface across the levee was developed based on the following total head boundary conditions for the following model cases:

- Long-term Condition:
  - Riverward side of the levee – 100-year flood peak water surface elevation (Section AA' - EL. 80 feet, Section BB'- EL. 80 feet, Section CC' - EL. 82 feet, Section DD' - EL. 85 feet),
  - Landward side of the levee – ground surface elevation (Section AA' - EL. 72 feet, Section BB' - EL. 73 feet, Section CC' - EL. 79 feet, Section DD' - EL. 81 feet).
- Rapid Drawdown Condition:
  - Riverward side of the levee – drop from 100-year flood level elevation to landward side ground elevation at a rate of 0.5 inches per hour in 6 to 12 hours;
  - Landward side of the levee - ground surface elevation.

For underseepage conditions, the current USACE criterion for the average vertical exit hydraulic gradient through a levee's landward side blanket was used. This criterion is to be less than or equal to 0.5 for the design floodwater level condition (see USACE, 2000 and USACE, 2005).

Table 3 shows results of the seepage analyses for long-term steady seepage conditions. An exit vertical gradient contour output figure was generated using SEEP/W for each case as shown on Figures C1 to C5 included in Appendix C. The results of the seepage analysis are summarized in Table 3. The analyses were performed on the four different sections with different core fill soil types as follows:

- Fill with an estimated 25 percent fines with a conservative estimate of permeability equal to 0.003 cm/sec (Section 1 at locations AA,' CC', and DD'; Section 2 at location BB'). In this case a "conservative" permeability is one that is in the high end of the expected range.

- Fill with an estimated 25 percent fines with typical estimate of permeability equal to 0.003 cm/sec (Sections 3a and 3b).
- Fill with an estimated 20 percent fines passing the #200 sieve and higher permeability of 0.020 cm/sec (Section 1 at Location AA; Section 2 at BB).

Topsoil was not modeled as a separate layer from the levee fill in Section 1 and Section 2. However, both of these sections were modeled using permeability of 0.02 cm/sec for the levee

fill, which is the same permeability used in modeling topsoil in Sections 3a and 3b. Therefore, 12 inches of topsoil placed as part of the section at AA and BB would not be inconsistent with the modeled results.

It should be noted that the estimates of permeability for levee core material having 20 to 25 percent fines were made assuming that these fines are non-plastic to low plasticity silt and/or clay to account for the potential difficulty in obtaining borrow fill containing higher plasticity fines that would also have lower permeabilities.

**Table 3: Summary of Seepage Gradient Estimates at Setback Levee Toe**

| Analyzed Location | Levee Core Material | | Maximum Vertical Exit Gradient ($i_{max}$) | Figure No. |
|---|---|---|---|---|
| | Passing #200 Sieve * (%) | Permeability (cm/sec) | | |
| ***SECTION 1*** | | | | |
| AA' | 25 | 0.003 | 0.38 | C1 |
| | 20 | 0.020 | 0.43 | C1a |
| CC' | 25 | 0.003 | 0.35 | C3 |
| DD' | 25 | 0.003 | 0.35 | C4 |
| ***SECTION 2*** | | | | |
| BB' | 25 | 0.003 | 0.45 | C2 |
| | 20 | 0.020 | 0.46 | C2a |
| ***SECTION 3a*** | | | | |
| AA' | 25 | 0.003 | 0.40 | C5 |
| ***SECTION 3b*** | | | | |
| AA' | 25 | 0.003 | 0.41 | C5a |
| DD' | 25 | 0.003 | 0.39 | C6 |

* Percent fines passing the #200 sieve.

The vertical exit gradients listed in Table 3 are less than the maximum acceptable value of 0.5 that is the current USACE criterion for the levee design floodwater level condition (see USACE, 2000 and USACE, 2005). The results of the seepage analysis indicate that the exit gradients are considered acceptable according to USACE criteria, and therefore a seepage cutoff trench, core or blanket is not required if soils encountered during construction are consistent with the values used in the analysis.

The analysis of core material with an estimated 20 percent fines was performed only at location AA' for Section 1 and location BB' for Section 2 to show the relative difference if fill is imported with lesser fines than assumed for the modeling.

The results of this comparative analysis show that soils with higher permeability consistent with lesser fines content (assumed 20 percent) would have greater exit gradients than soils with permeability corresponding to 25 percent fines. However, the difference in exit gradients for location BB' and Section 2 is insignificant, which may be related to the thinner impermeable section with the rock face on the waterward side of levee in this section.

A transient analysis was performed to simulate the phreatic surface (including groundwater levels on the landward side of the proposed levee) during a 100-year flood event in the White River. The results of the transient analysis indicate that groundwater is high enough to be at or above the ground surface during extreme flood events with associated high river stages lasting 48 hours or more. The high groundwater levels would not be from seepage through the levee but would occur from the surcharge of deeper pervious layers that would transmit groundwater to shallower alluvium near the surface. This is in contrast to existing conditions during moderate flood flows less than the 100-year flood event, in which the field areas south of the proposed setback levee would be inundated with floodwaters. Although the proposed setback levee will provide protection from flood inundation, the high groundwater levels that currently exist in the field areas south of the proposed setback levee will not be alleviated by the levee. The presence of near-surface moisture for 48 hours or more under existing and proposed conditions could have adverse impacts on the existing pavements near the toe of the future levee at the south end of the alignment. With or without the setback levee, consideration should be given to adding fill in areas where roads and buildings will be constructed immediately adjacent to the proposed setback levee toe.

## 4.4 STABILITY ANALYSES

URS performed a static slope stability analysis for long-term conditions and for rapid drawdown conditions using SLOPE/W (2007), a commercially available computer program for the general solution of slope stability problems by two-dimensional limit equilibrium methods. SLOPE/W provides analyses and results that comply with the USACE guidelines in EM 1110-2-1913 and ETL 1110-2-1902. The calculation of the factor of safety (FS) against instability of a slope can be performed using one of the following methods: Bishop Simplified Method (applicable to circular shaped failure surfaces), Ordinary Method, Janbu Simplified Method (applicable to failure surfaces of general shape), or Spencer's Method (applicable to any type of surface).

SLOPE/W features unique random techniques for generation of potential failure surfaces for subsequent determination of the more critical surfaces and their corresponding factors of safety. These techniques generate circular failure surfaces, surfaces of sliding block character, or more general irregular surfaces of random shape. For the purposes of these analyses, URS utilized Spencer’s Method. The pore pressure generated in the SEEP/W model run was used in the SLOPE/W program during stability analysis. The analysis incorporated the following options:

1. Analysis method: Spencer
2. Slip surface option: entry and exit
3. Directions of movement: left to right for landward side of levee; right to left for riverward side of levee
4. Tension crack option: no tension crack
5. Minimum slip surface depth: 5 feet

The minimum FS for static conditions required by the USACE (2000) are shown in Table 4.

**Table 4: Minimum Factors of Safety Required by the USACE (2000) for Levees under Static Conditions**

| Design Condition | Minimum FS |
|---|---|
| Rapid Drawdown | 1.0 to 1.2 * |
| Long Term (Steady Seepage) | 1.4** |

* Sudden drawdown analysis. F.S. = 1.0 applies to pool levels prior to drawdown conditions where these water levels are unlikely to persist for long periods preceding drawdown. F.S. = 1.2 applies to pool level likely to persist for long periods prior to drawdown.

** For existing slopes where either sliding or large deformation have occurred previously and back analyses have been performed to establish design shear strengths, lower factors of safety may be used. In such cases probabilistic analyses may be useful in supporting the use of lower factors of safety for design.

Cross sections for evaluation were selected based on levee height and the presence of the most critical foundation soil conditions and strata depths. Selected locations for stability analyses are as follows:

- Location AA' (near KCB-1) .
- Location BB' (near KCB-2/KCMW-2). *
- Location CC' (near KCB-7) .
- Location DD' (near KCB-9).

*Note that KCB-2 and KCMW-2 are the same boring with different names to designate that the boring is also used as groundwater monitoring well.

Static factors of safety were estimated for long-term and rapid drawdown conditions.

The results of the long-term and rapid drawdown stability analyses are summarized in Tables 5 and 6, respectively. These tables show that the calculated FS met the minimum acceptable FS specified by the USACE (2000) in all cases. The stability calculation output figures are attached in Appendix D.

**Table 5: Summary of Simulated Long-term Condition Factors of Safety**

| Analyzed Locations | Levee Core Material | | | | FS | | Figure No. |
|---|---|---|---|---|---|---|---|
| | Passing #200 Sieve (%) | Friction Angle (degrees) | Cohesion (lbs/ft$^2$) | Perm-eability (cm/sec) | Land-ward Side | River-ward Side | |
| AA' | 20 | 37 | 0 | 0.020 | 1.52 | 1.96 | D1, D2 |
| | 25 | 35 | 50 | 0.003 | 1.64 | 2.15 | D1a, D2a |
| BB' | 20 | 37 | 0 | 0.020 | 1.40 | 2.00 | D5, D6 |
| | 25 | 35 | 50 | 0.003 | 1.46 | 2.19 | D5a, D6a |
| CC' | 20 | 37 | 0 | 0.020 | 1.88 | 2.13 | D9, D10 |
| DD' | 20 | 37 | 0 | 0.020 | 1.68 | 2.03 | D13, D14 |

**Table 6: Summary of Simulated Rapid Drawdown Condition Factors of Safety**

| Analyzed Sections | FS* | | Figure No. |
|---|---|---|---|
| | Landward Side | Riverward Side | |
| Section AA' | 1.62 | 1.52 | D3, D4 |
| Section BB' | 1.56 | 1.91 | D7, D8 |
| Section CC' | 1.91 | 1.90 | D11, D12 |
| Section DD' | 1.74 | 1.74 | D15, D16 |

* $\phi$ = 37 °, c = 0 lbs/ft$^2$ , permeability = 0.02 cm/s, assumed 20% fines passing the #200 sieve for the modeled fill .

As in the seepage analyses, the stability analyses were performed for two separate hypothetical levee fill soil types, one having 20 percent fines and an assumed zero cohesion value but higher friction angle than a fill having 25 percent fines. In general, the use of the higher fines fill resulted in a slightly higher long-term factor of safety. The rapid drawdown case was only examined with 20 percent fines in the fill soil (zero cohesion), because the likelihood of obtaining a factor of safety less than the required 1.2 value was judged to be remote for the higher fines fill.

All FS values listed in Table 5 and Table 6 are greater than or equal to the minimum for static conditions (FS =1.4) and rapid drawdown conditions (FS = 1.2) required by the USACE (2000), as shown in Table 4.

## 5.0 CONCLUSIONS

The analyses conducted for the proposed setback levee along the alignment shown in Figure 2 indicate that all configurations modeled will meet the requirements of the USACE for slope stability. The analyses also indicate that the sections modeled meet the USACE seepage guidelines at the locations as follows:

- The proposed sections using a narrow core as shown for Sections 3a and 3b on Figure 5 can be used for the entire proposed setback levee except near location BB'.
- Location BB' requires a core section with rock riprap facing on the waterward side as shown in Section 2 on Figure 4.

Calculations indicate that for soil conditions at most borings, the estimated settlement magnitude for the new levee embankments is relatively small at 2 to 4 inches, most of which is expected to occur during construction. At a few locations where peat or organic silt have been encountered, such as at borings KCB-6 and KCB-7 , the settlement could increase to as much as approximately 6 inches, and could occur over an extended period of time.

Existing groundwater levels will not be lowered by installation of the setback levee. The transient modeling predicts that there may be low-gradient seepage beneath the levee during prolonged periods of high river flows that could result in shallow groundwater conditions landward of the setback levee that would otherwise be inundated with flood water if the project was not constructed. With or without the setback levee, roads or structures may experience saturated subgrades due to existing shallow groundwater conditions.

## 6.0 RECOMMENDATIONS AND CONSTRUCTION CONSIDERATIONS

The soil encountered within the area to be occupied by the new levee is suitable as a foundation for the new levee fills without preload or extensive modification. Total settlements ranging up to 6 inches could occur at the center of the levee during and after construction in locations overlying peat deposits. The settlement will be generated by consolidation of the silt and peat zones under the weight of the new embankment fill.

The permeability of potential on-site or imported embankment fill could vary naturally by a substantial amount. Accordingly, URS is recommending minimum fines content of 25 percent for the levee core so that portions of the fill that do not meet the assumed permeability will still meet the requirement for the maximum allowable seepage gradient.

Recommended fill materials for the core of the levee embankment are silts, clays, sands with silt, sands with clay, or a mixture thereof. The plasticity of the fines content of levee fill materials should be as high as possible to decrease permeability. The fill material should have a maximum particle size of 3 inches with a minimum of 25 percent of the material passing the #200 sieve (considering only material less than 3 inches) measured in accordance with ASTM D-1140. Organic and foreign substances should not be allowed in the earthfill material. URS recognizes that the minimum fines recommendation may be difficult to achieve given the available borrow sources, and accordingly has examined the seepage and stability assuming a coarser levee fill.

Zoned fills as shown on Figure 5 meet minimum seepage and stability guidelines as described in the Conclusions section above. The existing levee materials (alluvium) are gravels with minimal fines and are not acceptable for the core of the setback levee. For the zoned levee section, the core should contain soils with a minimum of 25 percent of the material passing the #200 sieve and it should be constructed up to the future 100-year flood peak water surface elevation. The portion of the levee above the 100-year flood level (freeboard) may be constructed of fill having less than 25 percent fines, including on-site alluvium.

The impervious core of the levee embankment fill should be placed in continuous, homogenous lifts with a maximum layer thickness of 8 inches before compaction. The alluvium may be placed with a maximum layer thickness of 12 inches before compaction. The recommendations for the degree of compaction made here consider that no specific numerical compaction requirement is contained in the latest guidance on levee construction (EM 1110-2-1913, Design and Construction of Levees) published by the USACE (2000). Given the above considerations, URS recommends that fill placed for construction of the setback levee be compacted to a minimum density of 95 percent of the maximum dry density as measured using ASTM Test Method D-698.

The moisture content of the fine-grained fill matrix should not be less than 2 percent below the optimum moisture content, and no more than 3 percent above optimum moisture content as determined by ASTM D-698.

The fill in the wetland (location DD') can be started by removing fine and organic material and filling with approved riprap as a base within the footprint of the riprap as shown in the design drawings. Levee fill behind the riprap should be placed in the dry, meeting all levee criteria described above, after the foundation has been stripped and proof rolled (compact foundation layer prior to initial fill placement).

A clubfoot or sheepsfoot roller is recommended for foundation subgrade preparation and levee compaction for fine-grained soils (e.g., silts, clay, sandy silt, and sandy clay) or soils that have a high fines component (e.g., silty sand), to be used for construction of the new levee. This type of roller is expected to minimize the potential for creating a preferred pathway for seepage at the interface between lifts of fill soil. If a smooth surface occurs during placement, the top of each lift should be scarified to a depth of approximately 1 inch before placement of the next lift to avoid development of a preferred pathway for seepage. If rainfall is expected during the construction period, the levee surface should be sloped to drain and "sealed" with a smooth drum roller to allow surface water runoff. The smooth surface should be scarified when fill placement is resumed. Vibratory compaction should be avoided for fine-grained soils or soils with high fines content. Rubber tire or smooth drum vibratory compactors can be used on coarser soils used in the zone identified as alluvium.

Fill soils immediately below the riprap blanket placed on the waterward face of the setback levee may be susceptible to erosion and washing from behind the riprap unless a filter is placed between the riprap blanket and the levee fill. The filter should consist of a 9-inch minimum thickness of well-graded sand and gravel meeting the gradation requirements in Appendix D of EM 1110-2-1913.

Before starting earthwork, site preparation should begin with stripping any surficial grass, roots, and topsoil from within the limits of fill placement. URS expects surface stripping will be necessary to a minimum depth of 1 foot.

One typically adverse existing soil condition that was not encountered in the soil borings, but if encountered during construction would likely result in an unacceptable seepage exit gradient is the presence of a clean sand (SP or SW) at the subgrade level of the new setback levee embankment. While it appears that the possibility of encountering such a condition is low, URS recommends that if the clean sand is present for a distance of at least 15 feet along the setback levee alignment, the low permeability core soil should be extended downward in the form of a keyway into the foundation to a depth of at least 4 feet. The final dimensions should be assessed according to the nature of conditions encountered.

Topsoil obtained from the foundation preparation may be stockpiled and placed on the setback levee prior to revegetation of the levee slopes. Prior to placing topsoil, the setback levee should be constructed to its full cross section using approved levee fill material. The setback levee side slopes should be “track-walked” by a tracked vehicle running up and down the slopes of the fill. The topsoil should be compacted by the same track-walking method leaving the final surface with horizontal indents from the tracks to collect rain and prevent erosion of the newly completed levee.

The soils expected to be exposed at the subgrade level for the setback levee are considered moderately to highly erodible in a disturbed condition. Erosion control efforts during construction should be diligently implemented in this large area of disturbance, and Best Management Practices (BMPs) applied as necessary to protect the nearby wetlands and river. Protection of compacted soil embankment slopes should be selected considering the velocity of the water that may be flowing towards or along the sloping surface.

## 7.0 LIMITATIONS

The recommendations and descriptions presented in this report are based on the soil conditions encountered in the field exploration conducted by King County at the site in 2010. The subsurface information referred to herein does not constitute a direct or implied warranty that the soil conditions between boring locations can be directly interpolated or extrapolated or that subsurface conditions and soil variations different from those encountered in the County’s explorations will not be revealed. If, during construction, subsurface conditions different from those described herein are observed, or if the structures and loading conditions described here are modified, URS Corporation should review such conditions and the recommendations given herein should be revised, as necessary.

## REFERENCES


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## APPENDICES

Appendix A - Logs of Borings, Results of Laboratory Testing
Appendix B - King County Modeling Data for Drawdown Analysis
Appendix C - Vertical Exit Gradient SEEP/W Output
Appendix D - Stability Analyses SLOPE/W Output
Appendix E - King County Groundwater Well Data

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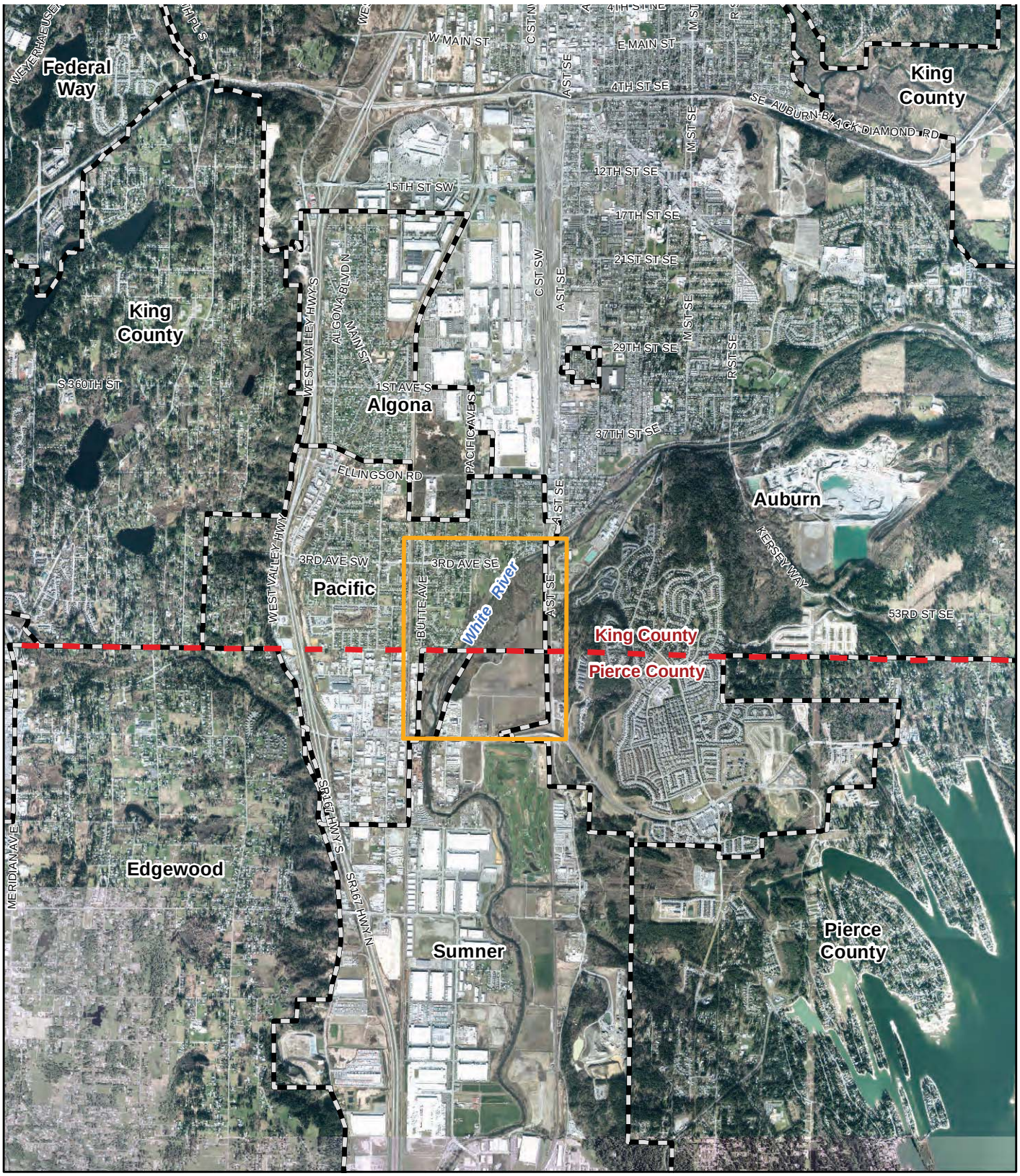


*Source: King County, Department of Natural Resources and Parks, Water and Land Resources Division*

Figure 2 Location
City Boundary
County Boundary

0 2,000 4,000 6,000
Feet

Figure 1
**Site Location**

Job No. 33762798

URS

White River Countyline Levee Project
King County, Washington

33762798_02.ai

*Source: King County, Department of Natural Resources and Parks, Water and Land Resources Division*

City Boundary
County Boundary
A A' Cross Section Location
Boring Sites
Test Pits
Scrapes

0 600 1,200
Feet

Figure 2

## Site Plan, Boring Locations and Cross Sections

Job No. 33762798

URS

White River Countyline Levee Project
King County, Washington

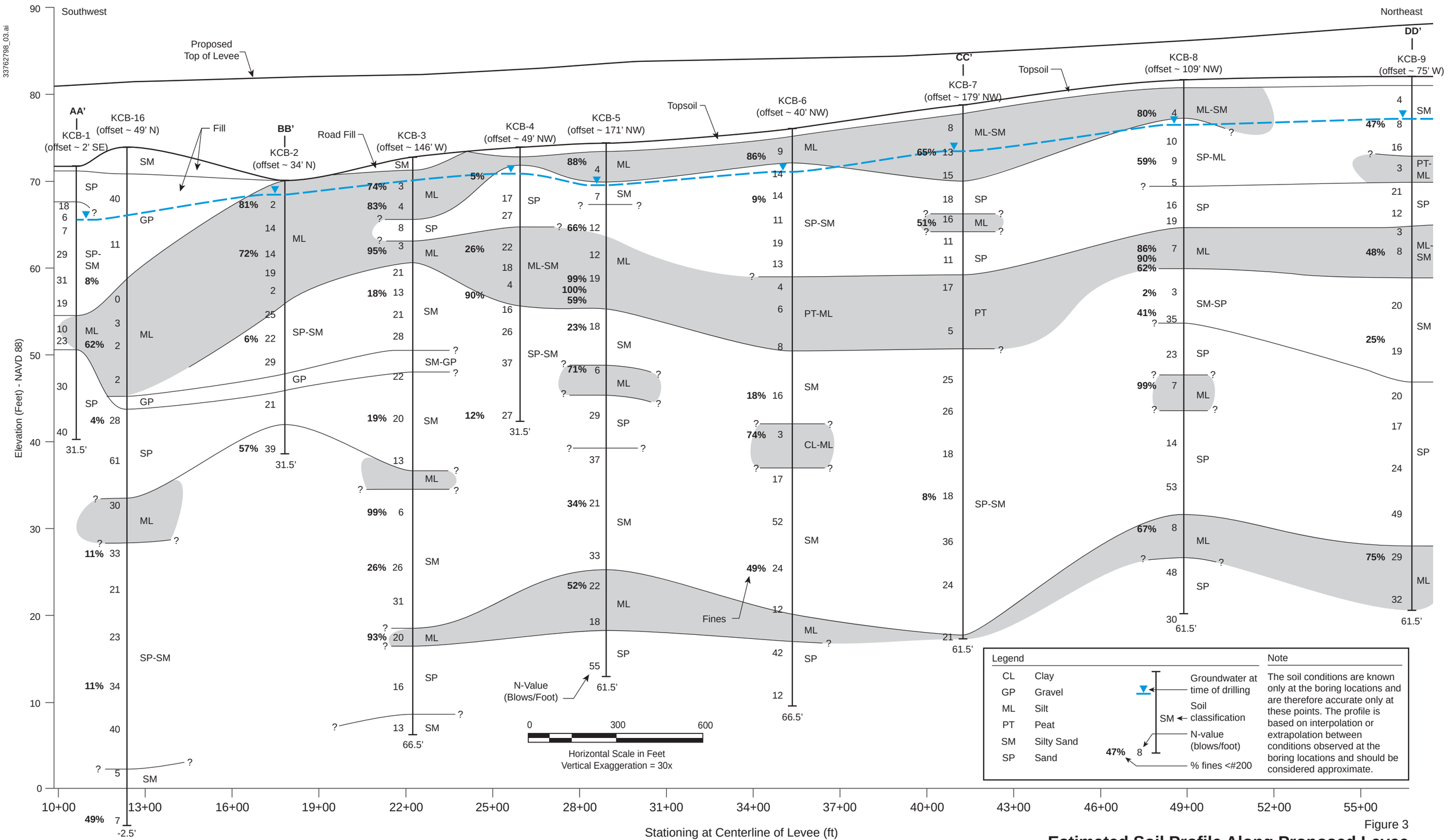


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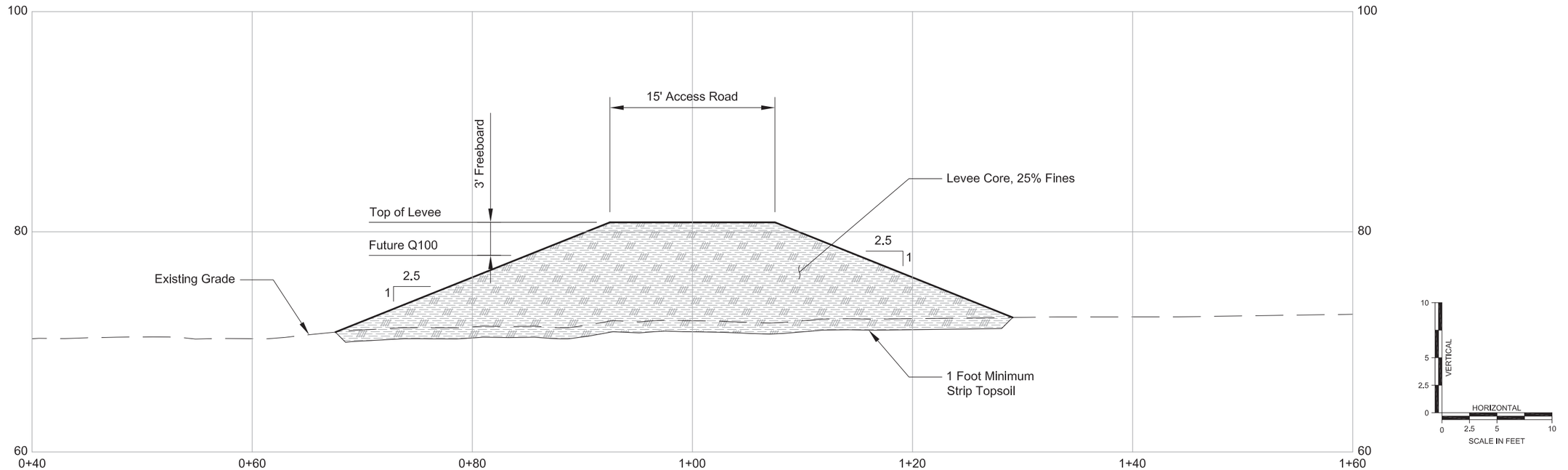
Figure 3

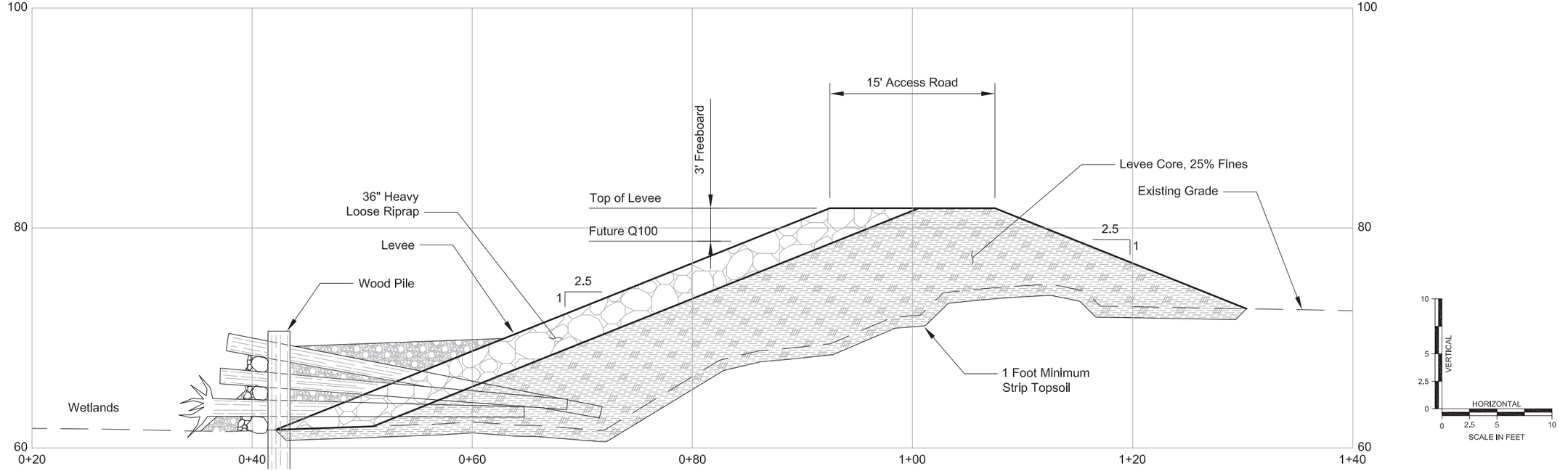
**Estimated Soil Profile Along Proposed Levee**

URS

White River Countyline Levee Project
King County, Washington




**Typical Section 1 at A, C, and D**




**Section 2 at B**

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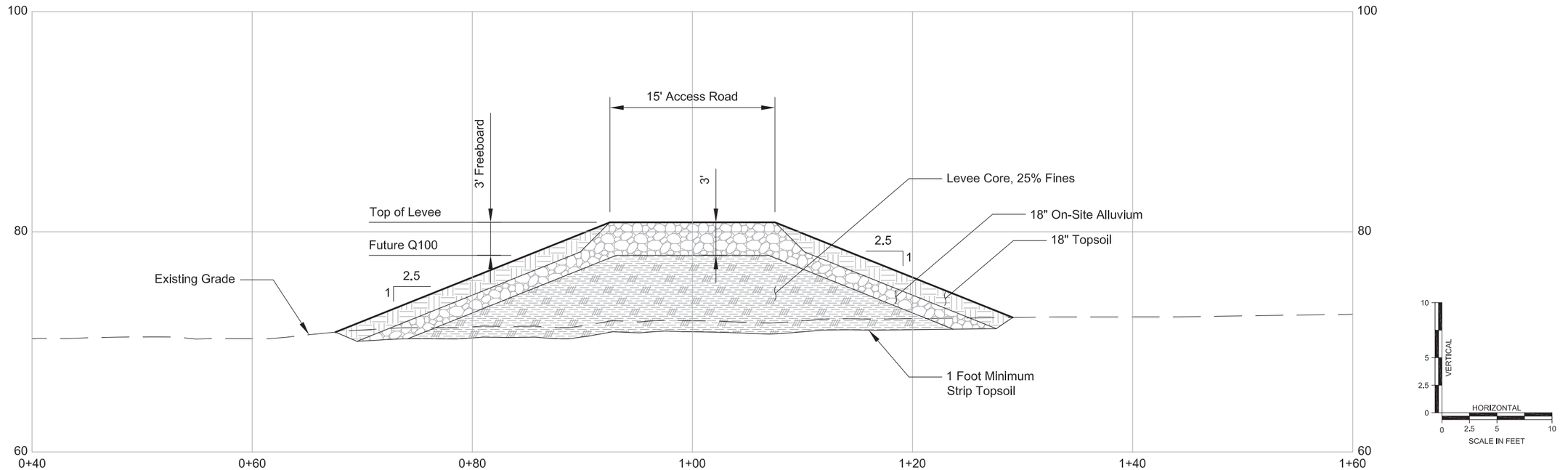
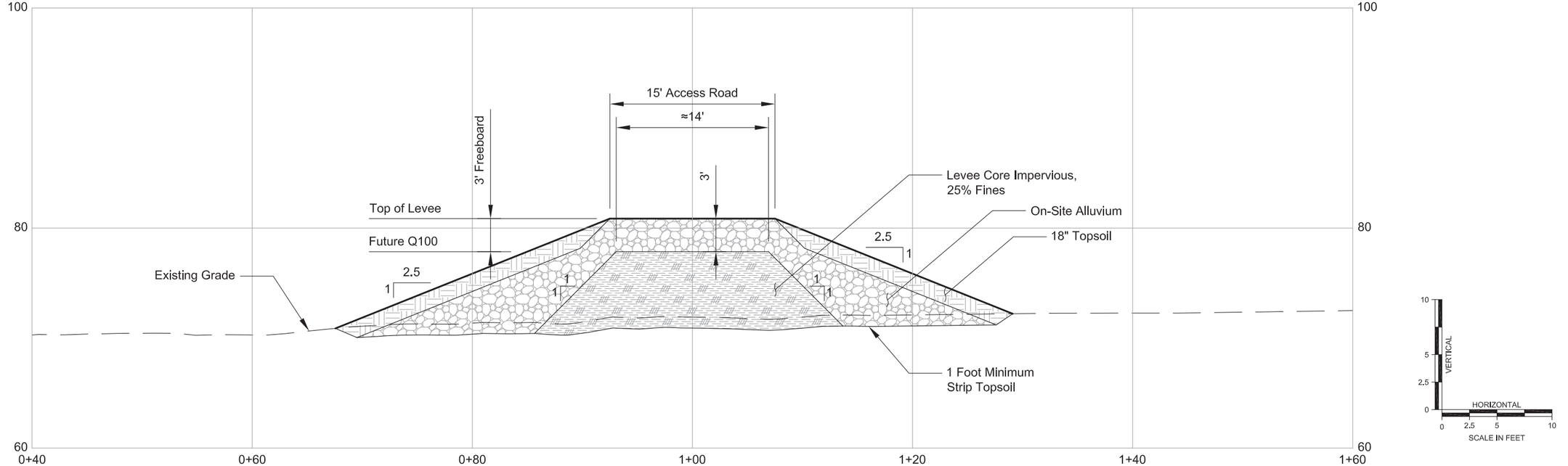
URS

**Figure 4**
**Typical Sections**

White River Countyline Levee Project
King County, Washington




**Alternate Section 3a at A, C and D**




**Alternate Section 3b at A, C and D**

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URS

**Figure 5**
**Alternate Sections**

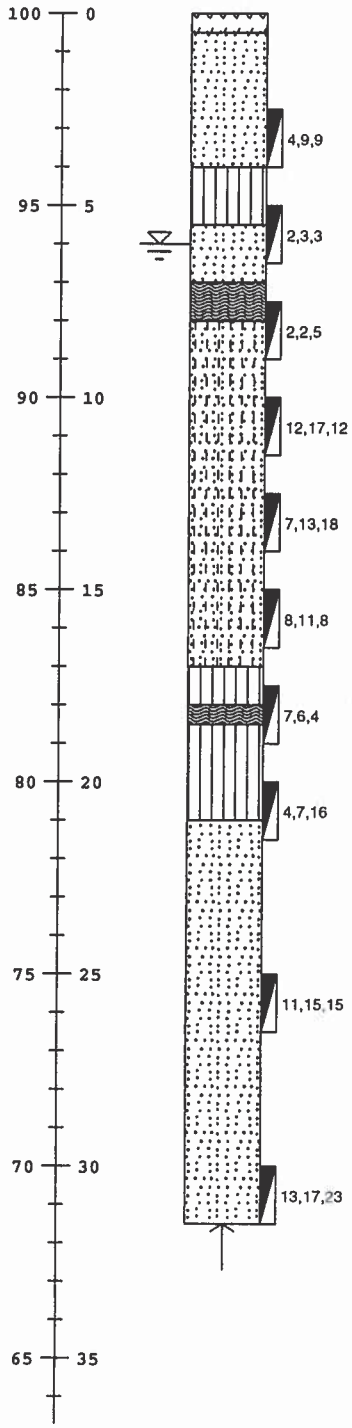
White River Countyline Levee Project
King County, Washington

# Appendix A: Borings and Laboratory Test Results

# BORING LOG
## BORING KCB-1

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Setback Levee Location 1**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **6 ft** Caving: **N. A.**

DATE: **September 28, 2010**
START: **12:00 PM 9/28/2010**
FINISH: **2:00 PM 9/28/2010**
LOGGER: **DA**
DATE CHECKED: **During**




| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | SP | Sod and sandy topsoil. | | | |
| | | ML | Dark brown poorly graded fine to medium grained sand with silt, gravel, and occasional cobbles, moist, medium dense. (Fill) | | | |
| | | SP | Gray silt with sand, moist, loose. The silt contains a few fragments of decaying vegetation. | | | |
| | | PT | | 168.0 | | |
| | | SP-SM | Black poorly graded fine to medium sand, wet, loose. | | | |
| | | | Peat. | | | |
| | | | Black poorly graded fine to medium grained sand with silt, wet, loose to dense. | 26.4 | 7.9 | The sample contained scattered gravel. |
| | | ML | Black silt, wet, medium dense. | | | |
| | | PT | Peat. | 168.1 | | |
| | | ML | Dark gray sandy silt, wet, medium dense. | 35.4 | 61.7 | The silt was found to be non-plastic. |
| | | SP | Black poorly graded fine to medium grained sand, wet, medium dense to dense. | | | |
| | | | The sample contained scattered tephra granules. | | | |

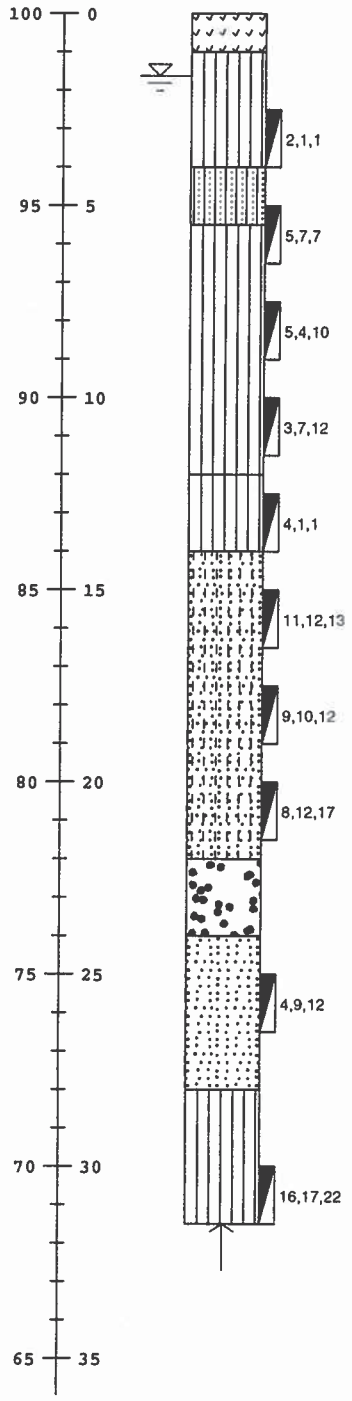
*Boring KCB-1 was located in the field by GPS. The approximate boring location is provided in Figure 2.*

PLATE NUMBER **A1**

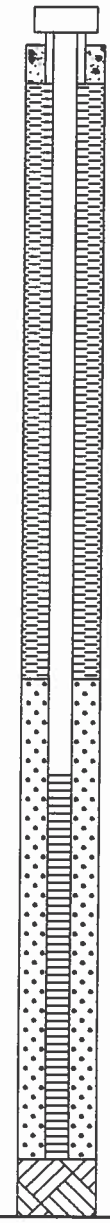
# LOG OF MONITOR WELL INSTALLATION
## WELL NO. KCB-2

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Setback Levee Location 2**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **1.62 ft**

DATE: **September 22 2010**
START: **12:00 PM 9/22/2010**
FINISH: **2:00 PM 9/22/2010**
LOGGER: **DA**
DATE CHECKED: **7:30 AM 9/30/**




| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks | Monitor Well Construction Schematic |
|---|---|---|---|---|---|---|---|
| | | | Cultivated sandy topsoil. | | | | |
| | | ML | Gray mottled silt with sand, moist to wet, very loose. Sample also contained scattered organic material. | 53.0 | 80.6 | The silt was found to be non-plastic. | |
| | | SM | | | | | |
| | | ML | Black silty sand, wet, medium dense. The sand contains thin lenses of fine sand and silt. | 31.6 | 72.2 | The silt was found to be non-plastic. | |
| | | | Black silt with sand, wet, loose to medium dense. | | | | |
| | | ML | Gray silt, wet, very loose. The sample also contained a 6 inch thick lense of peat. | | | | |
| | | SP-SM | | | | | |
| | | | Black poorly graded fine to medium sand with silt, wet, medium dense. | 29.5 | 5.5 | | |
| | | GP | Poorly graded gravel with sand, wet, medium dense. | | | The gravel was detected by the action of the drill. | |
| | | SP | Black poorly graded fine to medium grained sand, wet, medium dense to dense. | | | Sample contained scattered decomposed wood debris and root fibers. | |
| | | ML | Dark gray sandy silt, wet, dense. | 30.0 | 56.6 | The silt was found to be non-plastic. | |



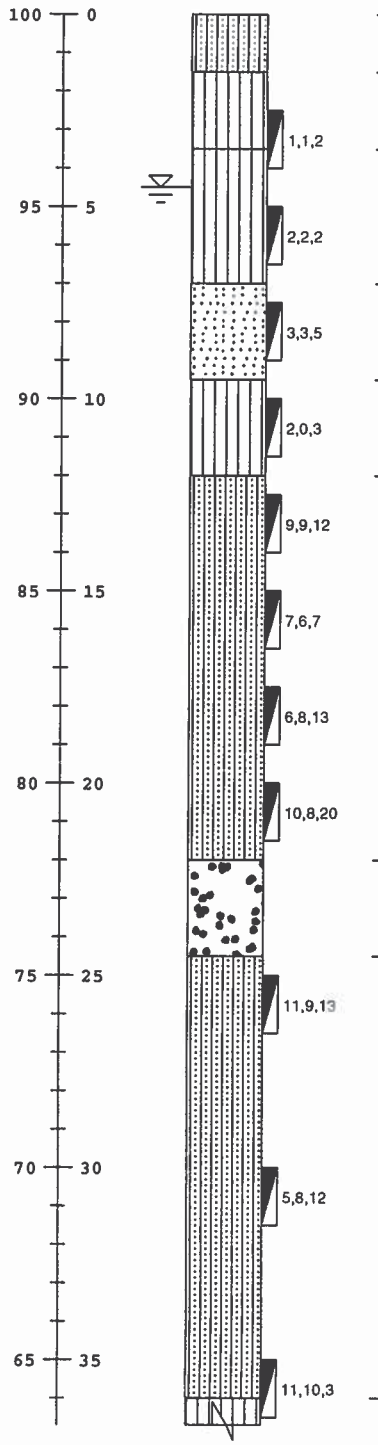
*Well KCB-2 was located in the field by GPS. The approximate well location is provided in Figure 2. Well KCB-2 is identified by Washington State Department of Ecology discrete well tag number BCJ 225.*

PLATE NUMBER **A2**

# BORING LOG
## BORING KCB-3

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Setback Levee Log Jam Location 3**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **4.5 ft** Caving: **N.A.**

DATE: **September 22, 2010**
START: **9:00 AM 9/22/2010**
FINISH: **2:00 PM 9/22/2010**
LOGGER: **D. A.**
DATE CHECKED: **During**

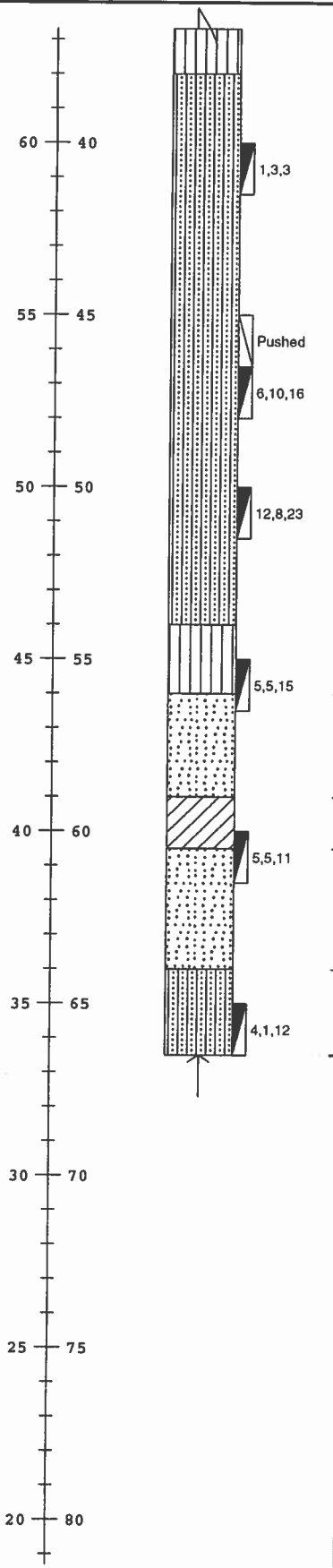



| USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|
| SM | Brown silty sand with gravel, moist, medium dense. (Road fill) | | | |
| ML | Gray silt with sand, wet, very loose. | 42.9 | 73.8 | The silt was found to be non-plastic. |
| ML | Gray silt with fine grained sand, wet, very loose. The sample contained roots and traces of decomposed wood debris. | 36.5 | 82.5 | The silt was found to be non-plastic. |
| SP | Black poorly graded fine to medium grained sand, wet, loose. | | | |
| ML | Gray silt, wet, loose. | 45.5 | 95.3 | The silt was found to be non-plastic. |
| SM | Black silty fine to medium grained sand, wet, medium dense. | 28.4 | 17.9 | |
| GP | Black poorly graded gravel with sand, wet, dense. | | | The gravel was detected by the action of the drill. |
| SM | Black silty fine grained sand with scattered gravel, wet, medium dense. | 26.2 | 18.7 | A 1-foot thick gravel lense was detected during drilling. |
| SM | | | | |
| ML | | | | |

*Boring KCB-3 was located in the field by GPS. The approximate boring location is provided in Figure 2.*

PLATE NUMBER **A3**

# LOG OF Boring
## BORING KCB-3
(continued)

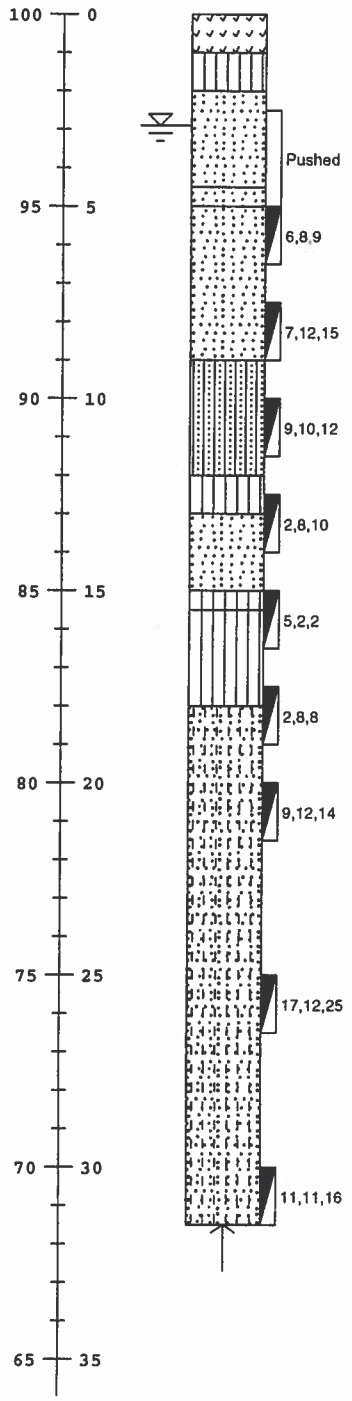



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | SM | Brown silt, wet, loose. A 1 inch thick peat lens was found on the surface of the silt. | | | |
| | | | Black silty fine to medium grained sand, wet, loose to medium dense. The soil zone from 38 to 54 feet also contains scattered thin silt and peat lenses with occasional decomposed wood. | 45.9 | 98.5 | Liquid Limit 35 Plastic Index 2. The testing at 40 feet was performed on one of the intermittent silt lenses. |
| | | | | 24.2 | 25.6 | A sampler containing rings was pushed at this elevation resulting in no sample recovery. |
| | | ML | Peat and dark brown silt, wet, loose. | 51.3 | 92.7 | Liquid Limit 42 Plastic Index 8 |
| | | SP | Black poorly graded fine to medium sand, wet, medium dense. | | | |
| | | CL | Gray silty lean clay, wet, stiff. | | | |
| | | PT | Peat | 112.9 | | |
| | | SP | Black poorly graded fine to medium sand, wet, medium dense. | | | |
| | | SM | Dark gray silty fine grained sand, wet, medium dense. | | | |

# LOG OF MONITOR WELL INSTALLATION
## WELL NO. KCB-4

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Set Back Levee Location 4**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **2.90 ft**

DATE: **September 22, 2010**
START: **2:00 PM 9/22/2010**
FINISH: **9:00 AM 9/23/2010**
LOGGER: **DA**
DATE CHECKED: **7:30 AM 9/30/10**




| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks | Monitor Well Construction Schematic |
|---|---|---|---|---|---|---|---|
| | | | Cultivated sandy topsoil. | | | | |
| | | ML | Gray mottled sandy silt, moist to wet, very loose. The sample also contained scattered organic material. | 26.7 | 4.5 | Brown fine sand observed in the tip of the shelby. | |
| | | SP | | | | | |
| | | SP | Black poorly graded fine to medium grained sand, wet, medium dense. | | | | |
| | | SP | | | | | |
| | | SM | Brown poorly graded fine grained sand, wet, medium dense. | | | | |
| | | | Black poorly graded fine to medium grained sand with 1 to 2 inch thick lenses of fine sand and silt, wet, medium dense. | 28.3 | 26.1 | | |
| | | ML | | | | | |
| | | SP | | | | | |
| | | | Dark gray silty sand, wet, medium dense. Slight bedding visible. | 62.5 | 89.8 | | |
| | | ML | | | | | |
| | | ML | | | | | |
| | | | Gray silt, wet, very loose. The sample also contained a 3 inch thick lens of peat at the bottom of the silt. | | | | |
| | | SP-SM | | | | | |
| | | | Black poorly graded fine to medium grained sand, wet, medium dense. | | | | |
| | | | Gray silt, wet, very loose. The sample also contained a 3-inch thick lens of peat at the bottom of the silt. | 26.7 | 11.8 | | |
| | | | Black poorly graded fine to medium grained sand with silt, wet, medium dense to dense. | | | | |

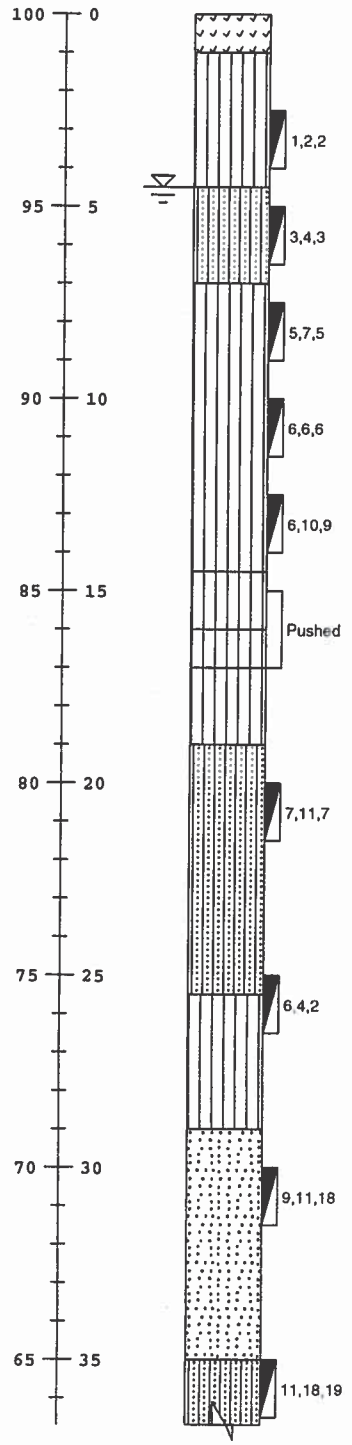
*Well KCB-4 was located in the field by GPS. The approximate well location is provided in Figure 2. Well KCB-4 is identified by Washington State Department of Ecology discrete well tag number BCJ 226.*

PLATE NUMBER **A4**

# BORING LOG
## BORING KCB-5

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Setback Levee Log Jam Location 5**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **4.5 ft** Caving: **N.A.**

DATE: **September 23, 2010**
START: **1:45 PM 9/23/2010**
FINISH: **10:AM 9/24/2010**
LOGGER: **D. A.**
DATE CHECKED: **During**

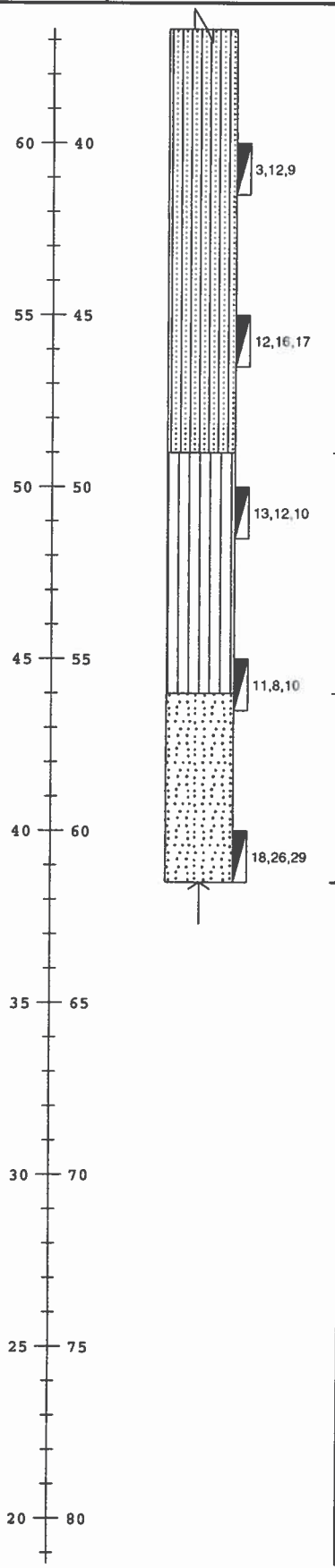



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | | Cultivated sandy topsoil. | | | |
| | | ML | Gray brown mottled silt, wet, loose. The sample contained scattered root fragments. | 49.0 | 87.9 | |
| | | SM | Dark gray silty sand, wet, loose. | 29.1 | | |
| | | ML | Black fine to medium grained sandy silt, wet, medium dense. | 48.6 | 66.2 | The silt was found to be non-plastic. |
| | | ML | Brown silt, wet, medium dense. | 52.6 | 98.6 | The silt was found to be non-plastic. |
| | | ML | Gray silt, wet, medium stiff to stiff. | 49.6 | 99.6 | Liquid Limit 44 |
| | | ML | Black sandy silt, wet, medium dense. | 36.4 | 59.0 | Plastic Index 10 The silt was found to be non-plastic. |
| | | SM | Dark gray silty sand, wet, medium dense. | 29.1 | 23.0 | The mud level in the boring at 7:45 AM on 9/24/10 was 4 feet below the surface. |
| | | ML | Dark gray silt with a 4-inch thick peat lens, wet, loose. The silt also contained scattered decomposed wood debris. | 40.2 | 71.3 | Scattered decomposed wood debris observed in the drill fluid. The silt was found to be non-plastic. |
| | | SP | Black poorly graded fine to medium grained sand, wet, medium dense to dense. | | | |
| | | SM | Dark gray silty sand, wet, medium dense | | | Silt noted in the drill cuttings |

*Boring KCB-5 was located in the field by GPS. The approximate boring location is provided in Figure 2.*

PLATE NUMBER **A5**

# LOG OF Boring
## BORING KCB-5
(continued)

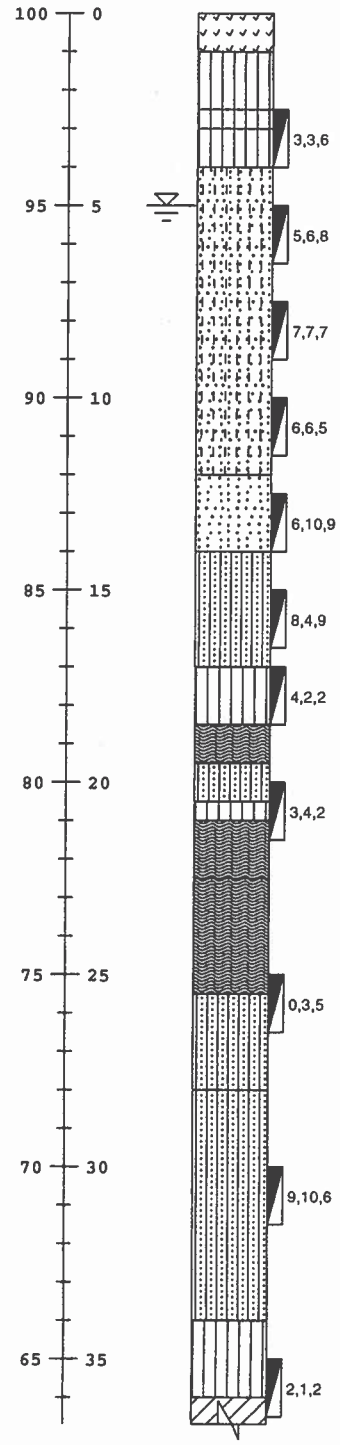



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | | to dense. | | | between 38 and 40 feet below the surface. |
| | 3,12,9 | | | 32.3 | 33.6 | |
| | 12,16,17 | | | | | Sloping thin lenses of fine sand in the sample. |
| | | ML | Dark gray sandy silt, wet, medium dense. | | | |
| | 13,12,10 | | | 29.1 | 52.1 | A thin volcanic ash lens was found overlying a minor layer of peat in the tip of the sampler. The silt was found to be non-plastic. |
| | 11,8,10 | | | | | |
| | | SP | Black poorly graded fine to medium sand, wet, medium dense to very dense. | | | |
| | 18,26,29 | | | | | Silt was observed in cuttings during drilling. |

# BORING LOG
## BORING KCB-6

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Setback Levee Location 6**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **5 ft** Caving: **N.A.**

DATE: **September 24, 2010**
START: **11:00 AM 9/24/2010**
FINISH: **3:30 PM 9/24/2010**
LOGGER: **D. A.**
DATE CHECKED: **During**

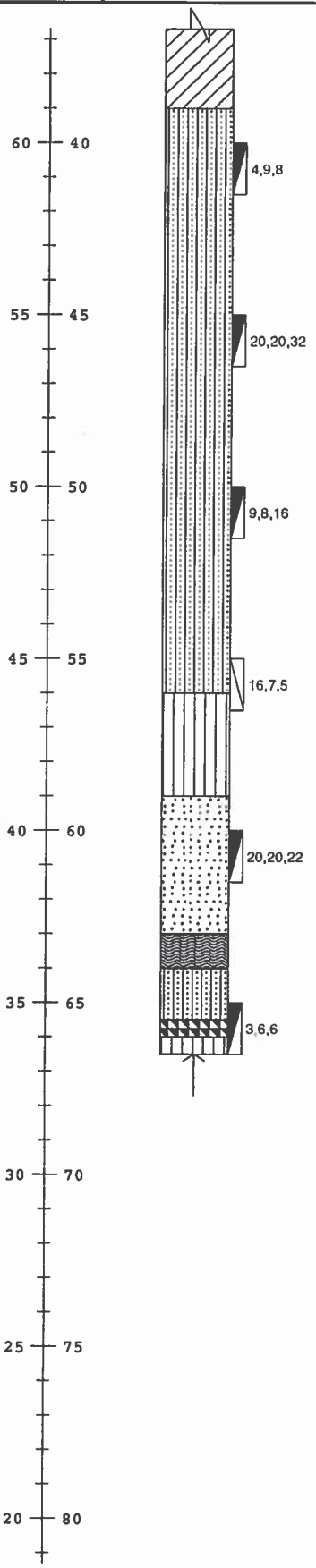



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | | Cultivated sandy topsoil. | | | |
| | | ML | Brown mottled poorly graded fine grained sand with silt, wet, loose. | | | |
| | | ML | | 35.3 | 86.4 | The silt was found to be non-plastic. |
| | | ML | Tan mottled silt, wet, loose. The sample also contained a few iron stained joints. | | | |
| | | SP-SM | Black poorly graded fine to medium grained sand with silt, wet, medium dense. Lenses of fine sand and silt are 1 to 2 inches thick. | 26.1 | 8.5 | |
| | | SP | Black poorly graded fine grained sand, wet, loose. This unit contains lenses of fine sand and silt 1 to 2 inches in thickness. | | | Sample contained scattered decomposed wood fragments. |
| | | SM | Dark gray silty sand, wet, loose. | | | |
| | | ML | Gray silt with sand, wet, loose. | | | |
| | | PT | Peat. | | | |
| | | SM | Dark gray silty sand, wet, loose. | | | |
| | | ML | Gray silt, wet, loose. | 134.7 | | |
| | | PT | Tan sedimentary peat, wet, soft. | | | |
| | | PT | Peat with alternating layers of organic silt and sand, wet, loose. | | | |
| | | SM | Dark gray silty sand, wet, loose. | | | |
| | | SM | Black silty sand, wet, medium dense. Tephra pebbles noted in the cuttings. | 24.0 | 18.0 | |
| | | ML | Dark gray silt with sand and a thin lens of sedimentary peat, wet, loose. | 88.9 | 74.2 | The silt was found to be non-plastic. |
| | | CL | | | | |

*Boring KCB-6 was located in the field by GPS. The approximate boring location is provided in Figure 2.*

PLATE NUMBER **A6**

# LOG OF Boring
## BORING KCB-6
(continued)

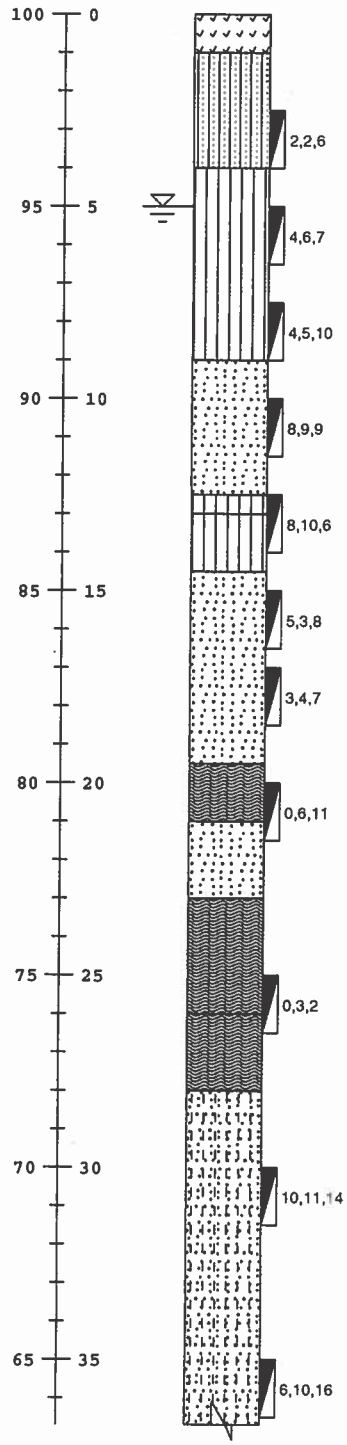



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | | Green lean clay, wet, soft. | | | |
| | | SM | Black silty fine to medium grained sand, wet, medium dense to very dense. | | | |
| | | | | | | Sloping thin lenses of fine sand in the sample. |
| | | | | 36.7 | 49.7 | Scattered decomposed wood in the sample. |
| | | ML | Dark gray silt, wet, medium dense. | | | Silt observed in the drill cuttings between 56 and 59 feet below the surface. |
| | | SP | Black poorly graded fine to medium sand, wet, dense. | | | |
| | | PT | Peat and organic silt, wet, loose. | | | Material composition based on drill cuttings. |
| | | SM | Dark gray silty sand, wet, loose. | | | |
| | | | Decomposed wood. | | | |
| | | ML | Dark gray silt with scattered wood debris, wet, medium dense. | | | |

# BORING LOG
## BORING KCB-7

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Setback Levee Log Jam Location 7**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **5 ft** Caving: **N.A.**

DATE: **September 27, 2010**
START: **7:30 AM 9/27/2010**
FINISH: **10:30 AM 9/27/2010**
LOGGER: **D. A.**
DATE CHECKED: **During**




| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | | Cultivated sandy topsoil. | | | |
| | | SM | Brown mottled silty sand, moist, loose. | | | |
| | | ML | Dark brown sandy silt, wet, medium dense. | 29.8 | 65.3 | The silt was found to be non-plastic. |
| | | SP | Black poorly graded fine to medium grained sand, wet, medium dense. | | | |
| | | ML | Dark gray sandy silt, wet, medium dense. | 27.4 | 50.8 | The sample contained scattered decomposed wood fragments. The silt was found to be non-plastic. |
| | | ML | | | | |
| | | SP | Brown silt, wet, medium dense. The silt contains scattered organic material. | | | |
| | | PT | Black poorly graded fine to medium grained sand with scattered 1 to 2 inch thick lenses of fine sand and silt, wet, medium dense. | 166.0 | | |
| | | SP | Peat and lenses of organic silt. | | | |
| | | PT | Black poorly graded fine to medium sand, wet, medium dense. | | | |
| | | | Brown peat with lenses of gray organic silt, wet, soft. | 201.6 | | |
| | | PT | Yellow sedimentary peat, wet, soft. | | | |
| | | SP-SM | Black poorly graded fine to medium grained sand with silt, wet, medium dense. Fine sand in the form of 1 to 2 inch thick lenses throughout this section. | | | |

*Boring KCB-7 was located in the field by GPS. The approximate boring location is provided in Figure 2.*

PLATE NUMBER **A7**

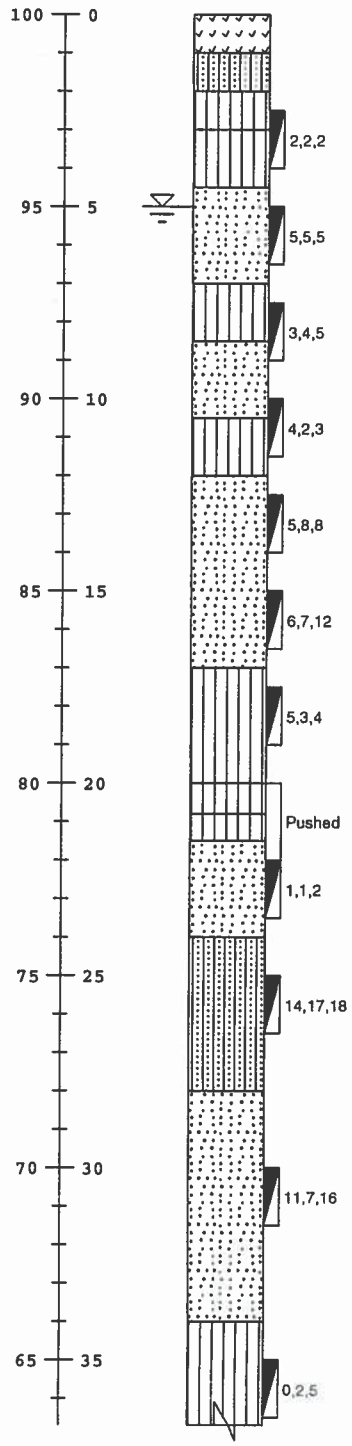
# LOG OF Boring
## BORING KCB-7
(continued)

| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| 60 — 40 | 11,5,13 | | | | | |
| 55 — 45 | 5,3,15 | | | 39.3 | 8.2 | |
| 50 — 50 | 12,14,22 | | | | | |
| 45 — 55 | 8,11,13 | | | | | Scattered decomposed wood in the sample. |
| 40 — 60 | 22,12,9 | | | | | |
| | | ML | Dark gray silt with scattered wood debris, wet, medium dense. | | | |
| 35 — 65 | | | | | | |
| 30 — 70 | | | | | | |
| 25 — 75 | | | | | | |
| 20 — 80 | | | | | | |

# BORING LOG
## BORING KCB-8

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Set Back Levee Log Jam Location 8**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **5 ft** Caving: **N.A.**

DATE: **September 27, 2010**
START: **11:30 AM 9/27/2010**
FINISH: **3:30 PM 9/27/2010**
LOGGER: **D. A.**
DATE CHECKED: **During**

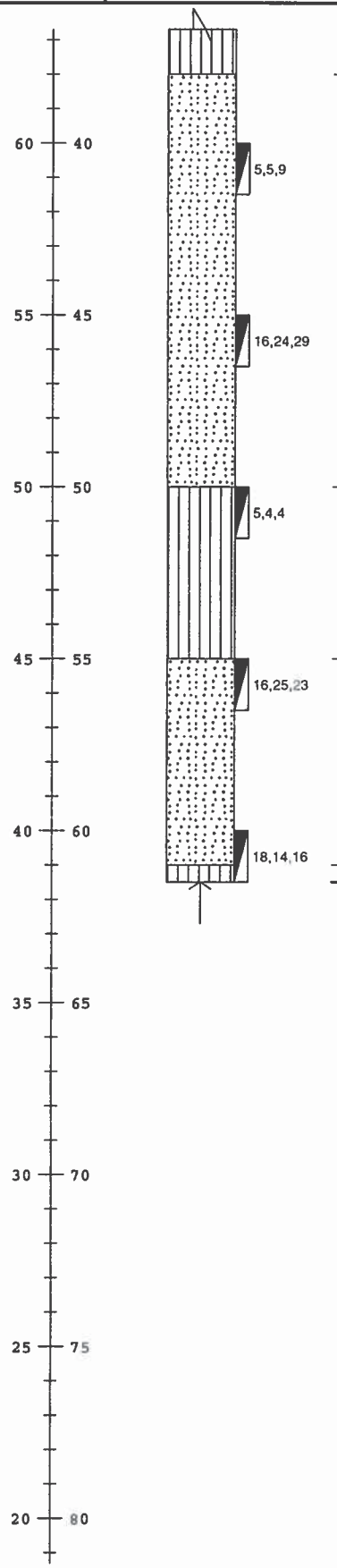



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | | Cultivated sandy topsoil. | | | |
| | | SM | Brown mottled silty sand, moist, loose. | | | |
| | | ML | Tan mottled silt, moist, loose. | 35.7 | 80.4 | The silt was found to be non-plastic. |
| | | ML | Dark gray silt with scattered organic material, wet, loose. | | | |
| | | SP | Brown mottled poorly graded fine grained sand, wet, loose to medium dense. | | | |
| | | ML | Gray mottled sandy silt, wet, loose. | 38.6 | 58.8 | The silt was found to be non-plastic. |
| | | SP | Black poorly graded fine to medium grained sand, wet, loose. | | | |
| | | ML | Gray mottled silt with scattered organic material, wet, loose. | | | |
| | | SP | Black poorly graded fine to medium grained sand with 1 to 2 inch thick silt and fine grained sand lenses, wet, medium dense. | | | |
| | | ML | Dark gray silt with scattered organic material, wet, loose. | 42.7 | 86.2 | The silt was found to be non-plastic. |
| | | ML | | 32.8 | 90.1 | |
| | | ML | Dark gray sandy silt, wet, loose. | 33.3 | 62.1 | The silt was found to be non-plastic. |
| | | SP | Black poorly graded fine to medium sand, wet, medium dense. | 30.7 | 1.9 | |
| | | SM | Dark gray silty sand, wet, dense. | 29.0 | 40.5 | |
| | | SP | Black poorly graded fine to medium grained sand, wet, medium dense. Fine sand in the form of 1 to 2 inch thick lenses throughout this section. | | | |
| | | ML | Green silt, wet, loose. | 54.3 | 99.4 | Liquid Limit 45 Plastic Index 8 |

*Boring KCB-8 was located in the field by GPS. The approximate boring location is provided in Figure 2.*

PLATE NUMBER **A8**

# LOG OF Boring
## BORING KCB-8
(continued)

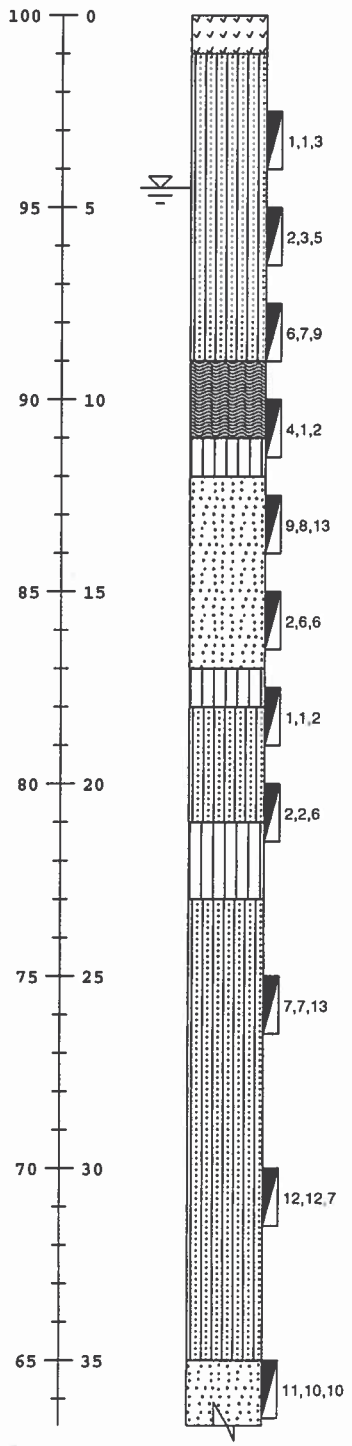



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | SP | Black poorly graded fine to medium grained sand, wet, loose to very dense. The fine sand and silt is in the form of 1 to 2 inch to thick lenses throughout out this section. | | | |
| | | ML | Gray sandy silt, wet, dense to very dense. | 33.2 | 66.7 | The silt was found to be non-plastic. |
| | | SP | Black poorly graded fine to medium grained sand, wet, loose to very dense. The fine sand and silt is in the form of 1 to 2 inch to thick lenses throughout out this section. | | | |
| | | ML | Dark gray silt with scattered wood debris, wet, dense. | | | |

# BORING LOG
## BORING KCB-9

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Setback Levee Log Jam Location 9**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **4.5 ft** Caving: **N.A.**

DATE: **September 28, 2010**
START: **8:00 AM 9/28/2010**
FINISH: **10:30 AM 9/28/2010**
LOGGER: **D. A.**
DATE CHECKED: **During**

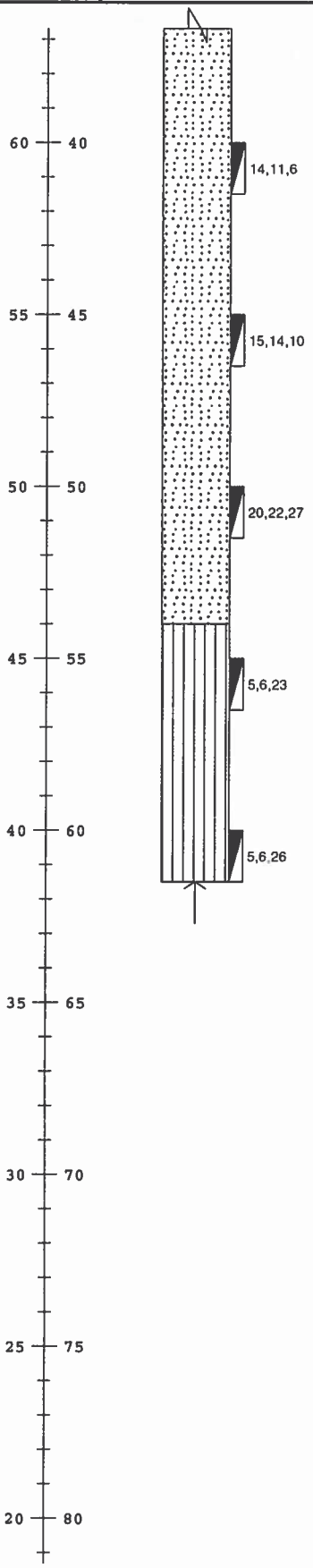



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | | Cultivated sandy topsoil. | | | |
| | | SM | Brown mottled poorly graded fine to medium grained sand, moist, loose. | 32.6 | 47.1 | |
| | | PT | Brown peat. | 47.1 | | |
| | | ML | Gray mottled silt with scattered organic material, wet, loose. | | | |
| | | SP | Black poorly graded fine to medium grained sand with 1 to 2 inch thick silt and fine grained sand lenses, wet, medium dense. | | | |
| | | ML | Dark gray silt with scattered organic material, wet, loose. | | | A thin peat lens was found at the base of the silt in the sampler. |
| | | SM | Dark gray silty fine grained sand, wet, loose. | 39.2 | 48.2 | |
| | | ML | Dark gray silt with thin fine sand lenses, wet, loose. A thin peat lens 1/4 inch thick was found on the surface of the silt. | | | |
| | | SM | Black silty fine to medium grained sand, wet, medium dense to dense. Silt and fine sand are in the form of 1 to 2 inch thick lenses throughout this section. | 26.6 | 24.6 | |
| | | SP | Black poorly graded fine to medium | | | |

*Boring KCB-9 was locate in the field by GPS. The approximate boring location is provided in Figure 2.*

PLATE NUMBER **A9**

# LOG OF Boring
## BORING KCB-9
(continued)

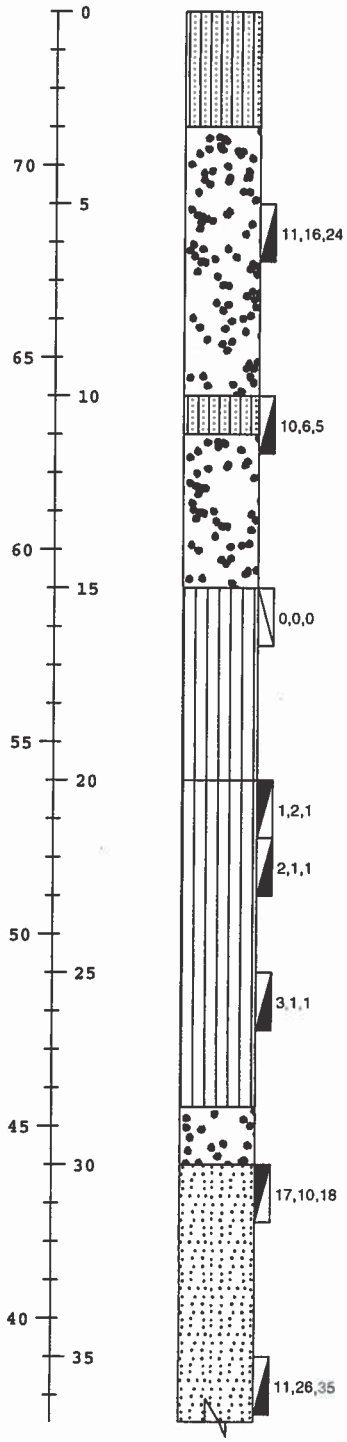



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | | grained sand, wet, medium dense to dense. Silt and fine sand are in the form of 1 to 2 inch thick lenses throughout this section. | | | |
| | | ML | Dark gray silt with sand, wet, medium dense to dense. | 30.3 | 75.3 | The silt was found to be non-plastic. |

# BORING LOG
## BORING KCB-16

PROJECT: **Countyline to A-Street Geotechnical Study**
BORING LOCATION: **Fairweather Property**
DRILL METHOD: **Mud Rotary**
DRILLER: **Holocene Drilling Inc.**
DEPTH TO - Water: **N/A** Caving: **N/A**

DATE: **October 4, 2011**
START: **7:45 AM 10/4/2011**
FINISH: **2:15 PM 10/4/2011**
LOGGER: **DW**
DATE CHECKED: **N/A**

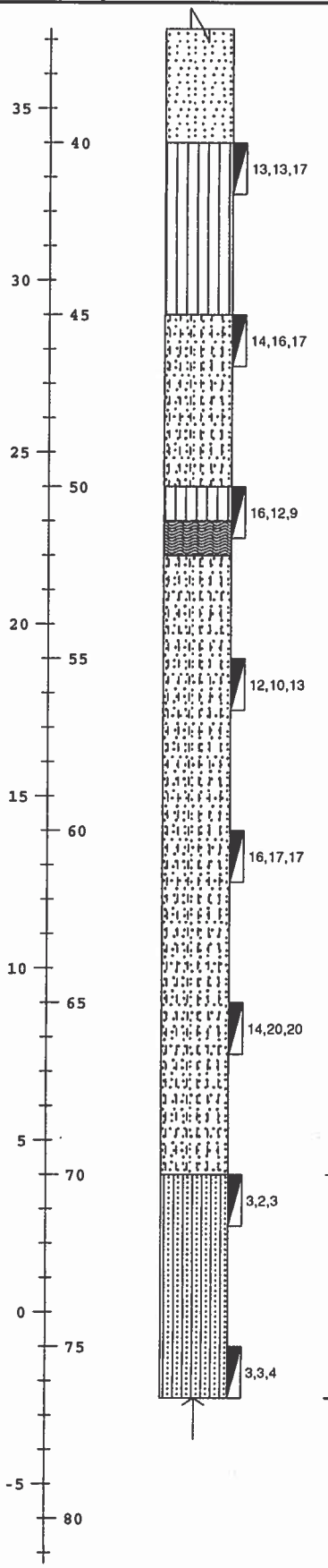



| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | SM | Brown silty sand with gravel, occasional cobble, scattered concrete debris, moist to wet, medium dense. (Fill) | | | |
| | | GP | Black poorly graded gravel with sand and cobble, scattered concrete debris, trace paper, moist to wet, medium dense to dense. (Fill) | | | Dames and Moore sample. |
| | | SM | Brown silty sand with gravel, trace concrete debris, moist to wet, medium dense. (Fill) | 26.2 | 29.6 | Dames and Moore sample. |
| | | GP | Black poorly graded gravel with sand, wet, medium dense. (Native contact?) | | | |
| | | ML | Gray sandy silt, wet, very loose? | | | Weight of hammer dropped sampler 18 inches. No sample recovery. |
| | | ML | Wood debris with gray sandy silt, wet, very loose? | | | No sample recovery at 20 or 21.5 feet. Description based on minor sample recovery at 25 feet. Heavy mud loss between 20 and 30 feet. Dames and Moore sample. |
| | | GP | Black poorly graded gravel with sand, occasional cobble, wet, dense. | | | Dames and Moore sample. |
| | | SP | Black poorly graded sand with gravel, wet, dense. | 39.0 | 3.8 | Minor recovery of wood debris (twigs) and gray sandy silt. Installed casing to 35 feet. Black sand at tip of sampler. |

*Boring KCB-16 was drilled in the Fairweather Propery south of the wetland. The boring location is provided in Figure 2. No water level was determined for the boring due to use of mud rotary methodology. However, the water level is anticipated to be at the approximate depth of the adjacent wetland.*

PLATE NUMBER **A16**

# LOG OF Boring
## BORING KCB-16
(continued)




| ELEVATION/ DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | USCS | Description | Moist (%) | -200 (%) | Remarks |
|---|---|---|---|---|---|---|
| | | ML | Dark gray sandy silt, wet, medium dense to dense. | | | |
| | | SP-SM | Black poorly graded fine to medium sand with silt, wet, dense. | 19.2 | 11.0 | |
| | | ML | Gray sandy silt, wet, medium dense. | | | |
| | | SP-SM | Dark brown fibrous peat, wet, medium dense. | | | |
| | | | Black poorly graded fine grained sand with silt, trace gravel, wet, medium dense to dense. | 28.9 | 10.8 | |
| | | SM | Gray silty sand to sandy silt, scatterd organics and wood debris, wet, loose. | 69.3 | 49.2 | LL=29, PL=29, PI=0, KCB-16 terminated at 76.5 feet. |

# KEY TO SYMBOLS

| Symbol | Description |
|---|---|
| **Strata symbols** | |
| | Silty sand |
| | Silt |
| | Poorly graded sand |
| | Poorly graded gravel |
| | Low plasticity clay |
| | Topsoil |
| | Peat |
| | Poorly graded sand with silt |
| | Decomposed wood |
| | Poorly graded gravel with silt |
| | Elastic silt |
| **Misc. Symbols** | |
| | Water table during drilling |
| | End of boring |

| Symbol | Description |
|---|---|
| | Boring continues |
| **Soil Samplers** | |
| | Standard penetration test |
| | No recovery |
| | Undisturbed thin wall Shelby tube |
| | Dutch cone test |
| **Monitor Well Details** | |
| | riser with cover and protective casing |
| | protective casing set in concrete |
| | bentonite pellets |
| | silica sand, blank PVC |
| | slotted pipe w/ sand |
| | no pipe, filler material |

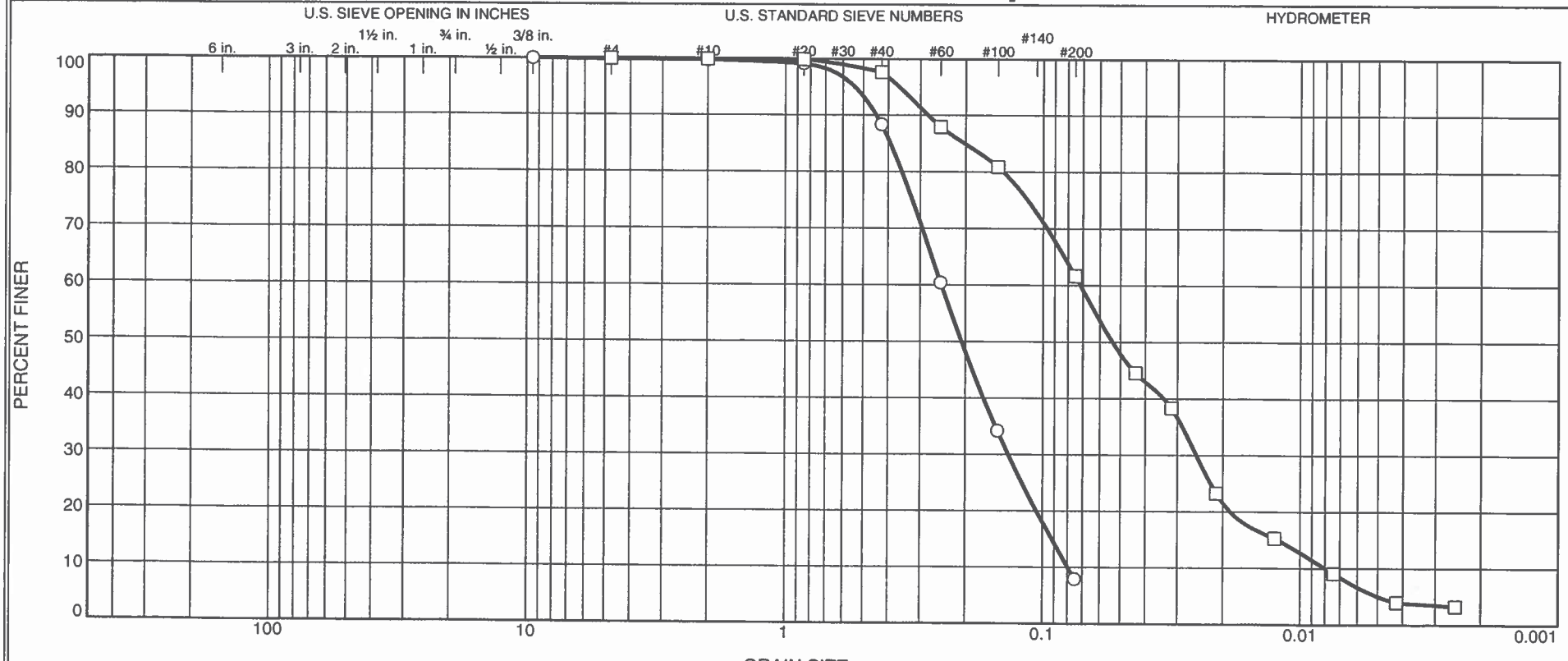
**Notes:**

1. KCB-1 through KCB-12 were drilled between September 22, 2010 and October 1, 2010. KCB-13 through KCB-16 were drilled between September 28, 2011 and October 4, 2011. All borings were drilled using a CME-850 track mounted drill utilizing mud rotary methodology.

2. Results of tests conducted on samples recovered are reported on the logs.

3. These logs are subject to the limitations, conclusions, and recommendations in this report.

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.1 | 0.1 | 11.4 | 80.5 | 7.9 | |
| □ | 0.0 | 0.0 | 0.0 | 0.0 | 2.4 | 35.9 | 56.7 | 5.0 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-1 | KC-10-971 | 12.5 | 10/8/10 | SP-SM | Poorly graded sand with silt | 26.4 | NV | NP |
| □ | KCB-1 | KC-10-973 | 20 | 10/8/10 | ML | Sandy silt | 35.4 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

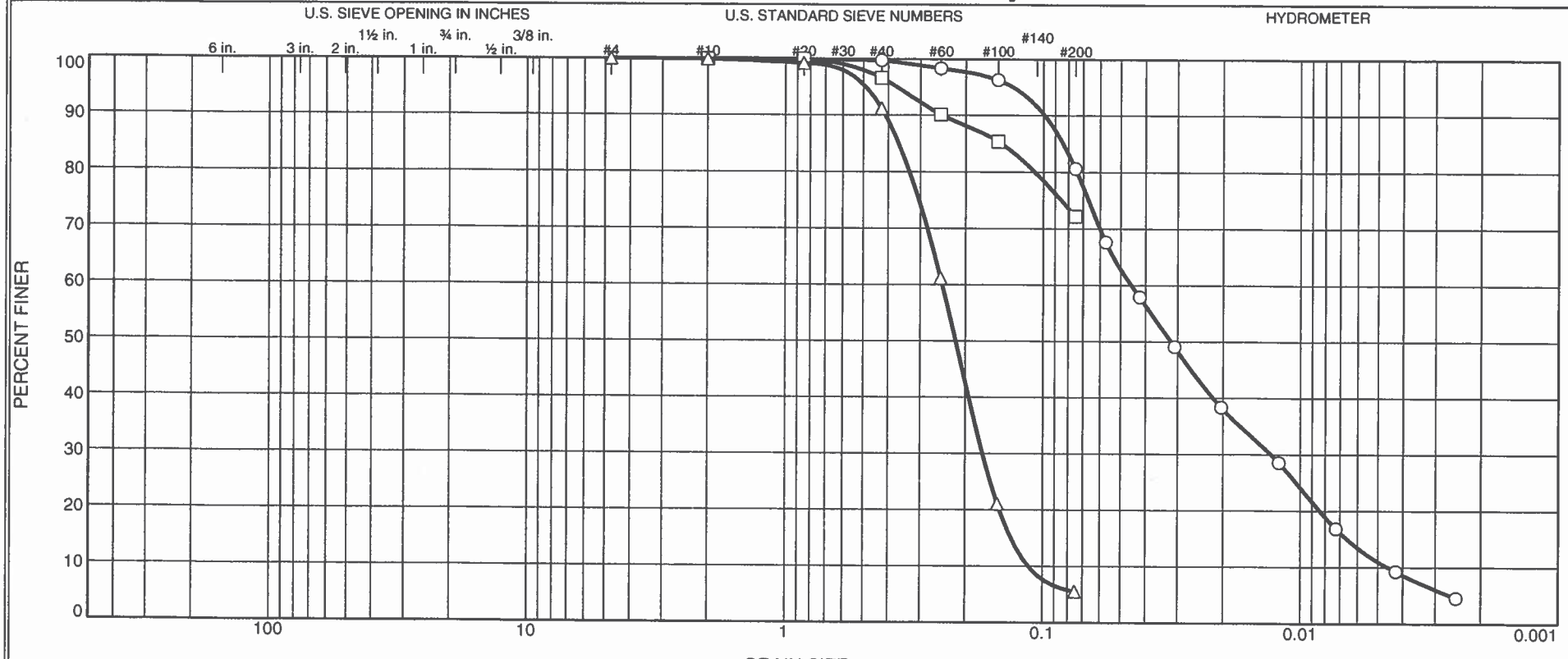
Project No. FL9001 Figure A1

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 19.1 | 69.6 | 11.0 |
| □ | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 | 24.4 | 72.2 | |
| △ | 0.0 | 0.0 | 0.0 | 0.1 | 8.7 | 85.7 | 5.5 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-2 | KC-10-974 | 2.5 | 10/8/10 | ML | Silt with sand | 53.0 | NV | NP |
| □ | KCB-2 | KC-10-975 | 7.5 | 10/8/10 | ML | Silt with sand | 31.6 | NV | NP |
| △ | KCB-2 | KC-10-976 | 17.5 | 10/8/10 | SP-SM | Poorly graded sand with silt | 29.5 | NV | NP |

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Project Countyline to A-Street Geotechnical Study

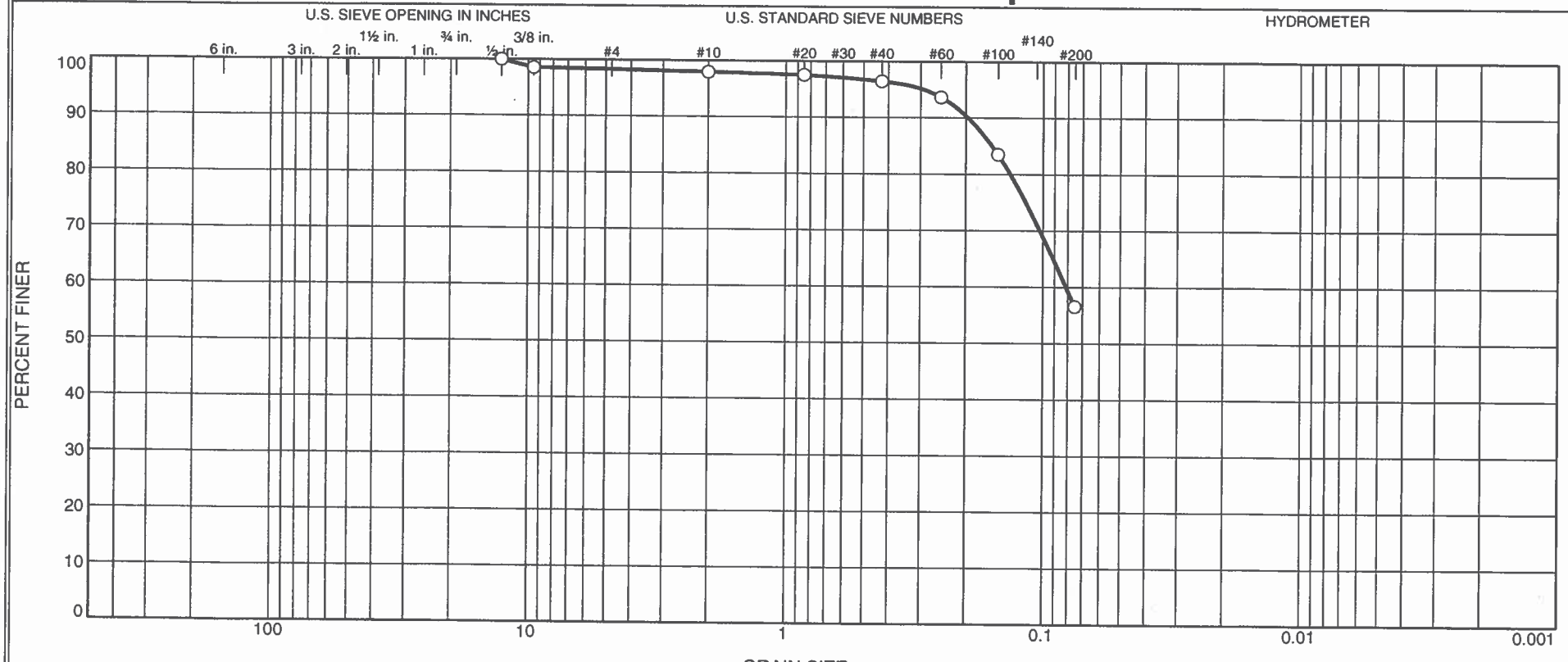
Project No. FL9001 Figure A2

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| O | 0.0 | 0.0 | 1.7 | 0.4 | 1.4 | 39.9 | 56.6 | |
| | | | | | | | | |
| | | | | | | | | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| O | KCB-2 | KC-10-977 | 30 | 10/8/10 | ML | Sandy silt | 30.0 | NV | NP |
| | | | | | | | | | |
| | | | | | | | | | |

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Project Countyline to A-Street Geotechnical Study

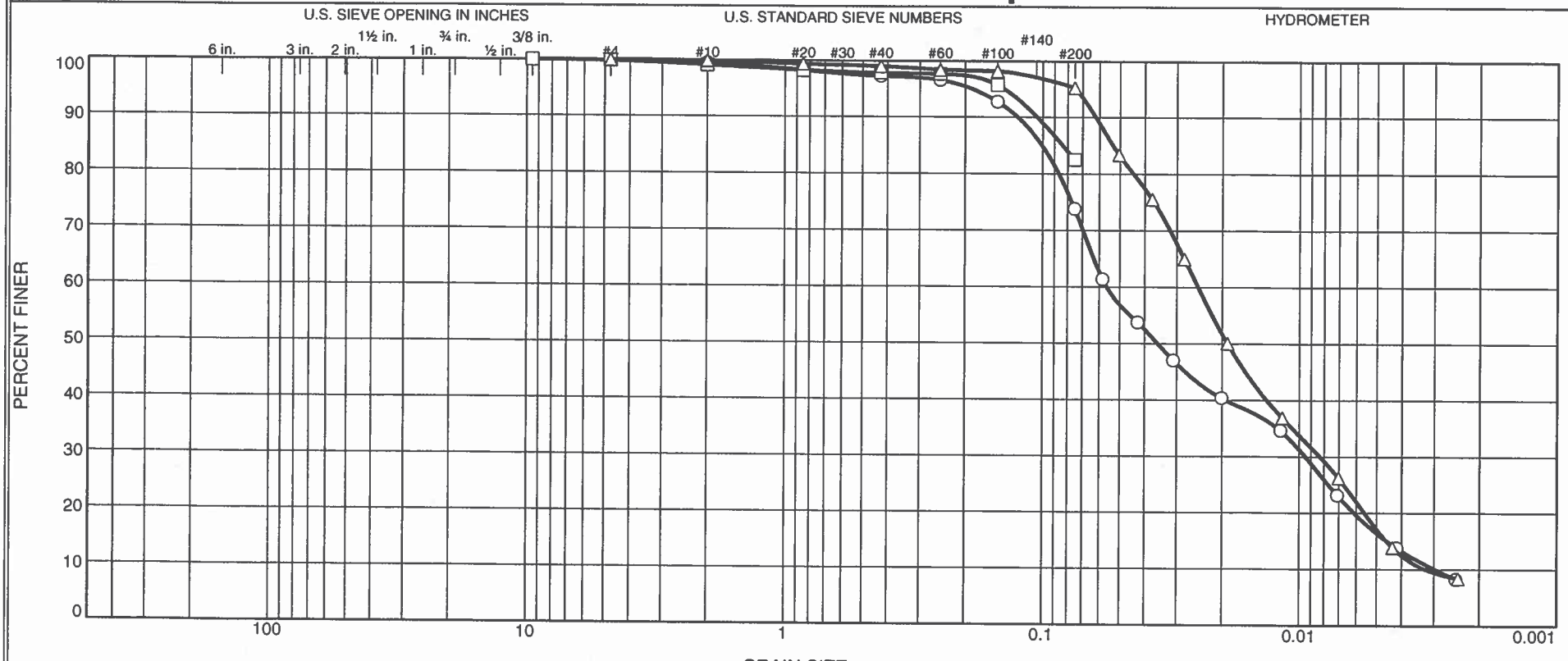
Project No. FL9001 Figure A3

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.5 | 2.2 | 23.5 | 57.4 | 16.4 |
| □ | 0.0 | 0.0 | 0.1 | 0.7 | 1.4 | 15.3 | 82.5 | |
| △ | 0.0 | 0.0 | 0.0 | 0.1 | 0.9 | 3.7 | 78.2 | 17.1 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-3 | KC-10-978 | 2.5 | 10/8/10 | ML | Silt with sand | 42.9 | NV | NP |
| □ | KCB-3 | KC-10-979 | 5 | 10/8/10 | ML | Silt with sand | 36.5 | NV | NP |
| △ | KCB-3 | KC-10-980 | 10 | 10/8/10 | ML | Silt | 45.5 | NV | NP |

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Project Countyline to A-Street Geotechnical Study

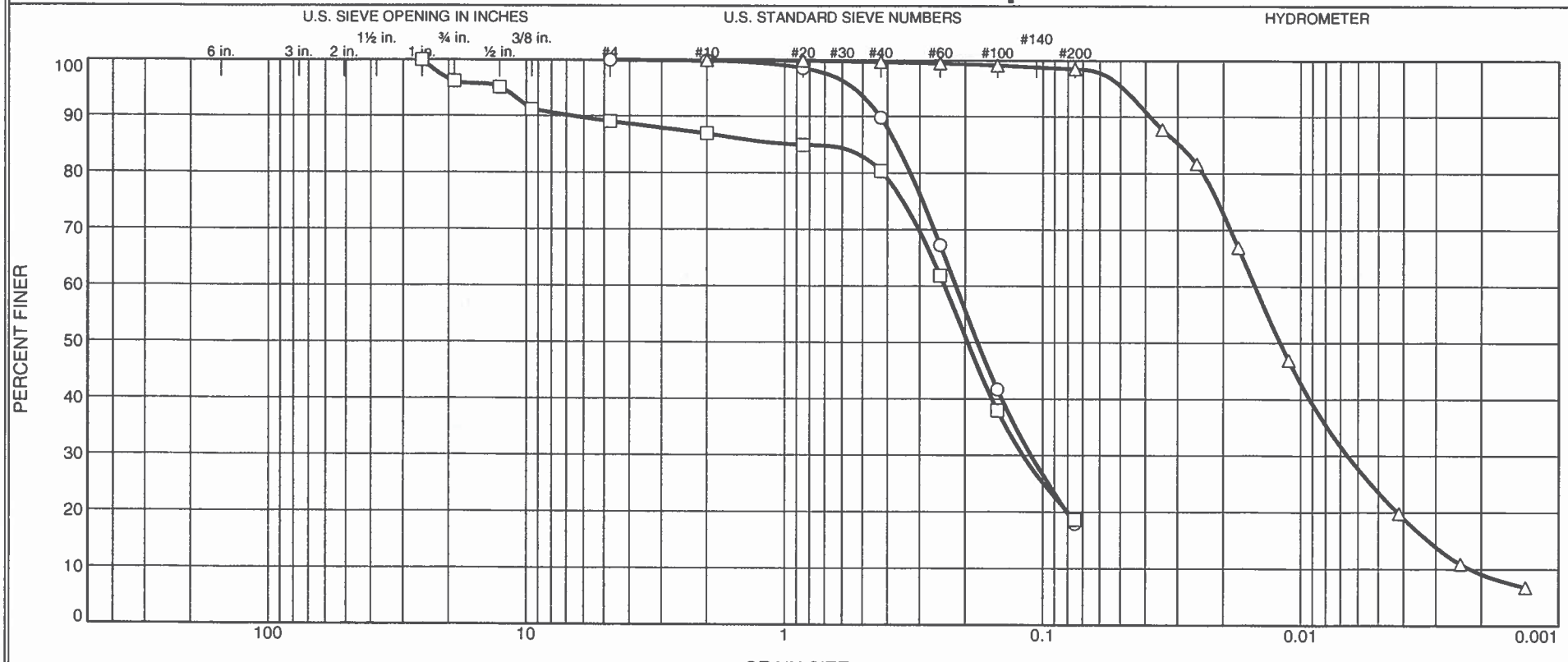
Project No. FL9001 Figure A4

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 10.1 | 71.9 | 17.9 | |
| □ | 0.0 | 3.8 | 7.1 | 2.1 | 6.6 | 61.7 | 18.7 | |
| △ | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 1.2 | 74.9 | 23.6 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-3 | KC-10-981 | 15 | 10/8/10 | SM | Silty sand | 28.4 | NV | NP |
| □ | KCB-3 | KC-10-982 | 30 | 10/8/10 | SM | Silty sand | 26.2 | NV | NP |
| △ | KCB-3 | KC-10-983 | 40 | 10/8/10 | ML | Silt | 45.9 | 35 | 33 |

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Project Countyline to A-Street Geotechnical Study

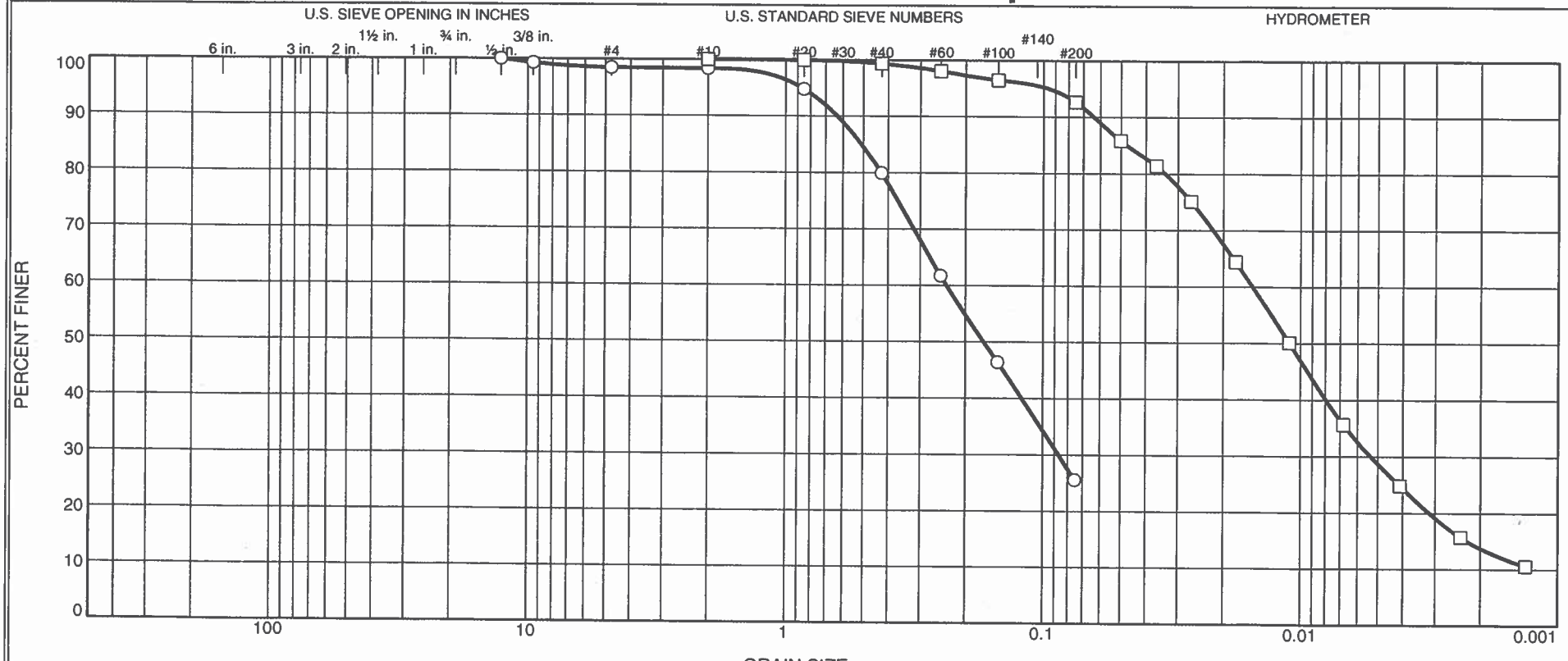
Project No. FL9001 Figure A5

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 1.5 | 0.1 | 18.5 | 54.3 | 25.6 | |
| □ | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 6.7 | 64.0 | 28.7 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-3 | KC-10-984 | 46.5 | 10/8/10 | SM | Silty sand | 24.2 | NV | NP |
| □ | KCB-3 | KC-10-985 | 55 | 10/8/10 | ML | Silt | 51.3 | 42 | 34 |

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Project Countyline to A-Street Geotechnical Study

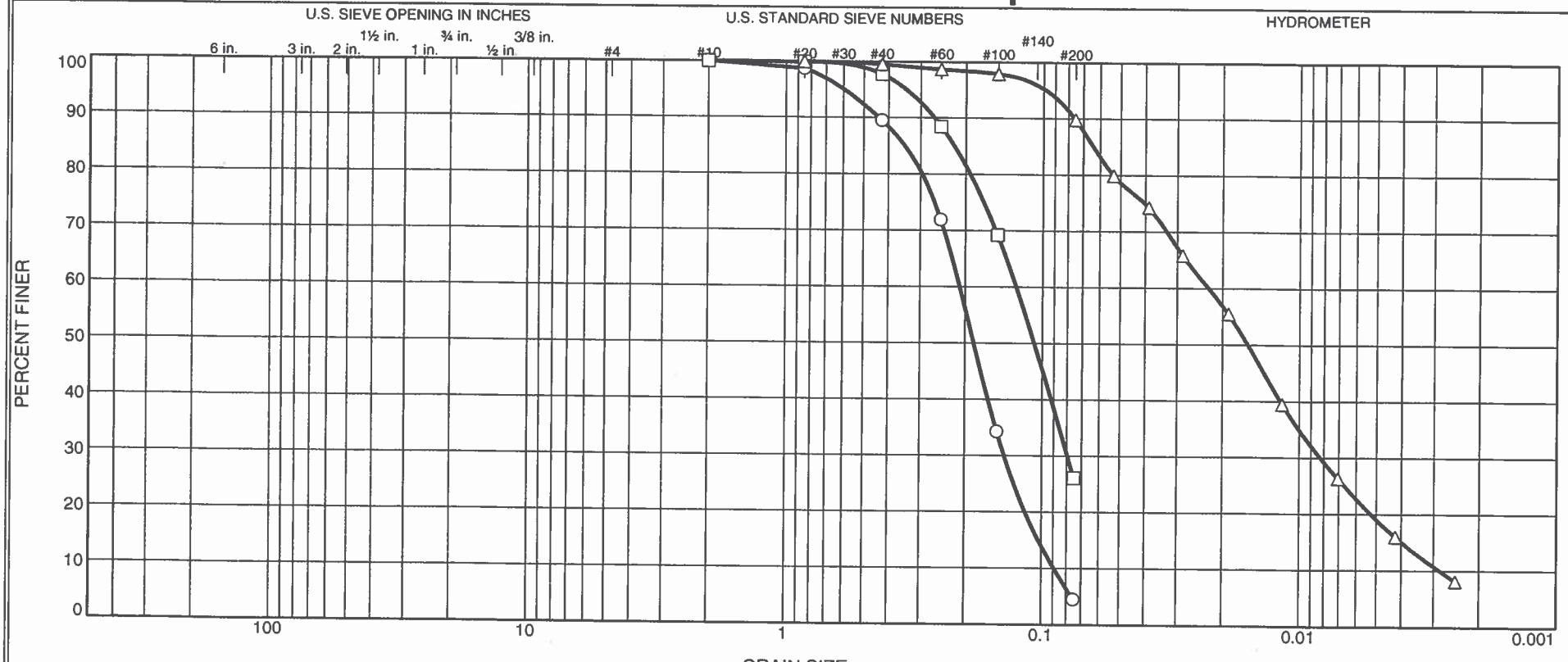
Project No. FL9001 Figure A6

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 10.5 | 85.0 | 4.5 | |
| □ | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 71.7 | 26.1 | |
| △ | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 9.7 | 70.7 | 19.1 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-4 | KC-10-1025 | 2.5 | 10/8/10 | SP | Poorly graded sand | 26.7 | NV | NP |
| □ | KCB-4 | KC-10-987 | 10 | 10/8/10 | SM | Silty sand | 28.3 | NV | NP |
| △ | KCB-4 | KC-10-988 | 15 | 10/8/10 | ML | Silt | 62.5 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

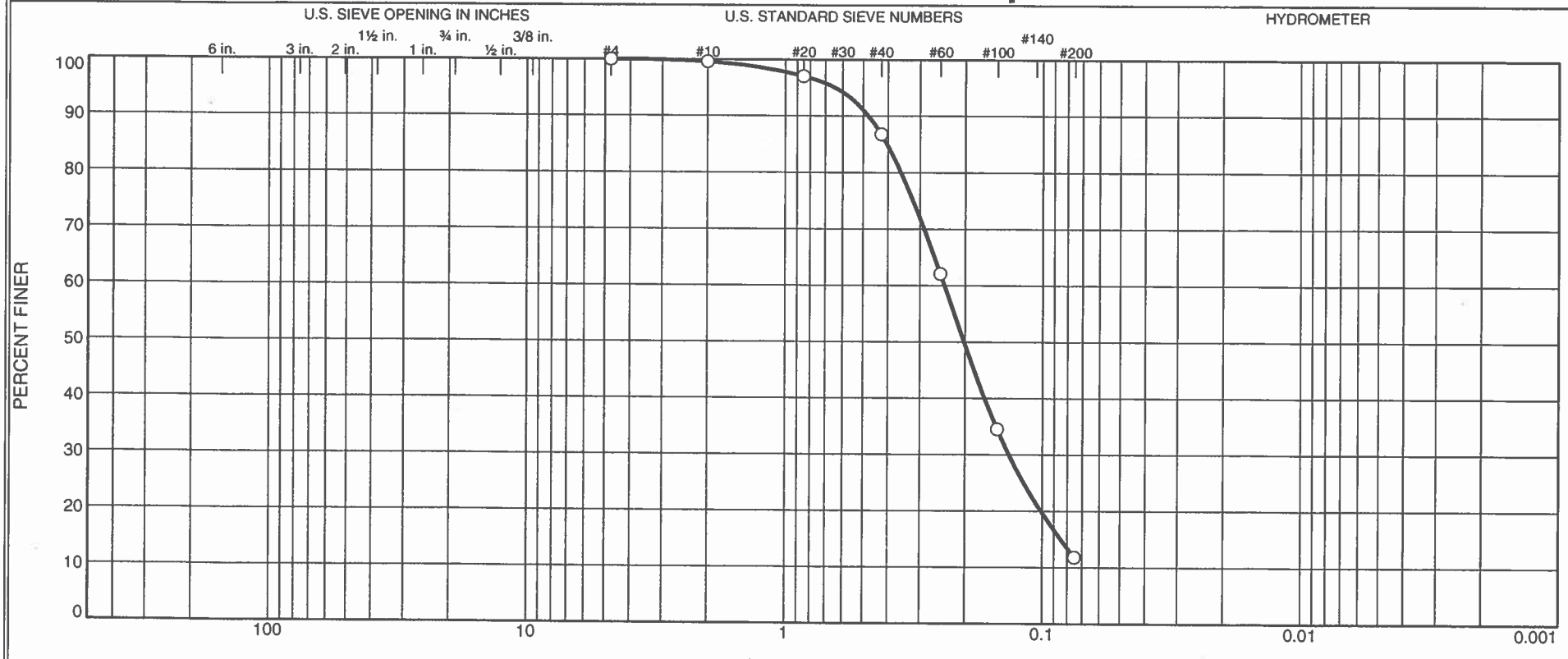
Project No. FL9001 Figure A7

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.4 | 12.8 | 75.0 | 11.8 | |
| | | | | | | | | |
| | | | | | | | | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-4 | KC-10-989 | 25 | 10/8/10 | SP-SM | Poorly graded sand with silt | 26.7 | NV | NP |
| | | | | | | | | | |
| | | | | | | | | | |

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Project Countyline to A-Street Geotechnical Study

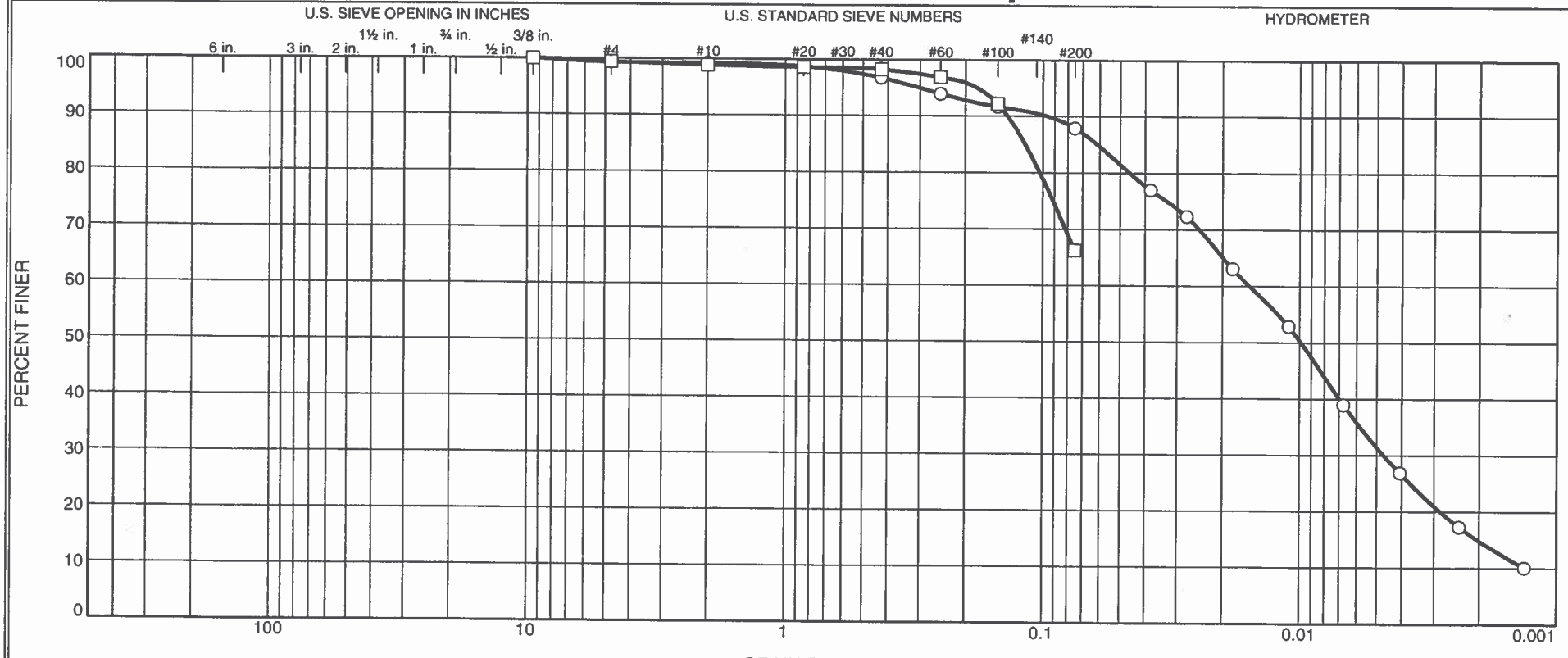
Project No. FL9001 Figure A8

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.7 | 0.1 | 2.5 | 8.8 | 56.5 | 31.4 |
| □ | 0.0 | 0.0 | 0.6 | 0.5 | 0.6 | 32.1 | 66.2 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-5 | KC-10-990 | 2.5 | 10/8/10 | ML | Silt | 49 | 35 | 30 |
| □ | KCB-5 | KC-10-991 | 10 | 10/8/10 | ML | Sandy silt | 48.6 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

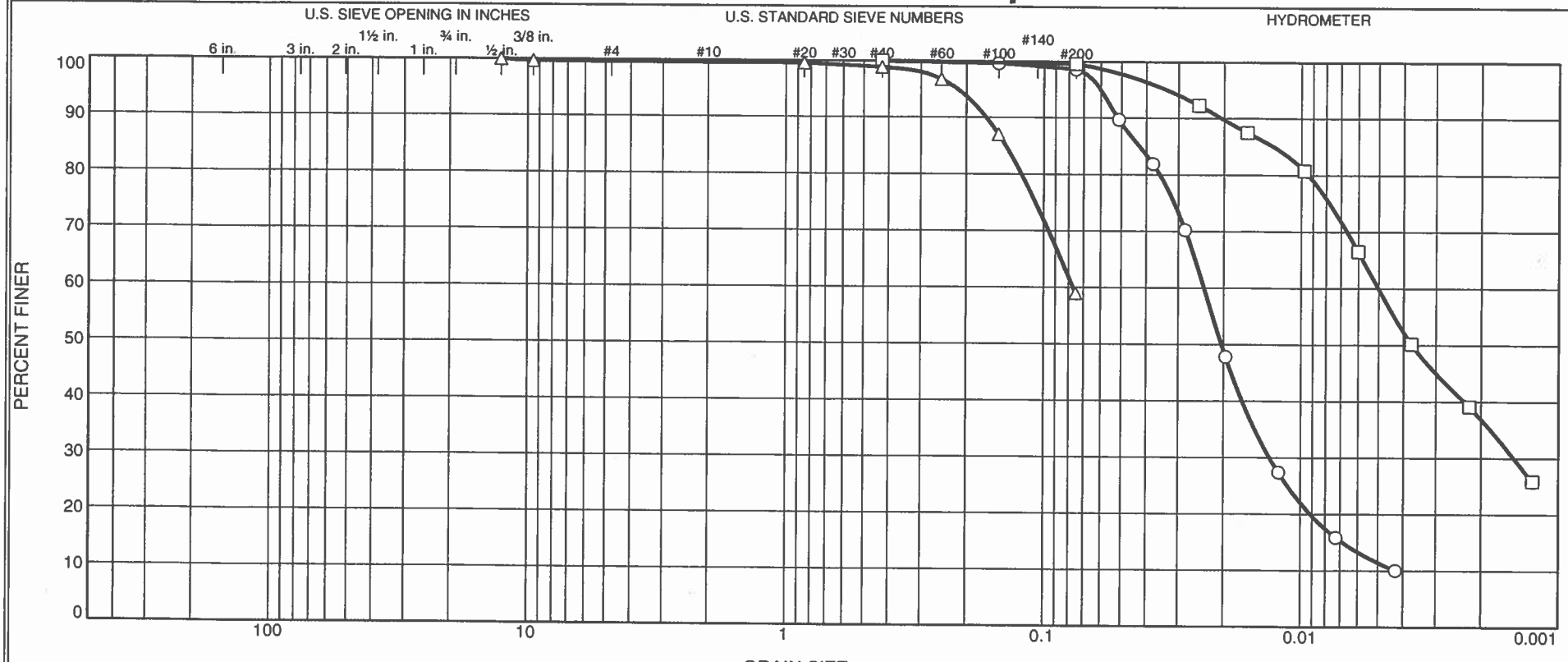
Project No. FL9001 Figure A9

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 87.1 | 11.5 |
| □ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 39.7 | 59.9 |
| △ | 0.0 | 0.0 | 0.4 | 0.0 | 0.7 | 39.9 | 59.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-5 | KC-10-1026 | 15 | 10/8/10 | ML | Brown silt | 52.6 | NV | NP |
| □ | KCB-5 | KC-10-1026 | 16 | 10/8/10 | ML | Gray silt | 49.6 | 44 | 34 |
| △ | KCB-5 | KC-10-1026 | 17 | 10/8/10 | ML | Sandy silt | 36.4 | NV | NP |

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Project Countyline to A-Street Geotechnical Study

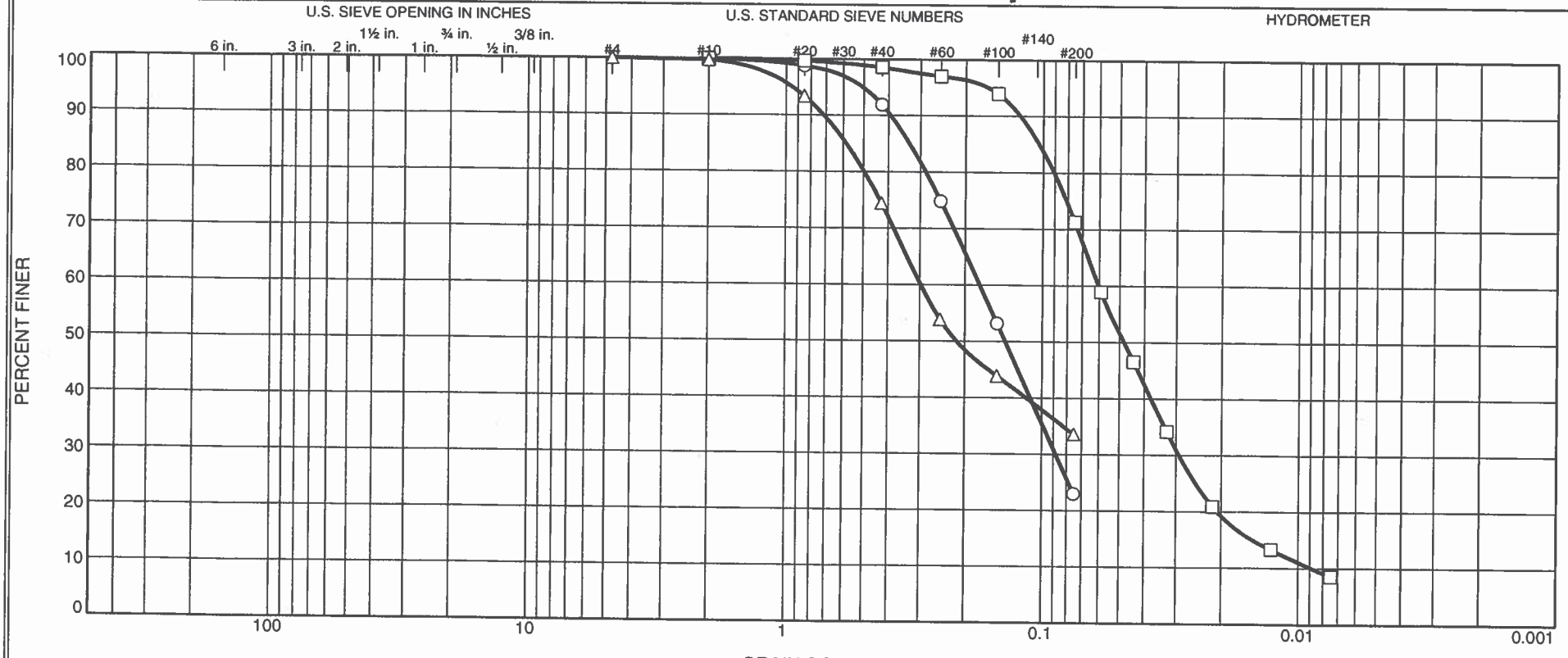
Project No. FL9001 Figure A10

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 8.1 | 68.9 | 23.0 | |
| □ | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 27.3 | 71.3 | |
| △ | 0.0 | 0.0 | 0.0 | 0.2 | 25.3 | 40.9 | 33.6 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-5 | KC-10-992 | 20 | 10/8/10 | SM | Silty sand | 29.1 | NV | NP |
| □ | KCB-5 | KC-10-993 | 25 | 10/8/10 | ML | Silt with sand | 40.2 | NV | NP |
| △ | KCB-5 | KC-10-994 | 40 | 10/8/10 | SM | Silty sand | 32.3 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

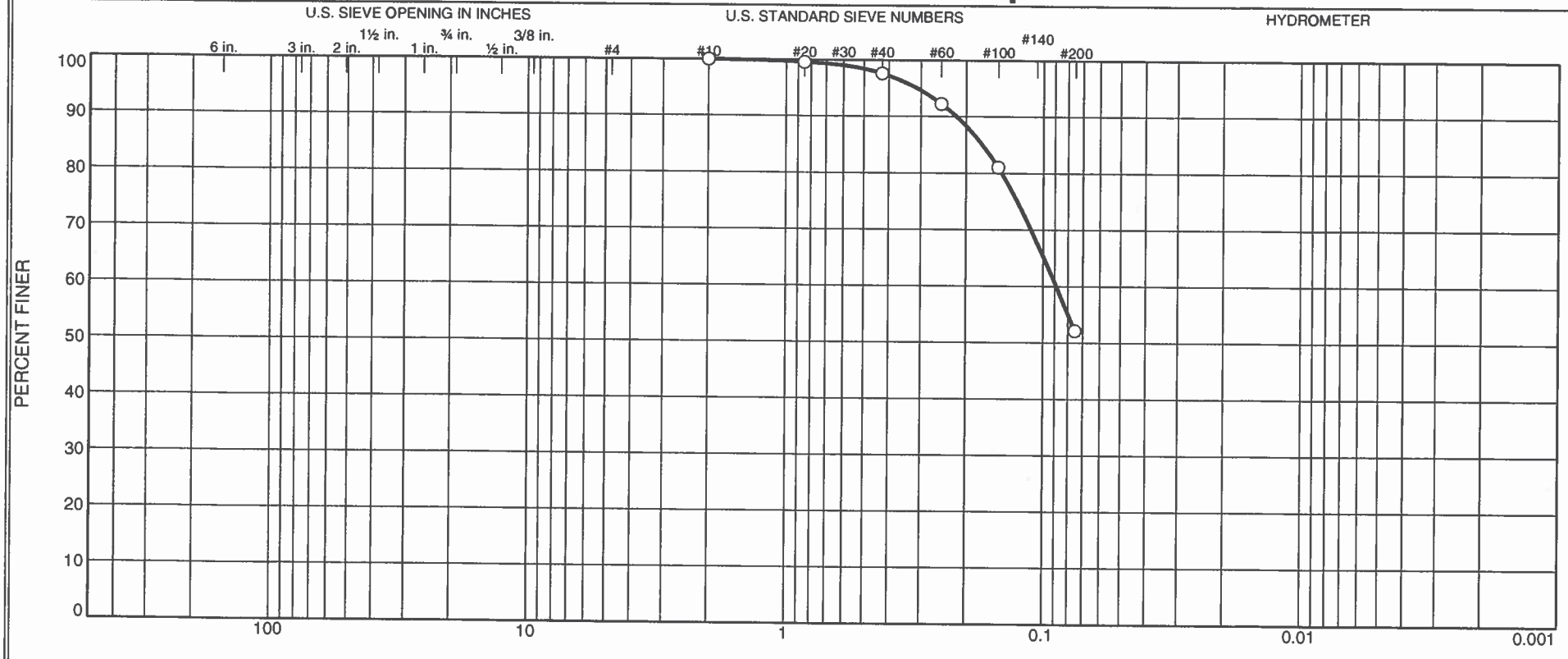
Project No. FL9001 Figure A11

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| O | 0.0 | 0.0 | 0.0 | 0.0 | 2.4 | 45.5 | 52.1 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| O | KCB-5 | KC-10-995 | 50 | 10/8/10 | ML | Sandy silt | 29.1 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

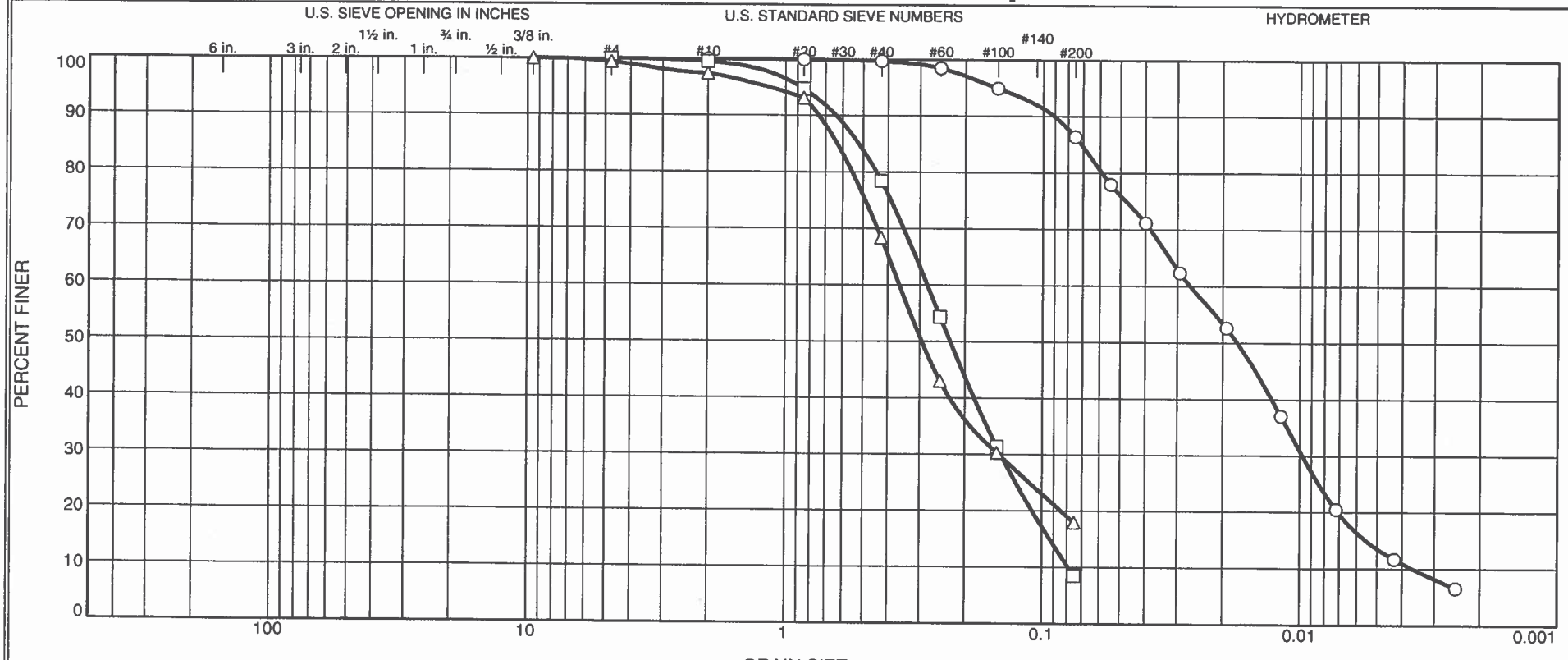
Project No. FL9001 Figure A12

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 13.3 | 72.8 | 13.6 |
| □ | 0.0 | 0.0 | 0.0 | 0.5 | 21.1 | 69.9 | 8.5 | |
| △ | 0.0 | 0.0 | 0.6 | 1.9 | 29.1 | 50.4 | 18.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-6 | KC-10-996 | 2.5 | 10/8/10 | ML | | 35.3 | NV | NP |
| □ | KCB-6 | KC-10-997 | 7.5 | 10/8/10 | SP-SM | Poorly graded sand with silt | 26.1 | NV | NP |
| △ | KCB-6 | KC-10-999 | 30 | 10/8/10 | SM | Silty sand | 24 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

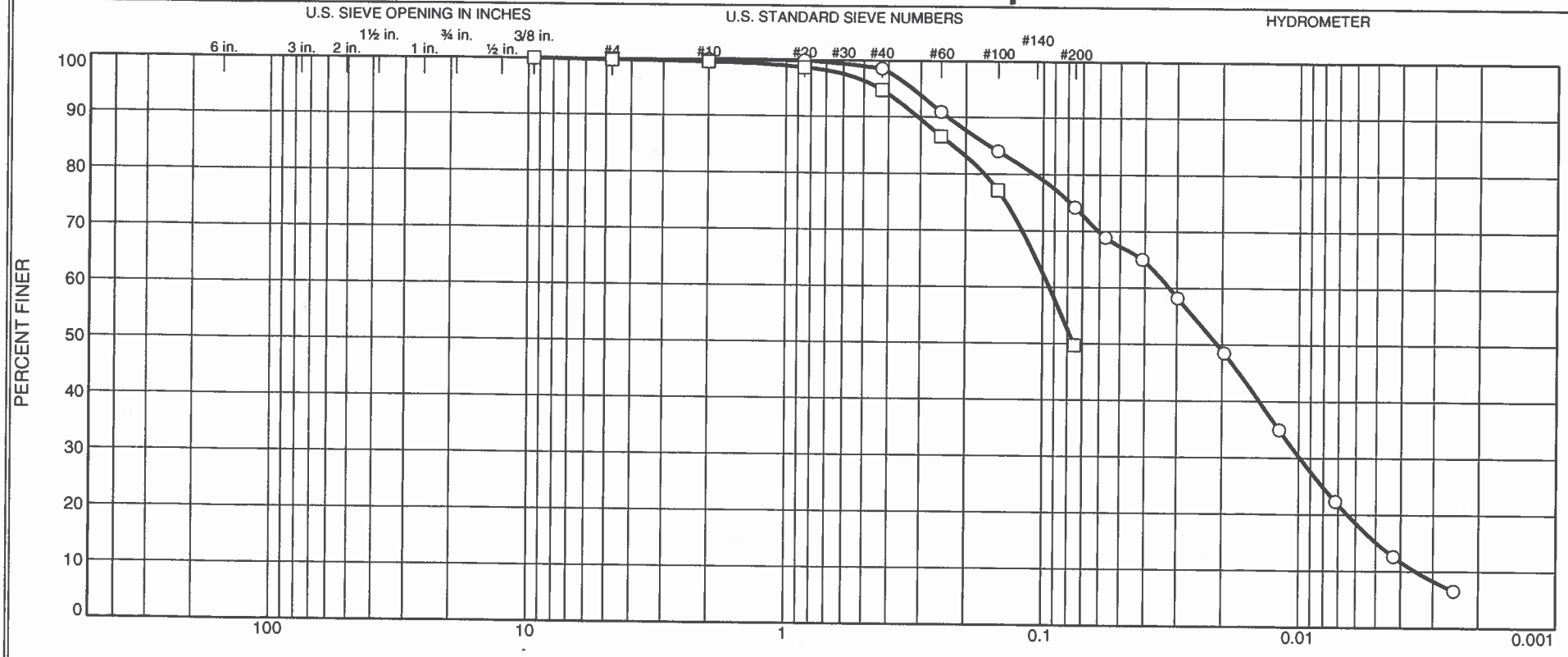
Project No. FL9001 Figure A13

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 24.4 | 59.1 | 15.1 |
| □ | 0.0 | 0.0 | 0.2 | 0.2 | 4.8 | 45.1 | 49.7 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-6 | KC-10-1000 | 35 | 10/8/10 | ML | Silt with sand | 88.9 | NV | NP |
| □ | KCB-6 | KC-10-1001 | 50 | 10/8/28 | SM | Silty sand | 36.7 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

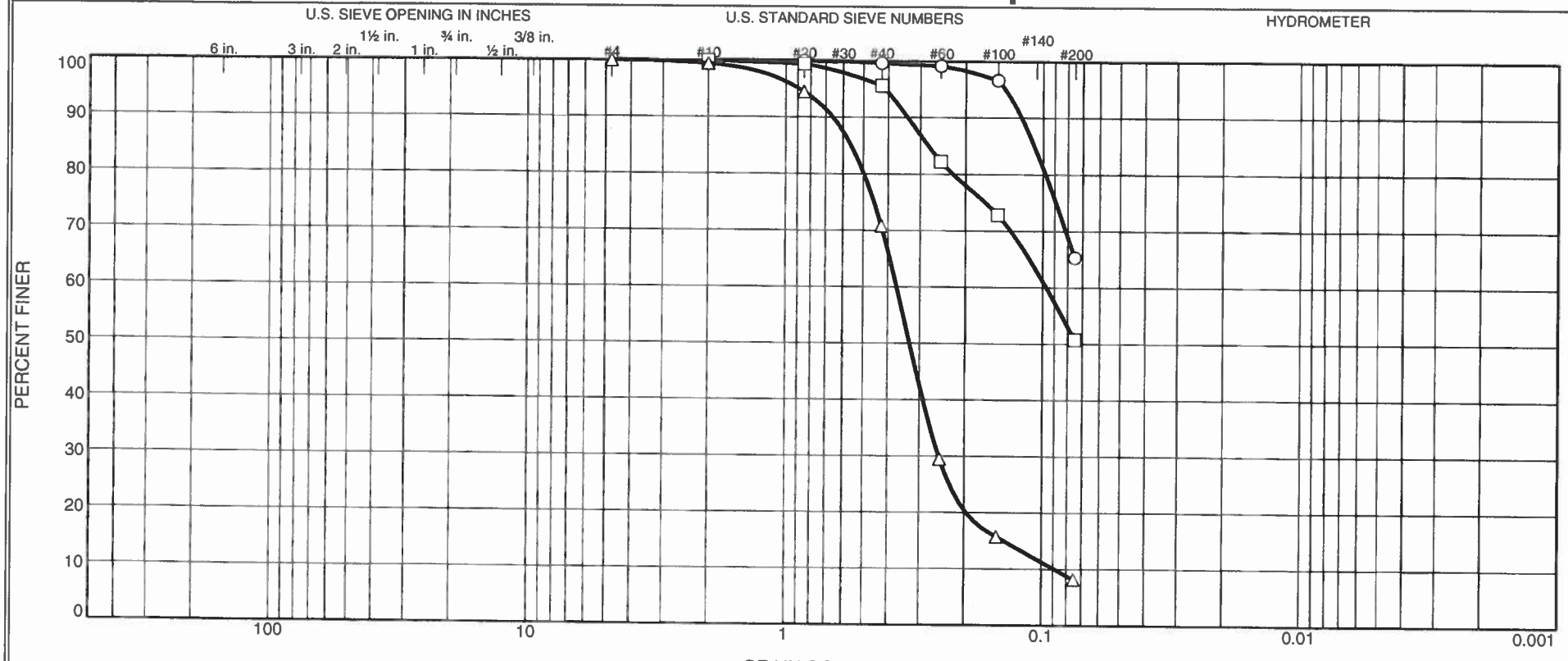
Project No. FL9001 Figure A14

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 34.3 | 65.3 | |
| □ | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 | 44.9 | 50.8 | |
| △ | 0.0 | 0.0 | 0.0 | 0.5 | 28.6 | 62.7 | 8.2 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-7 | KC-10-1002 | 5 | 10/8/10 | ML | Sandy silt | 29.8 | NV | NP |
| □ | KCB-7 | KC-10-1003 | 12.5 | 10/8/10 | ML | Sandy silt | 27.4 | NV | NP |
| △ | KCB-7 | KC-10-1006 | 45 | 10/8/10 | SP-SM | Poorly graded sand with silt | 39.3 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

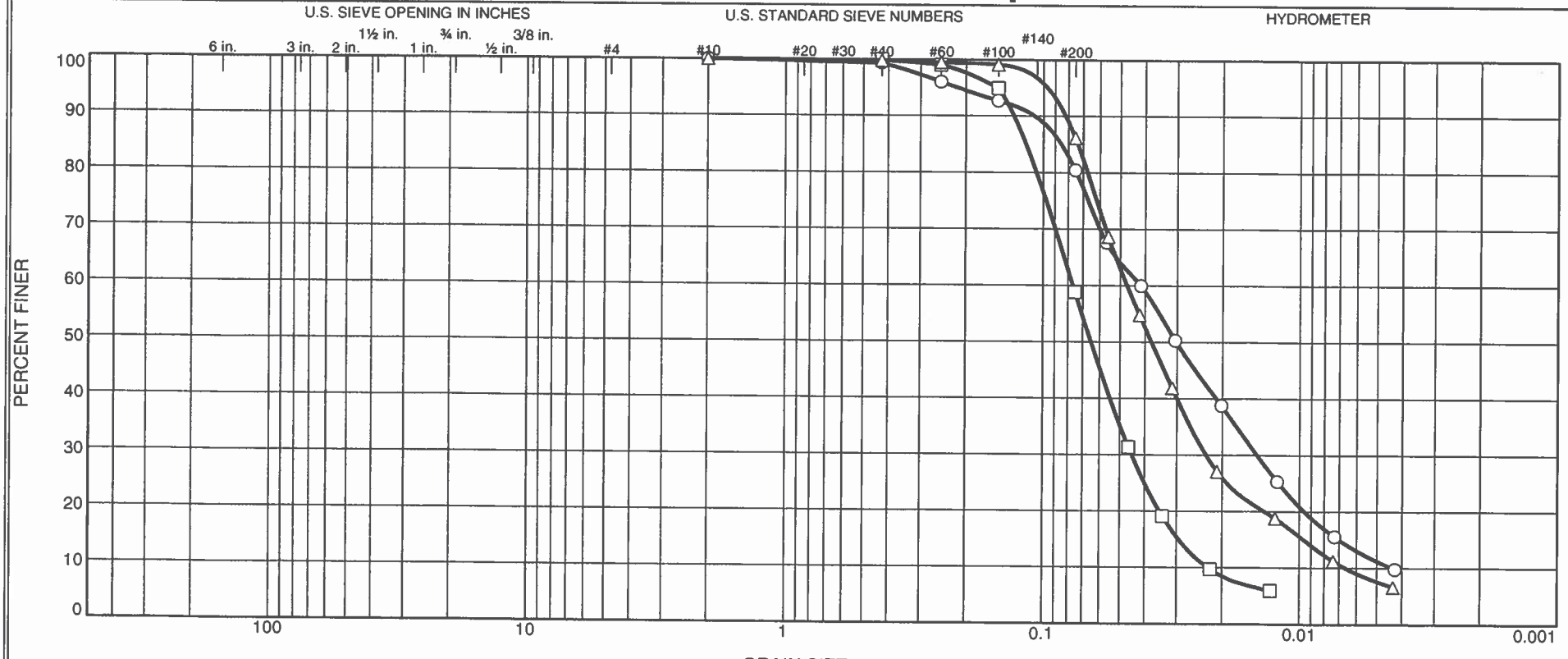
Project No. FL9001 Figure A15

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 19.0 | 69.2 | 11.2 |
| □ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 41.2 | 58.8 | |
| △ | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 13.6 | 78.6 | 7.6 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-8 | KC-10-1007 | 2.5 | 10/8/10 | ML | Silt with sand | 35.7 | NV | NP |
| □ | KCB-8 | KC-10-1008 | 7.5 | 10/8/10 | ML | Sandy silt | 38.6 | NV | NP |
| △ | KCB-8 | KC-10-1009 | 17.5 | 10/8/10 | ML | Silt | 42.7 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

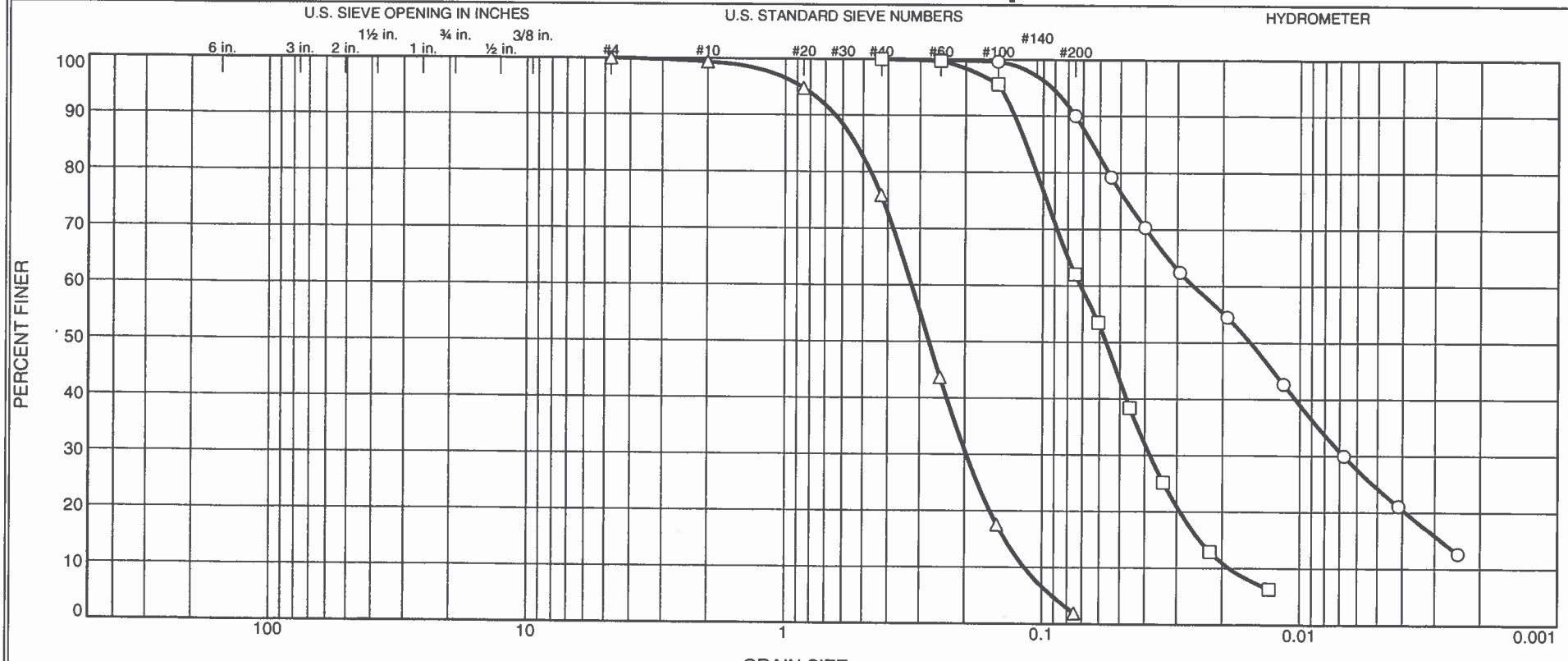
Project No. FL9001 Figure A16

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.9 | 65.8 | 24.3 |
| □ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 37.9 | 62.1 | |
| △ | 0.0 | 0.0 | 0.0 | 0.6 | 23.5 | 74.0 | 1.9 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-8 | KC-10-1027 | 20 | 10/8/10 | ML | Silt | 32.8 | NV | NP |
| □ | KCB-8 | KC-10-1027 | 20.8 | 10/8/10 | ML | Sandy silt | 33.3 | NV | NP |
| △ | KCB-8 | KC-10-1027 | 21.5 | 10/8/10 | SP | Poorly graded sand | 30.7 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

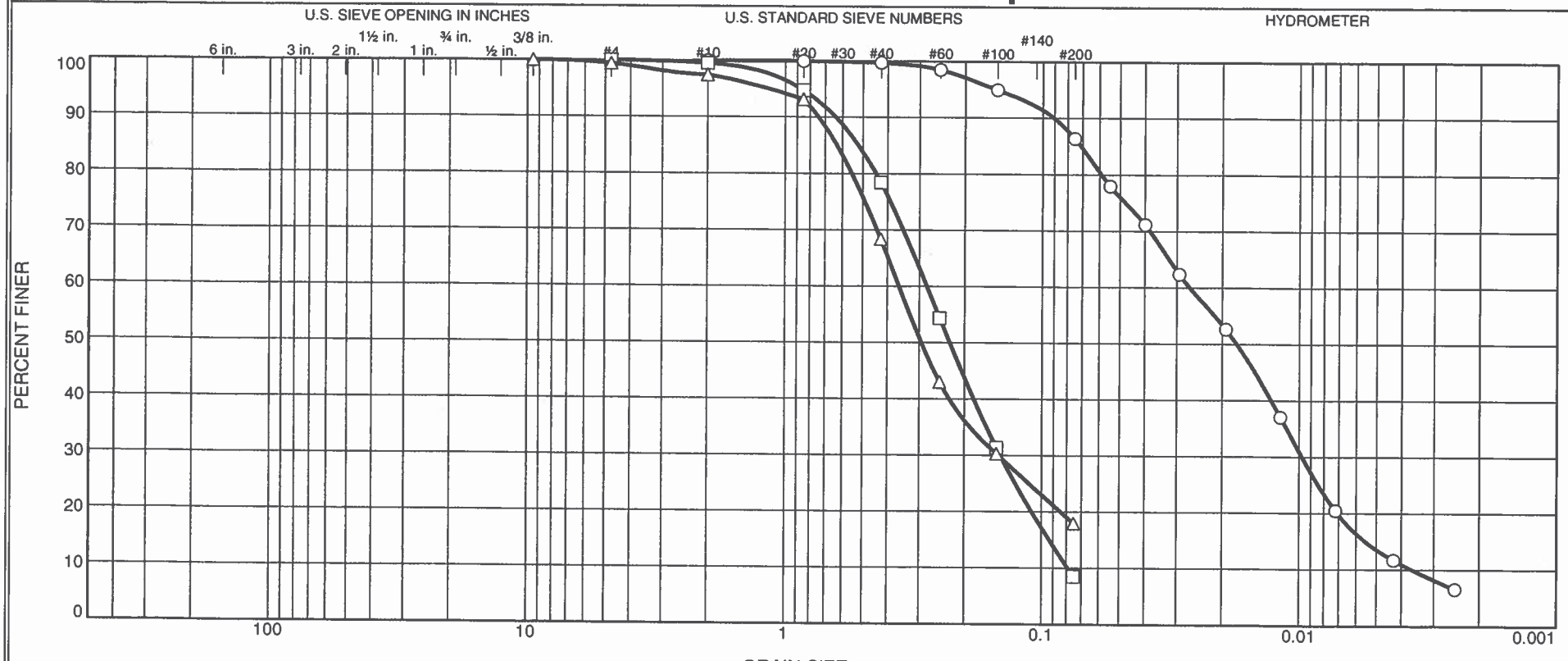
Project No. FL9001 Figure A17

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 13.3 | 72.8 | 13.6 |
| □ | 0.0 | 0.0 | 0.0 | 0.5 | 21.1 | 69.9 | 8.5 | |
| △ | 0.0 | 0.0 | 0.6 | 1.9 | 29.1 | 50.4 | 18.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-6 | KC-10-996 | 2.5 | 10/8/10 | ML | | 35.3 | NV | NP |
| □ | KCB-6 | KC-10-997 | 7.5 | 10/8/10 | SP-SM | Poorly graded sand with silt | 26.1 | NV | NP |
| △ | KCB-6 | KC-10-999 | 30 | 10/8/10 | SM | Silty sand | 24 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

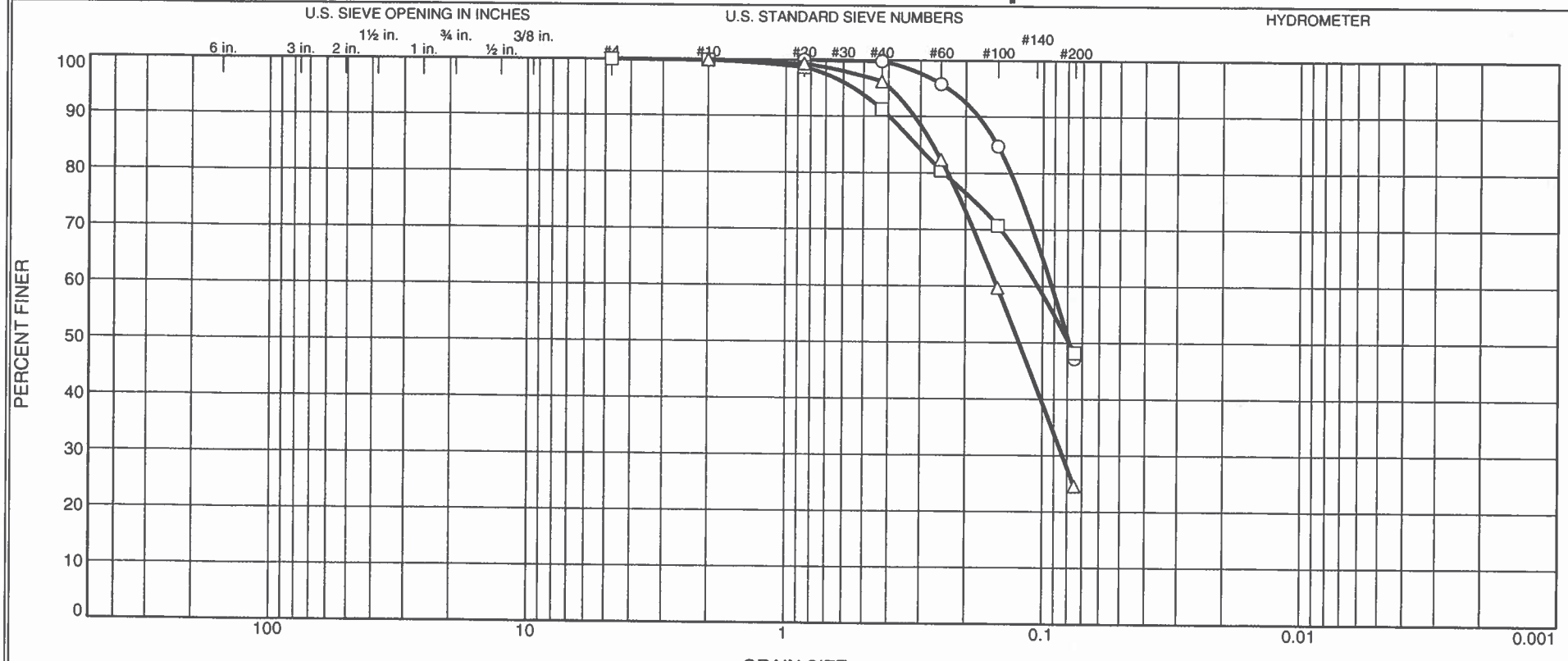
Project No. FL9001 Figure A18

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 52.7 | 47.1 | |
| □ | 0.0 | 0.0 | 0.0 | 0.1 | 8.6 | 43.1 | 48.2 | |
| △ | 0.0 | 0.0 | 0.0 | 0.0 | 3.8 | 71.6 | 24.6 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-9 | KC-10-1013 | 5 | 10/8/10 | SM | Silty sand | 32.6 | NV | NP |
| □ | KCB-9 | KC-10-1015 | 20 | 10/8/10 | SM | Silty sand | 39.2 | NV | NP |
| △ | KCB-9 | KC-10-1016 | 30 | 10/8/10 | SM | Silty sand | 26.6 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

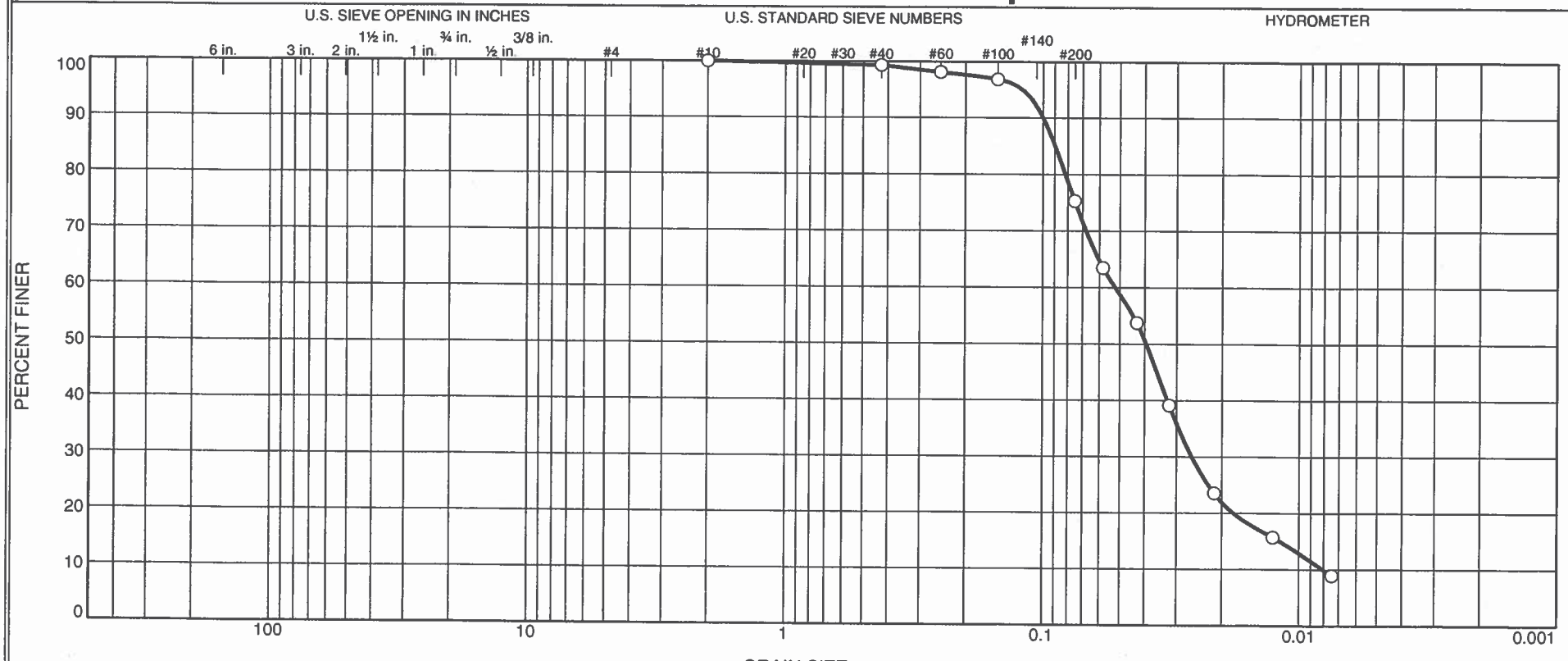
Project No. FL9001 Figure A19

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| O | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 24.0 | 75.3 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| O | KCB-9 | KC-10-1017 | 55 | 10/8/10 | ML | Silt with sand | 30.3 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

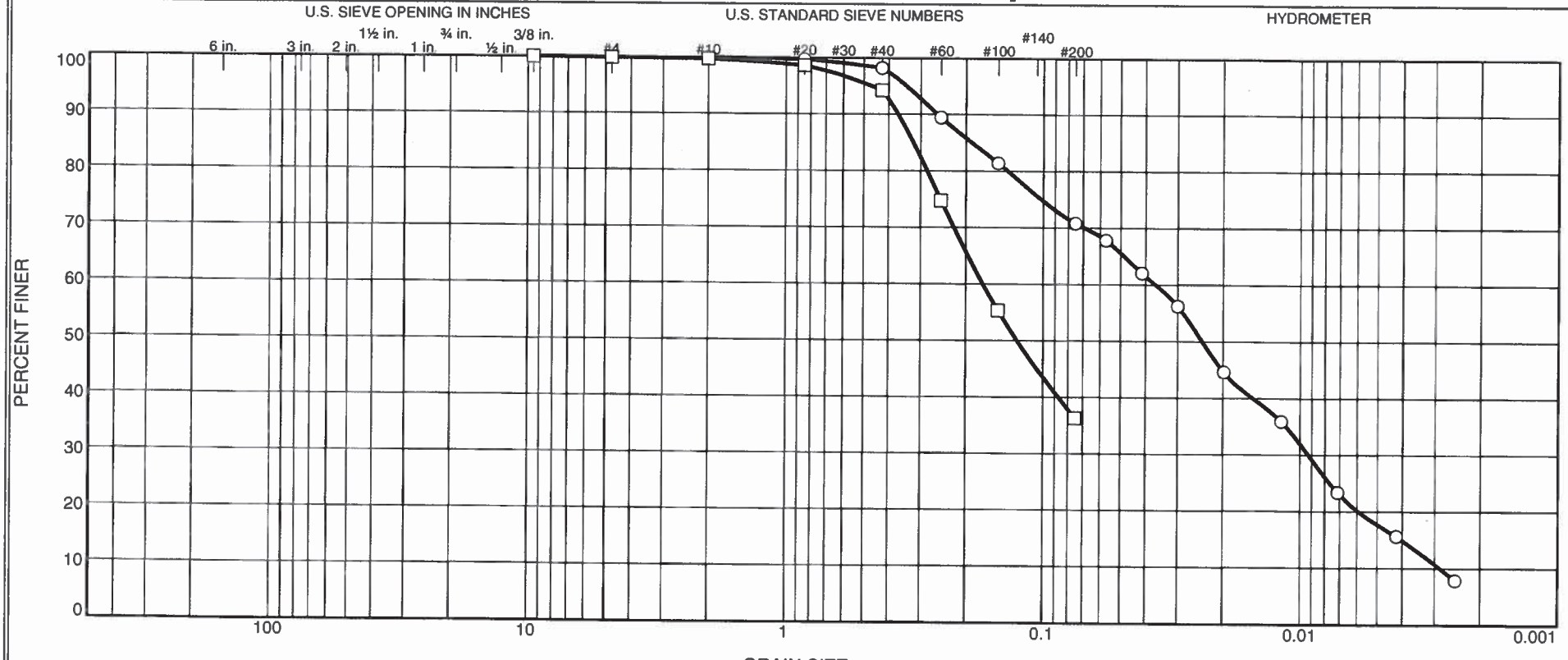
Project No. FL9001 Figure A20

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 27.4 | 53.1 | 17.7 |
| □ | 0.0 | 0.0 | 0.1 | 0.2 | 5.5 | 57.9 | 36.3 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-10 | KC-10-1018 | 40 | 10/8/10 | ML | Silt with sand | 46.6 | NV | NP |
| □ | KCB-10 | KC-10-1019 | 55 | 10/8/10 | SM | Silty sand | 36.1 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

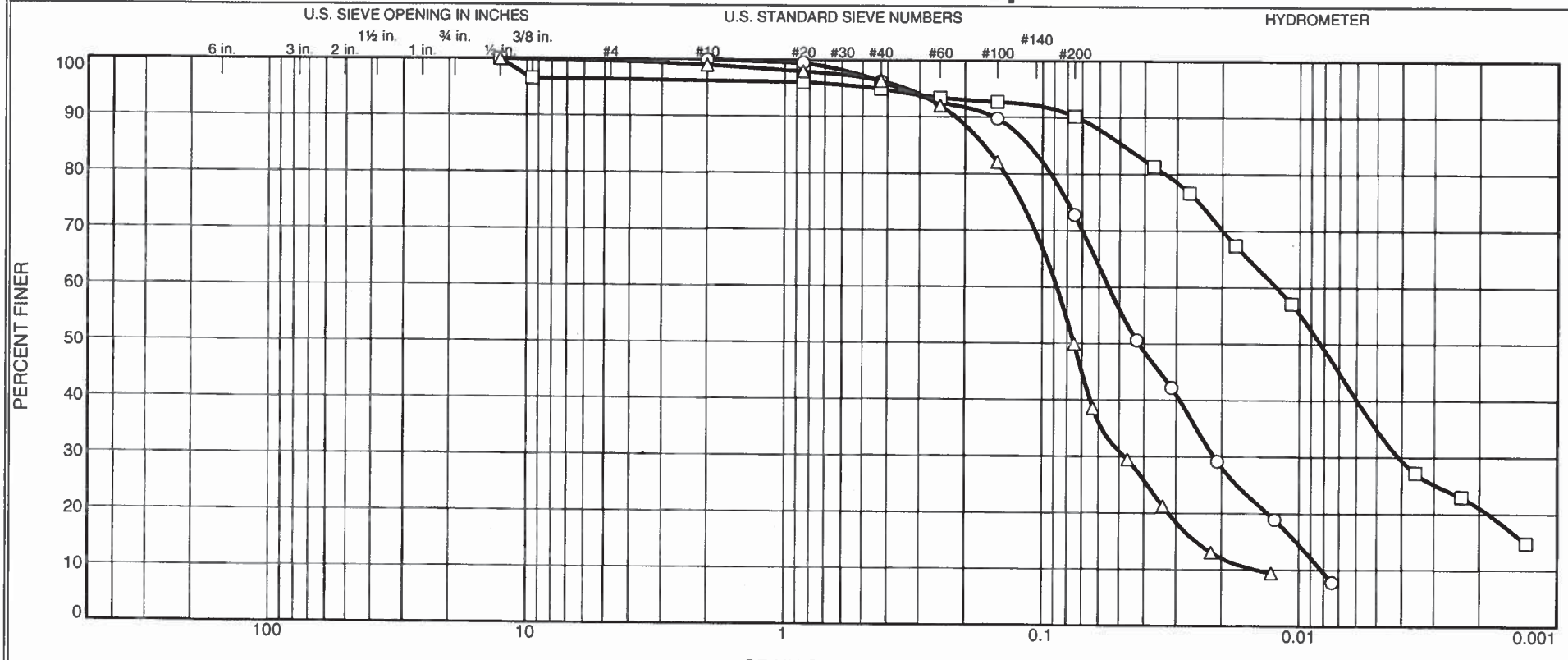
Project No. FL9001 Figure A21

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 | 23.5 | 72.8 | |
| □ | 0.0 | 0.0 | 3.6 | 0.1 | 1.4 | 4.7 | 55.4 | 34.8 |
| △ | 0.0 | 0.0 | 0.3 | 0.7 | 2.6 | 46.5 | 49.9 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-11 | KC-10-1020 | 40 | 10/8/10 | ML | Silt with sand | 33.9 | NV | NP |
| □ | KCB-11 | KC-10-1021 | 60 | 10/8/10 | ML | Silt | 43.6 | 40 | 31 |
| △ | KCB-11 | KC-10-1022 | 65 | 10/8/10 | SM | Silty sand | 31.5 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

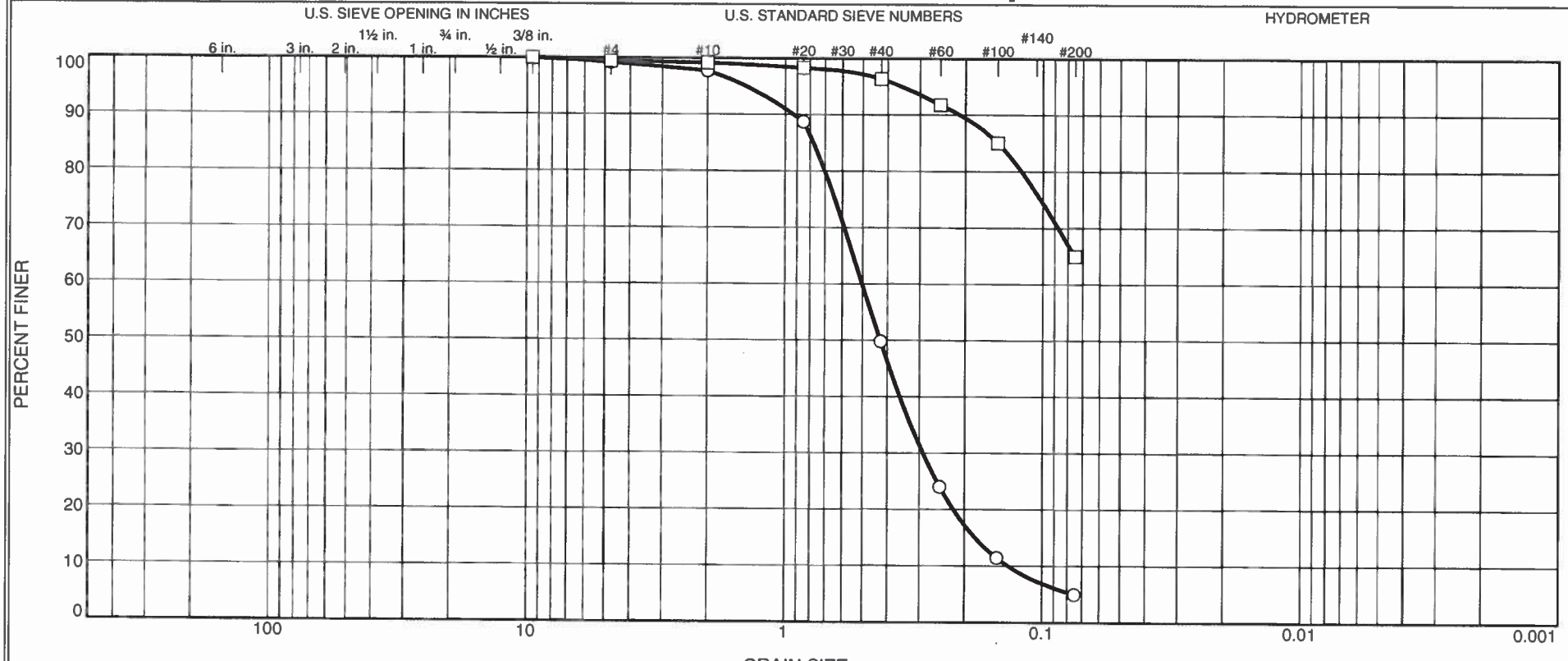
Project No. FL9001 Figure A22

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.8 | 1.4 | 48.0 | 44.8 | 5.0 | |
| □ | 0.0 | 0.0 | 0.5 | 0.3 | 2.8 | 31.4 | 65.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-12 | KC-10-1023 | 25 | 10/8/10 | SP-SM | Poorly graded sand with silt | 24.4 | NV | NP |
| □ | KCB-12 | KC-10-1024 | 50 | 10/8/10 | ML | Sandy silt | 45.5 | NV | NP |

Client WLRD

Project Countyline to A-Street Geotechnical Study

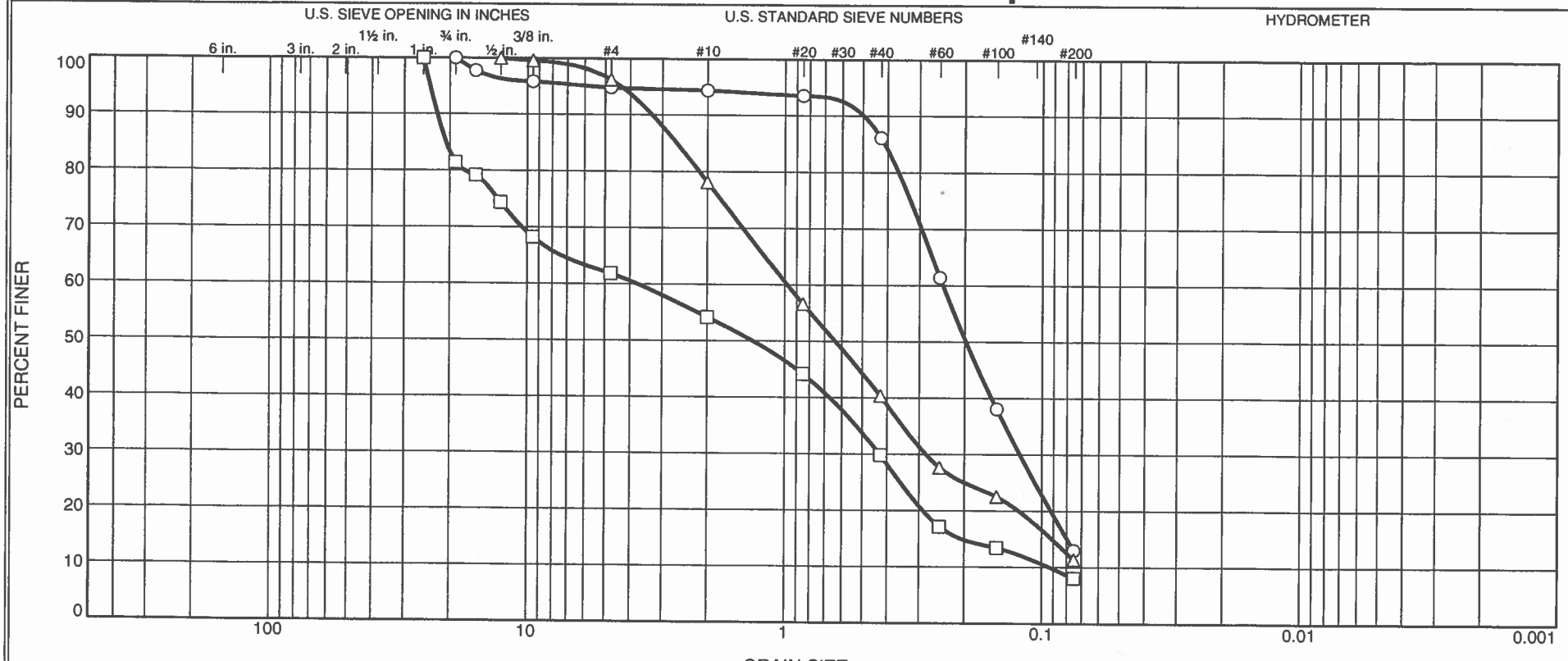
Project No. FL9001 Figure A23

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 5.2 | 0.4 | 8.2 | 73.2 | 13.0 | |
| □ | 0.0 | 18.6 | 19.5 | 7.7 | 24.4 | 21.7 | 8.1 | |
| △ | 0.0 | 0.0 | 3.8 | 18.1 | 37.8 | 28.9 | 11.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-13 | KC-11-1361 | 5.0-6.5 | 10/6/11 | SM | Silty sand | 27.0 | | |
| □ | KCB-13 | KC-11-1362 | 20.0-21.5 | 10/6/11 | SP-SM | Poorly graded sand with silt and gravel | 17.6 | | |
| △ | KCB-13 | KC-11-1363 | 30.0-31.5 | 10/6/11 | SP-SM | Poorly graded sand with silt | 16.2 | | |

Client King County

Project County Line Levee Relocation

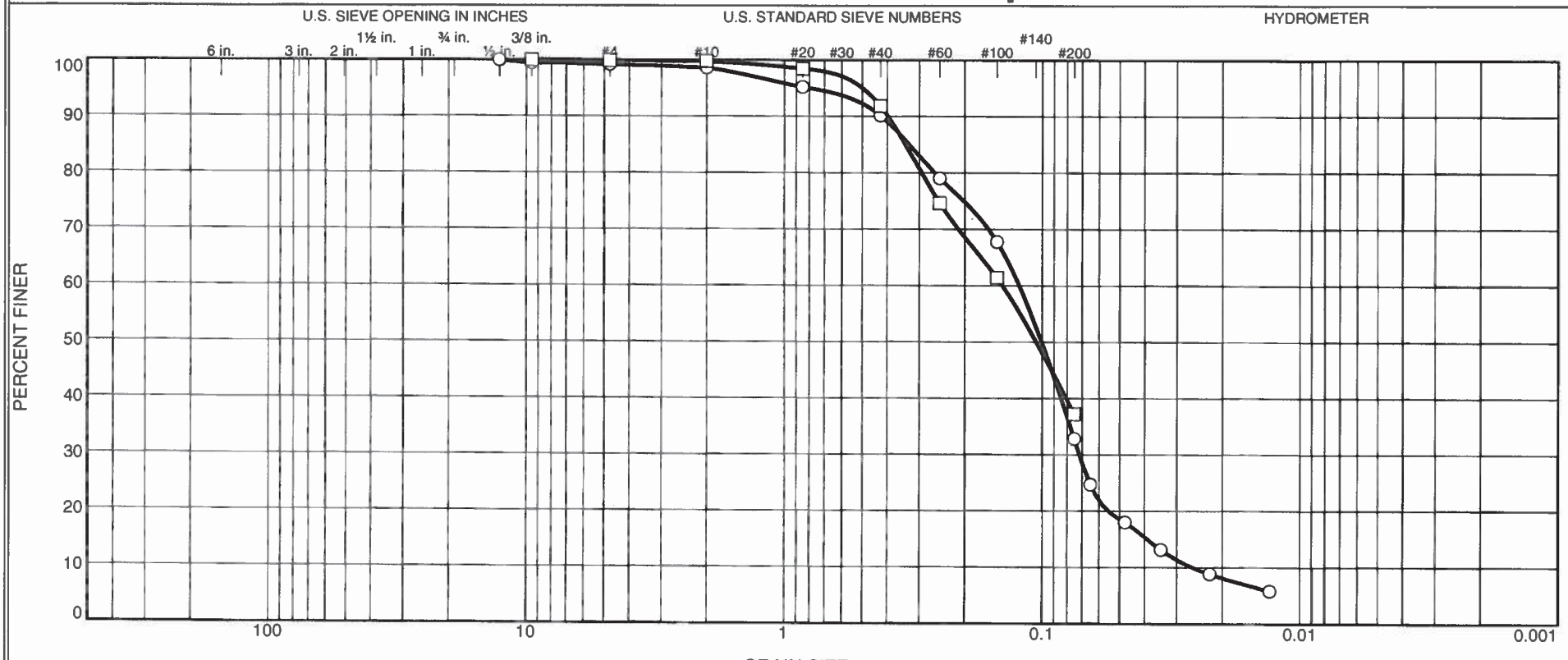
Project No. FL9001 Figure A24

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.8 | 0.6 | 8.4 | 57.4 | 32.8 | |
| □ | 0.0 | 0.0 | 0.1 | 0.1 | 7.9 | 54.7 | 37.2 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-13 | KC-11-1364 | 40.0-41.5 | 10/6/11 | SM | Silty sand | 27.3 | | |
| □ | KCB-13 | KC-11-1365 | 50.0-51.5 | 10/6/11 | SM | Silty sand | 24.9 | | |

Client King County

Project County Line Levee Relocation

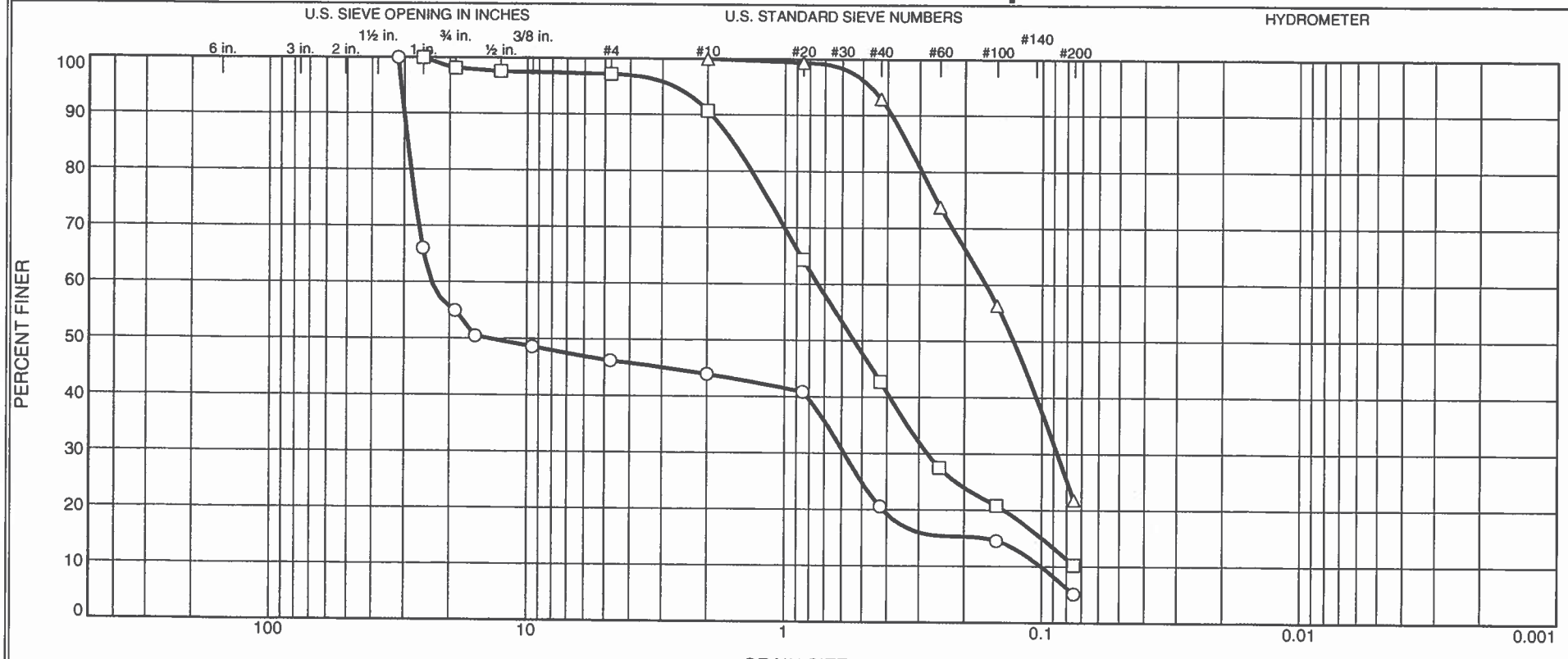
Project No. FL9001 Figure A25

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 45.1 | 8.7 | 2.3 | 23.3 | 15.5 | 5.1 | |
| □ | 0.0 | 1.9 | 0.9 | 6.5 | 48.0 | 32.4 | 10.3 | |
| △ | 0.0 | 0.0 | 0.0 | 0.0 | 7.1 | 71.1 | 21.8 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-14 | KC-11-1366 | 15.0-16.5 | 10/6/11 | GP-GM | Poorly graded gravel with silt and sand | 12.1 | | |
| □ | KCB-14 | KC-11-1367 | 35.0-36.5 | 10/6/11 | SP-SM | Poorly graded sand with silt | 16.3 | | |
| △ | KCB-14 | KC-11-1368 | 50.0-51.5 | 10/6/11 | SM | Silty sand | 28.2 | | |

Client King County

Project County Line Levee Relocation

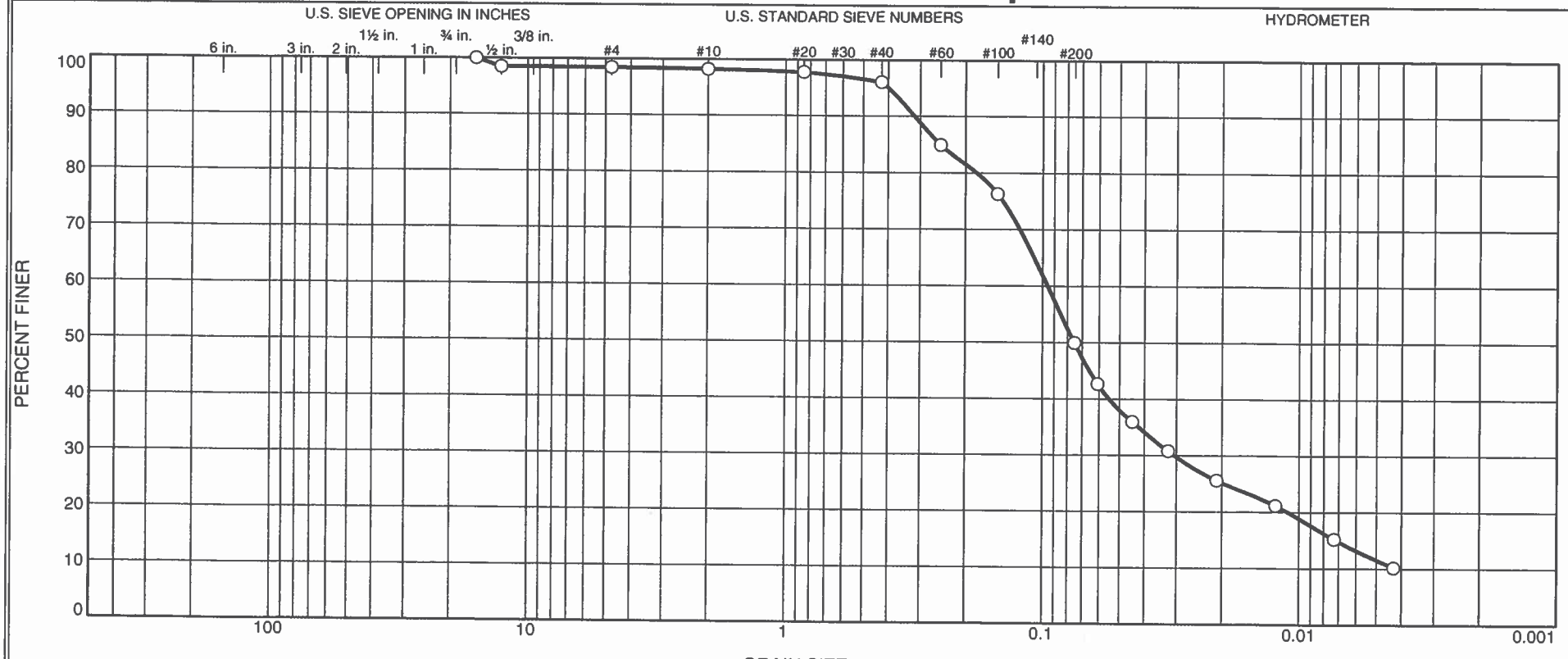
Project No. FL9001 Figure A26

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| O | 0.0 | 0.0 | 1.6 | 0.2 | 2.1 | 46.2 | 38.3 | 11.6 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| O | KCB-14 | KC-11-1369 | 70.0-71.5 | 10/6/11 | SP | Sandy silt | 36.5 | | NP |

Client King County

Project County Line Levee Relocation

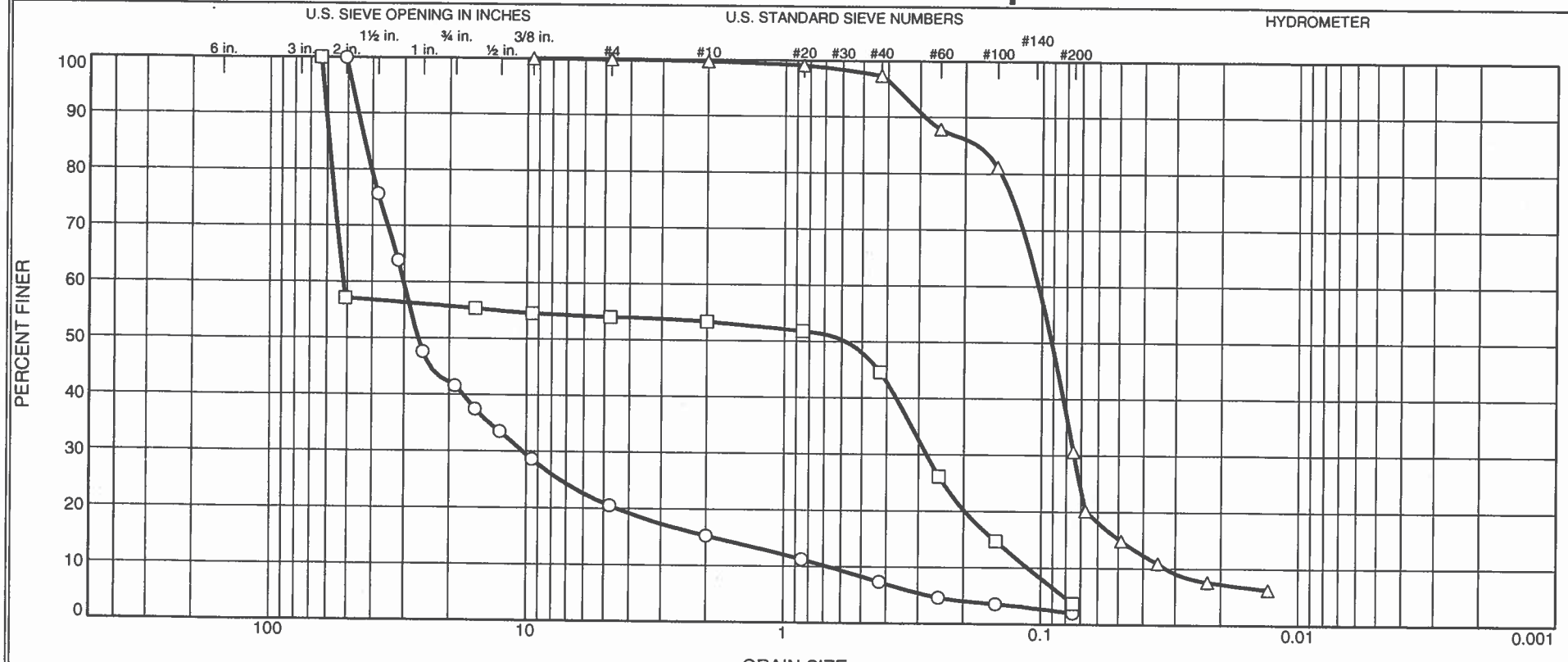
Project No. FL9001 Figure A27

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 58.4 | 21.1 | 5.2 | 7.9 | 5.4 | 2.0 | |
| □ | 0.0 | 44.3 | 1.7 | 0.6 | 8.8 | 40.9 | 3.7 | |
| △ | 0.0 | 0.0 | 0.1 | 0.2 | 2.3 | 66.7 | 30.7 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-15 | KC-11-1370 | 10.0-11.5 | 10/6/11 | GP | Poorly graded gravel with sand | 8.9 | | |
| □ | KCB-15 | KC-11-1371 | 20.0-21.5 | 10/6/11 | SP | Poorly graded sand with gravel | 17.4 | | |
| △ | KCB-15 | KC-11-1372 | 30.0-31.5 | 10/6/11 | SM | Silty sand | 26.7 | | |

Client King County

Project County Line Levee Relocation

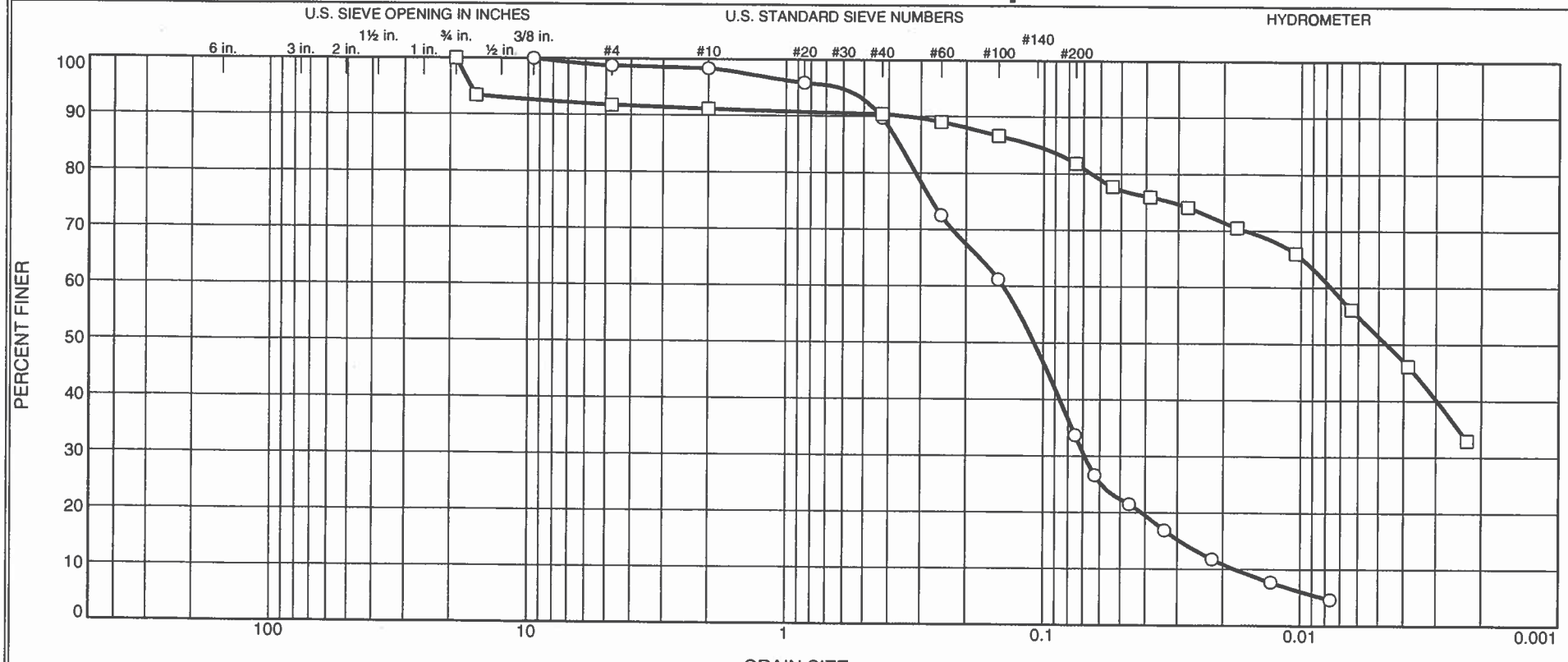
Project No. FL9001 Figure A28

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 1.2 | 0.4 | 8.6 | 56.1 | 33.7 | |
| □ | 0.0 | 0.0 | 8.2 | 0.6 | 0.8 | 8.6 | 30.4 | 51.4 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-15 | KC-11-1373 | 45.0-46.5 | 10/6/11 | SM | Silty sand | 26.6 | | |
| □ | KCB-15 | KC-11-1374 | 60.0-61.5 | 10/6/11 | MH | Elastic silt with sand | 76.8 | 59 | 42 |

Client King County

Project County Line Levee Relocation

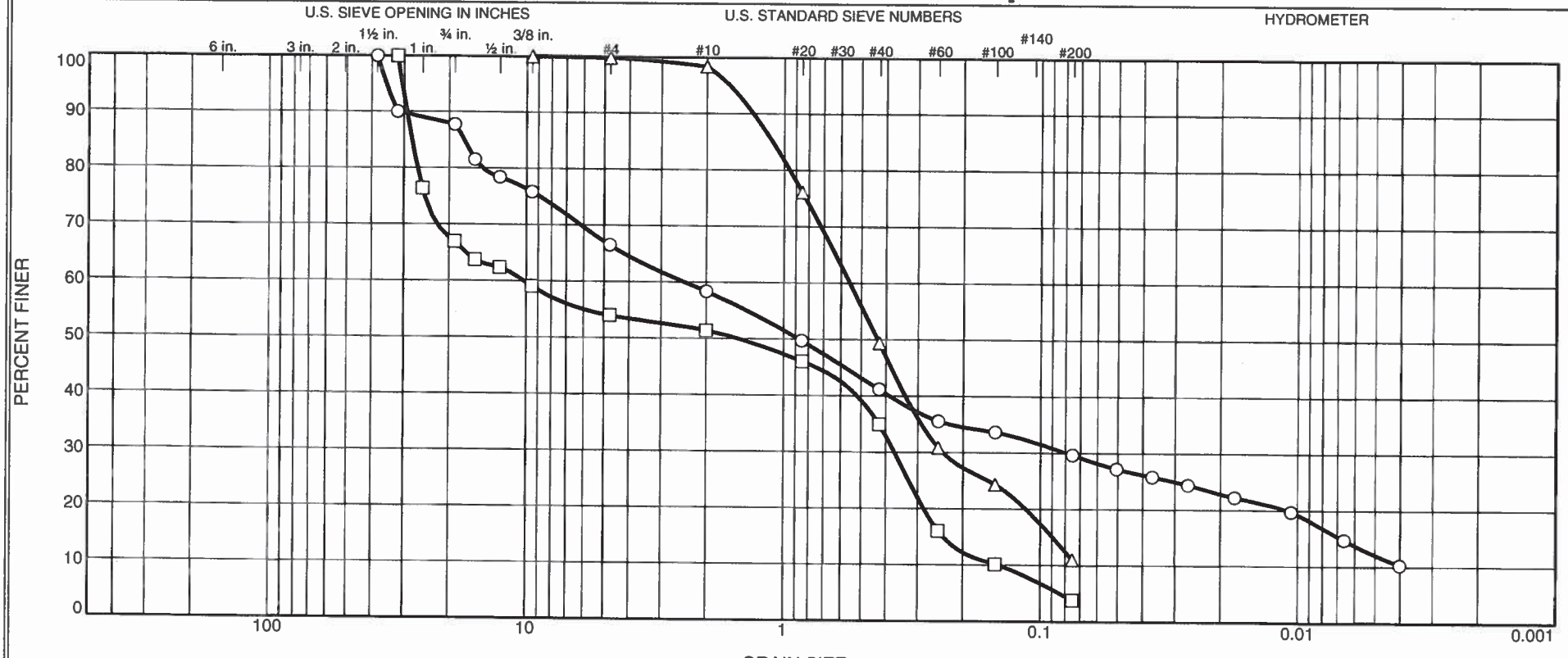
Project No. FL9001 Figure A29

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 12.2 | 21.3 | 8.1 | 17.2 | 11.6 | 17.5 | 12.1 |
| □ | 0.0 | 33.1 | 12.9 | 2.6 | 16.5 | 31.1 | 3.8 | |
| △ | 0.0 | 0.0 | 0.1 | 1.5 | 49.0 | 38.4 | 11.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-16 | KC-11-1375 | 10.0-11.5 | 10/6/11 | SM | Silty sand with gravel | 26.2 | | |
| □ | KCB-16 | KC-11-1376 | 30.0-31.5 | 10/6/11 | SP | Poorly graded sand with gravel | 39.0 | | |
| △ | KCB-16 | KC-11-1377 | 45.0-46.5 | 10/6/11 | SP-SM | Poorly graded sand with silt | 19.2 | | |

Client King County

Project County Line Levee Relocation

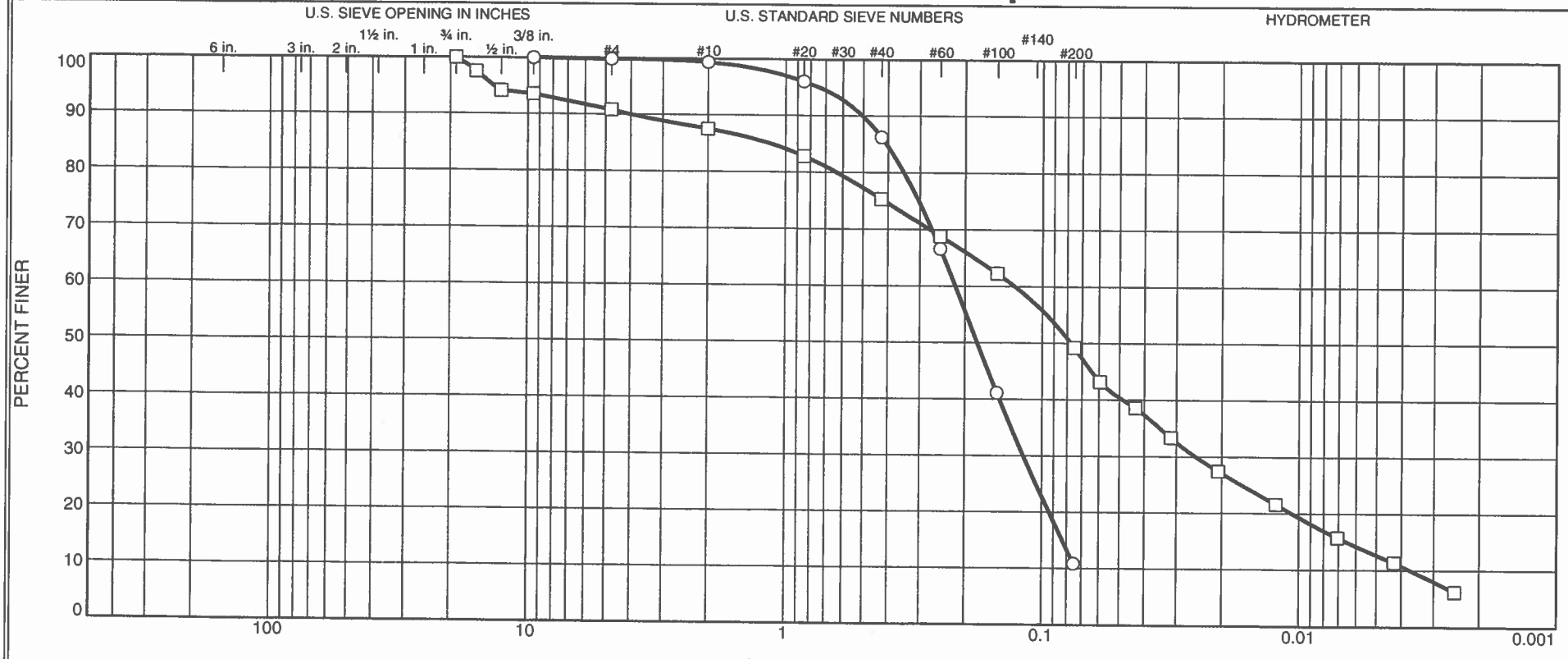
Project No. FL9001 Figure A30

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.1 | 0.5 | 13.1 | 75.5 | 10.8 | |
| □ | 0.0 | 0.0 | 9.2 | 3.3 | 12.2 | 26.1 | 36.5 | 12.7 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-16 | KC-11-1378 | 60.0-61.5 | 10/6/11 | SP-SM | Poorly graded sand with silt | 28.9 | | |
| □ | KCB-16 | KC-11-1379 | 75.0-76.5 | 10/6/11 | SM | Silty sand | 69.3 | 29 | 29 |

Client King County

Project County Line Levee Relocation

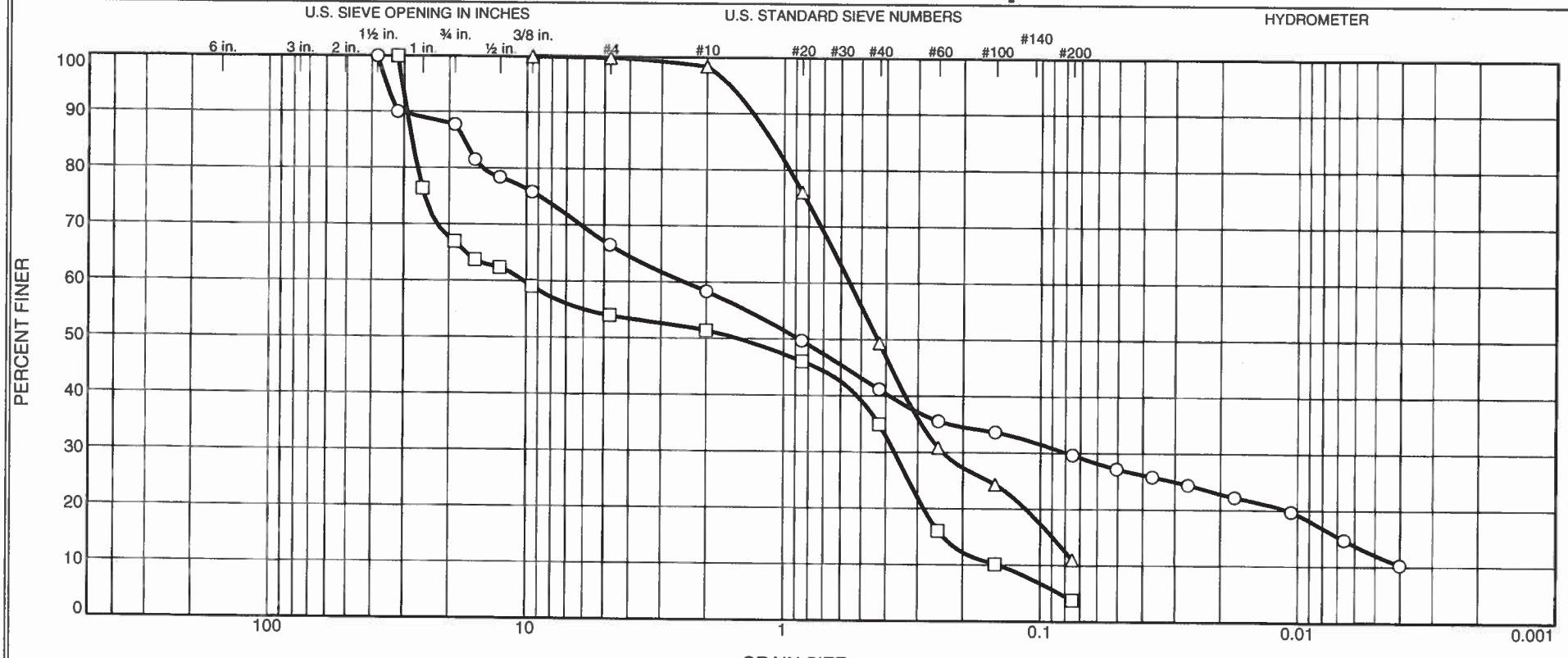
Project No. FL9001 Figure A31

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 12.2 | 21.3 | 8.1 | 17.2 | 11.6 | 17.5 | 12.1 |
| □ | 0.0 | 33.1 | 12.9 | 2.6 | 16.5 | 31.1 | 3.8 | |
| △ | 0.0 | 0.0 | 0.1 | 1.5 | 49.0 | 38.4 | 11.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-16 | KC-11-1375 | 10.0-11.5 | 10/6/11 | SM | Silty sand with gravel | 26.2 | | |
| □ | KCB-16 | KC-11-1376 | 30.0-31.5 | 10/6/11 | SP | Poorly graded sand with gravel | 39.0 | | |
| △ | KCB-16 | KC-11-1377 | 45.0-46.5 | 10/6/11 | SP-SM | Poorly graded sand with silt | 19.2 | | |

Client King County

Project County Line Levee Relocation

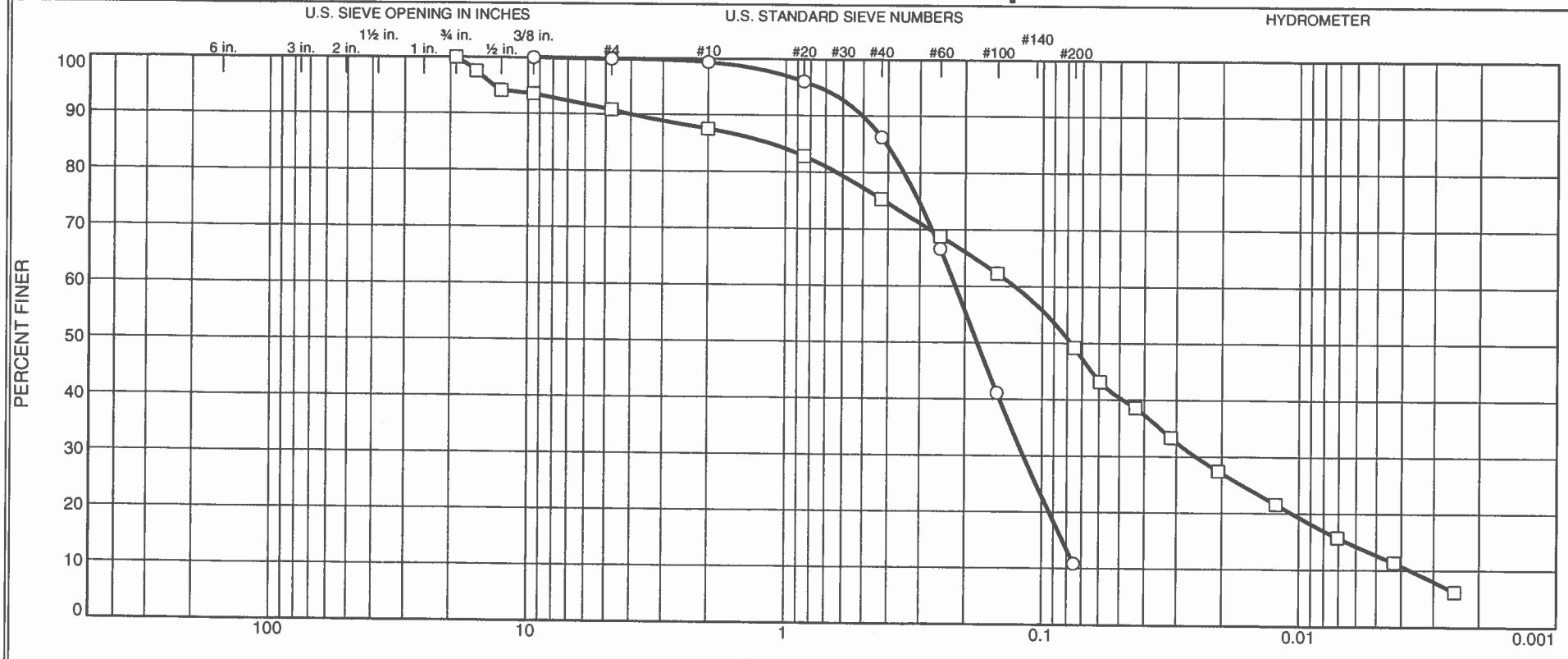
Project No. FL9001 Figure A30

**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.1 | 0.5 | 13.1 | 75.5 | 10.8 | |
| □ | 0.0 | 0.0 | 9.2 | 3.3 | 12.2 | 26.1 | 36.5 | 12.7 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | KCB-16 | KC-11-1378 | 60.0-61.5 | 10/6/11 | SP-SM | Poorly graded sand with silt | 28.9 | | |
| □ | KCB-16 | KC-11-1379 | 75.0-76.5 | 10/6/11 | SM | Silty sand | 69.3 | 29 | 29 |

Client King County

Project County Line Levee Relocation

Project No. FL9001 Figure A31

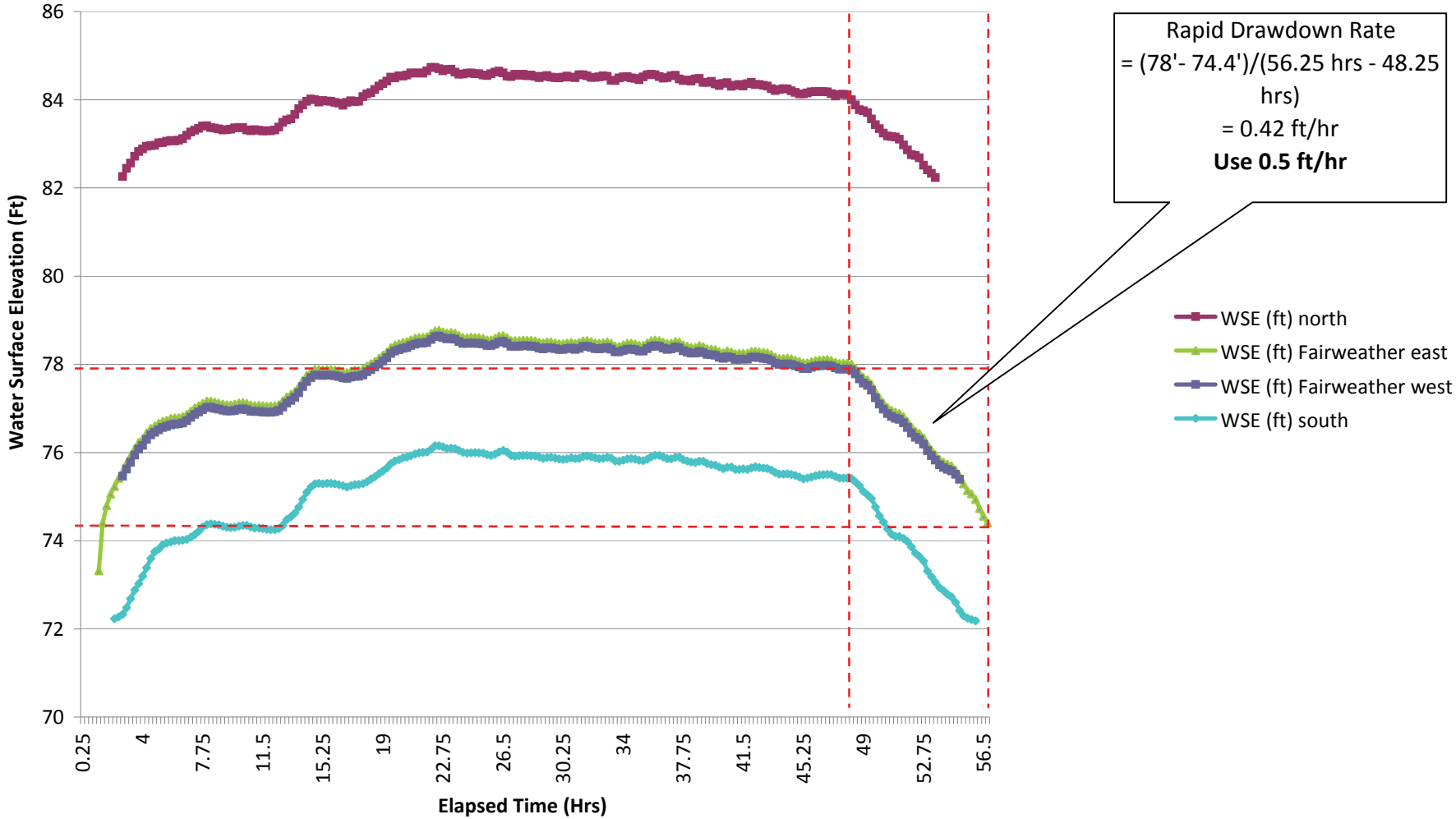
**KING COUNTY**

**MATERIALS LABORATORY**

**Tested By:** vw

# Appendix B: King County Rapid Drawdown Data

# Water Surface Elevation Along Levee in S1d 100 year Model



# Appendix C: Vertical Exit Gradient SEEP/W Output

Name: Proposed Fill Model: Saturated / Unsaturated K-Function: Proposed Fill Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: 2-Silt,Peat Model: Saturated Only K-Sat: 3.281e-007 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 3-Sand, Silty Sand Model: Saturated Only K-Sat: 9.8425e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 4-Silt Model: Saturated Only K-Sat: 9.8425e-008 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 1-Existing Fill Model: Saturated / Unsaturated K-Function: Stratum 1-Fill Vol. WC. Function: Sand K-Ratio: 0.25 K-Direction: 0

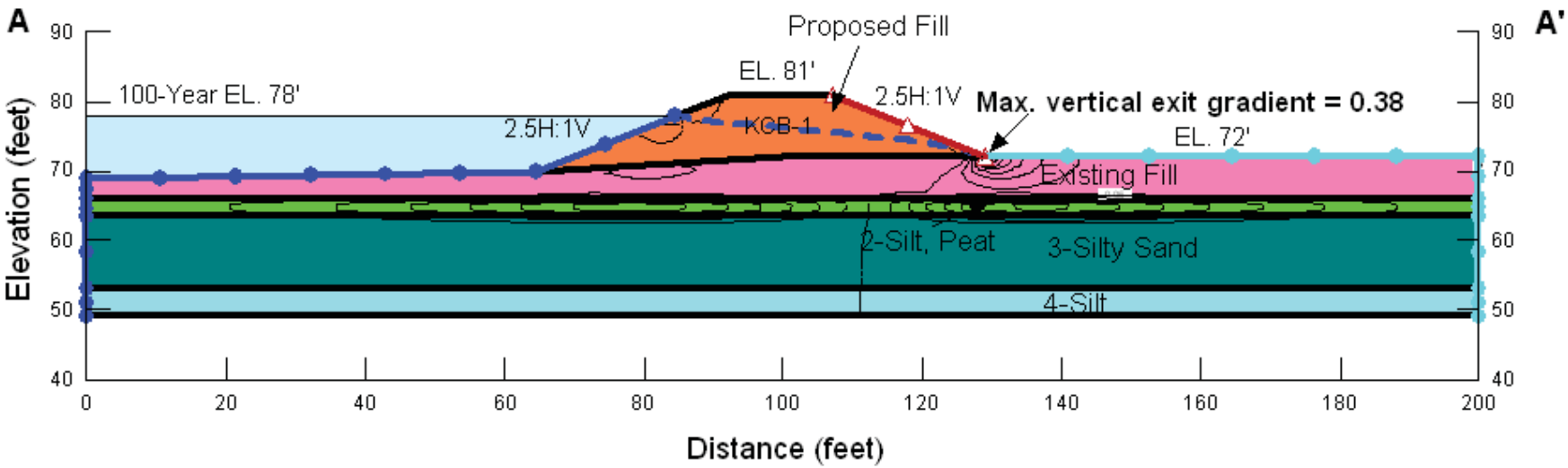



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Figure C1

Job No. 33762798

**Vertical Gradient Contours, Section AA'**

URS

White River Countyline Levee Project
King County, Washington

Permeability for Proposed Fill is 0.02 cm/s = 6.5616798E-4 ft/s

Name: Proposed Fill Model: Saturated / Unsaturated K-Function: Proposed Fill Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: 2-Silt,Peat Model: Saturated Only K-Sat: 3.281e-007 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 3-Sand, Silty Sand Model: Saturated Only K-Sat: 9.8425e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 4-Silt Model: Saturated Only K-Sat: 9.8425e-008 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 1-Existing Fill Model: Saturated / Unsaturated K-Function: Stratum 1-Fill Vol. WC. Function: Sand K-Ratio: 0.25 K-Direction: 0

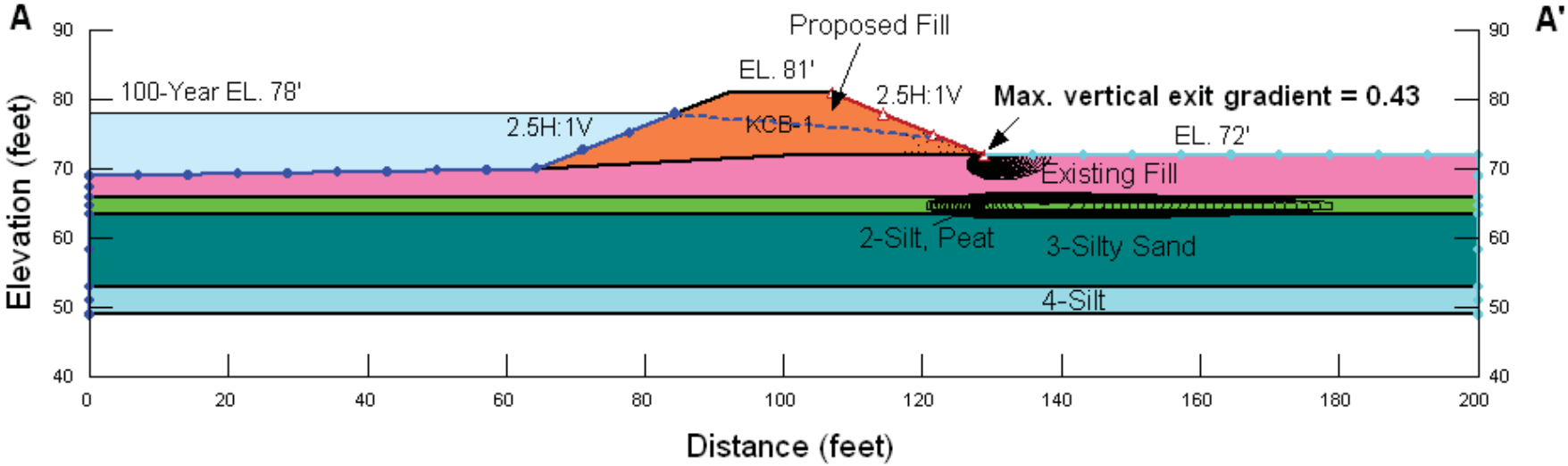


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Figure C1a

**Vertical Gradient Contours, Section AA'**

Job No. 33762798

URS

White River Countyline Levee Project
King County, Washington

Name: Proposed Fill Model: Saturated / Unsaturated K-Function: Proposed Fill Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: Riprap Model: Saturated / Unsaturated K-Function: Riprap Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: 3-Sand, Silty Sand Model: Saturated Only K-Sat: 9.84252e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 4-Silt Model: Saturated Only K-Sat: 9.84252e-008 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 5-Sand, Silty Sand Model: Saturated Only K-Sat: 9.84252e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 1-Existing Fill Model: Saturated / Unsaturated K-Function: Stratum 1-Fill Vol. WC. Function: Sand K-Ratio: 0.25 K-Direction: 0

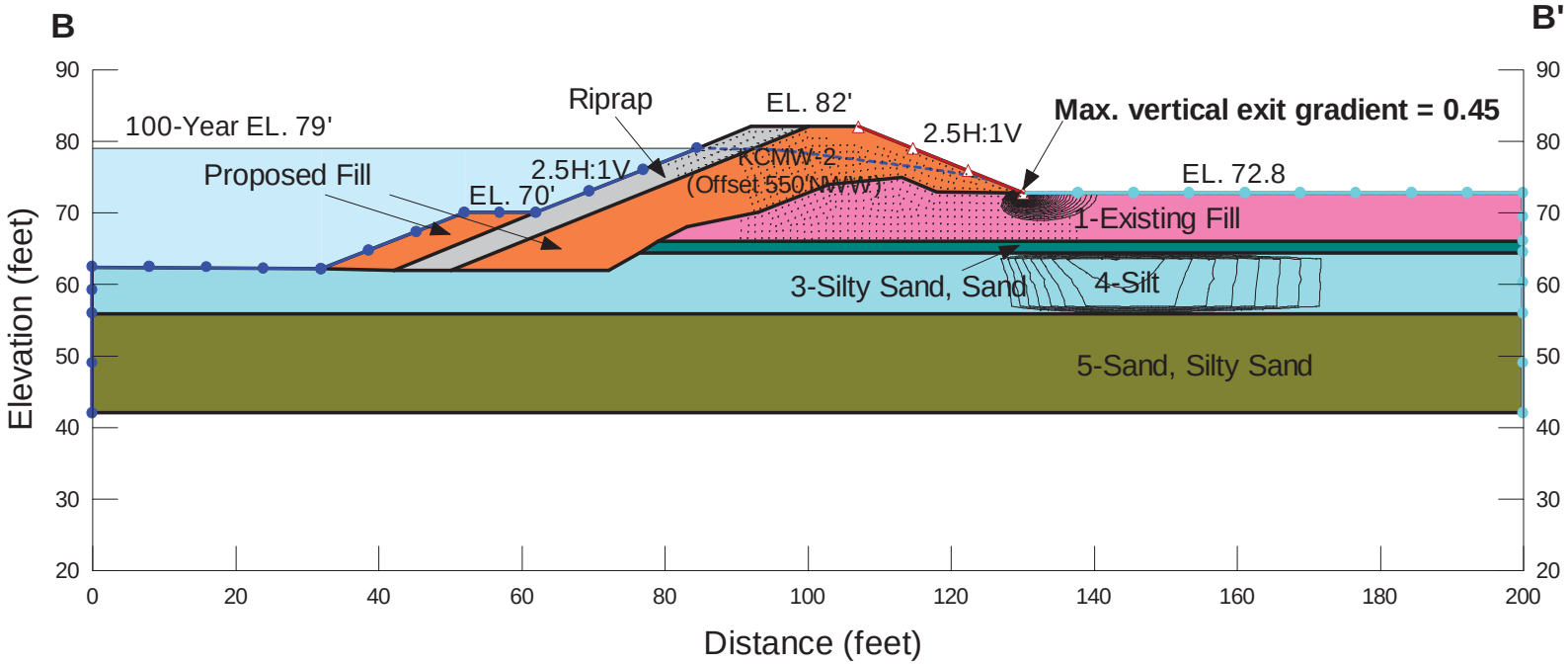


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Figure C2

Job No. 33762798

**Vertical Gradient Contours, Section BB'**

URS

White River Countyline Levee Project
King County, Washington

Permeability for Proposed Fill is 0.02 cm/s = 6.5616798E-4 ft/s

Name: Proposed Fill Model: Saturated / Unsaturated K-Function: Proposed Fill Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: Riprap Model: Saturated / Unsaturated K-Function: Riprap Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: 3-Sand, Silty Sand Model: Saturated Only K-Sat: 9.84252e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 4-Silt Model: Saturated Only K-Sat: 9.84252e-008 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 5-Sand, Silty Sand Model: Saturated Only K-Sat: 9.84252e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 1-Existing Fill Model: Saturated / Unsaturated K-Function: Stratum 1-Fill Vol. WC. Function: Sand K-Ratio: 0.25 K-Direction: 0

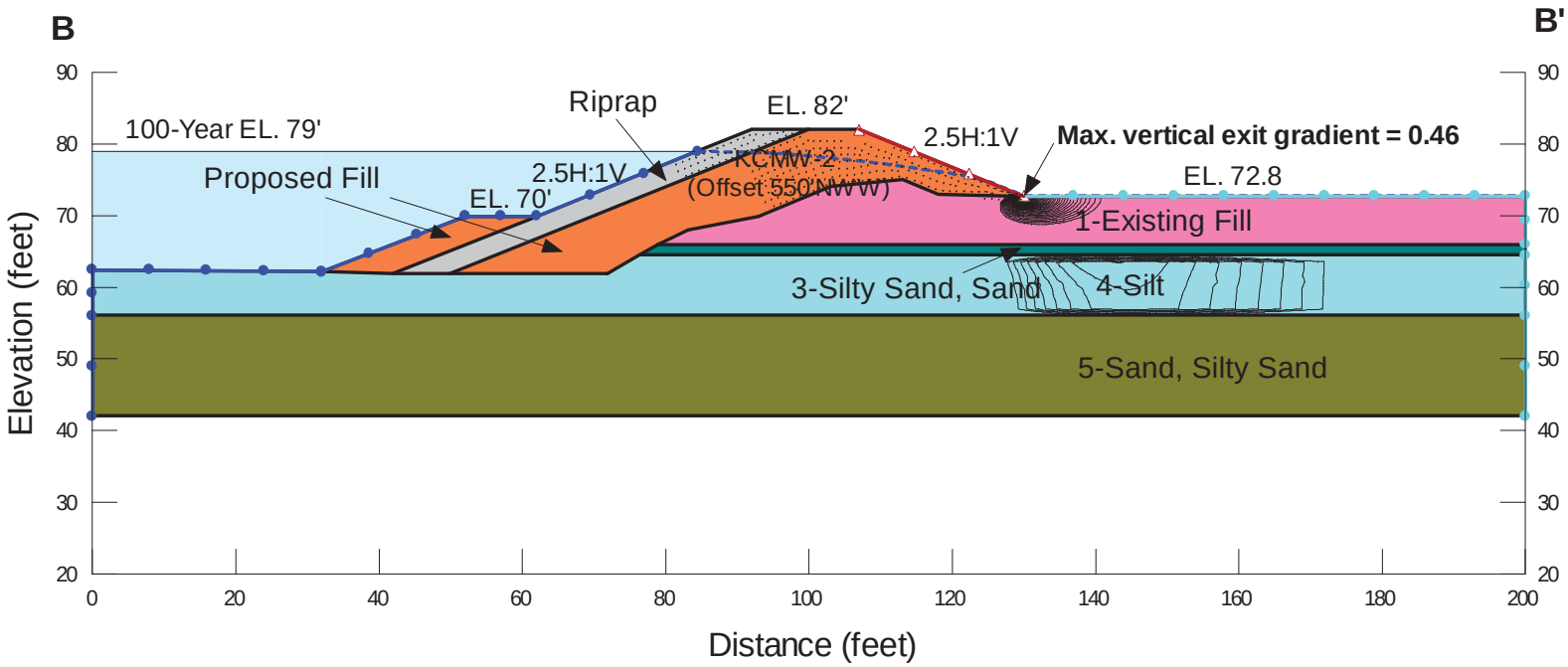


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Figure C2a

Job No. 33762798

**Vertical Gradient Contours, Section BB'**

URS

White River Countyline Levee Project
King County, Washington

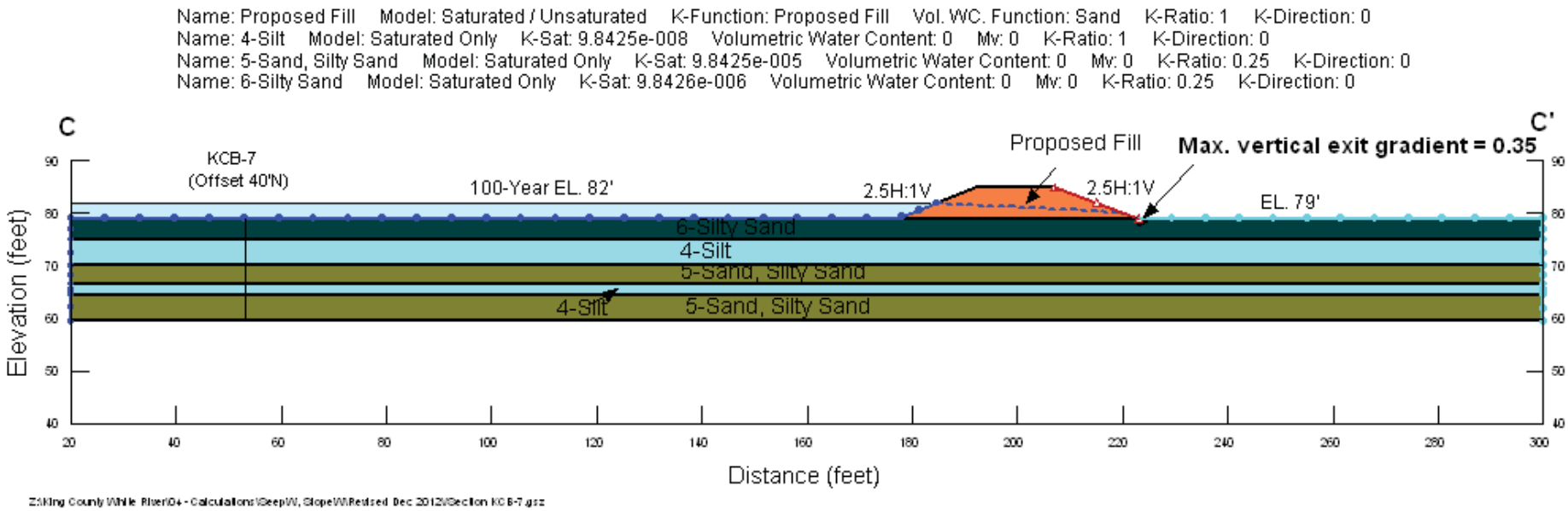


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Figure C3

**Vertical Gradient Contours, Section CC'**

White River Countyline Levee Project
King County, Washington

Job No. 33762798

URS

Name: Proposed Fill Model: Saturated / Unsaturated K-Function: Proposed Fill Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: 2-Silt,Peat Model: Saturated Only K-Sat: 3.28084e-007 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 3-Sand, Silty Sand Model: Saturated Only K-Sat: 9.8425e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 4-Silt Model: Saturated Only K-Sat: 9.8425e-008 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 5-Sand, Silty Sand Model: Saturated Only K-Sat: 9.8425e-005 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: Silty Sand Model: Saturated Only K-Sat: 9.8425e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0

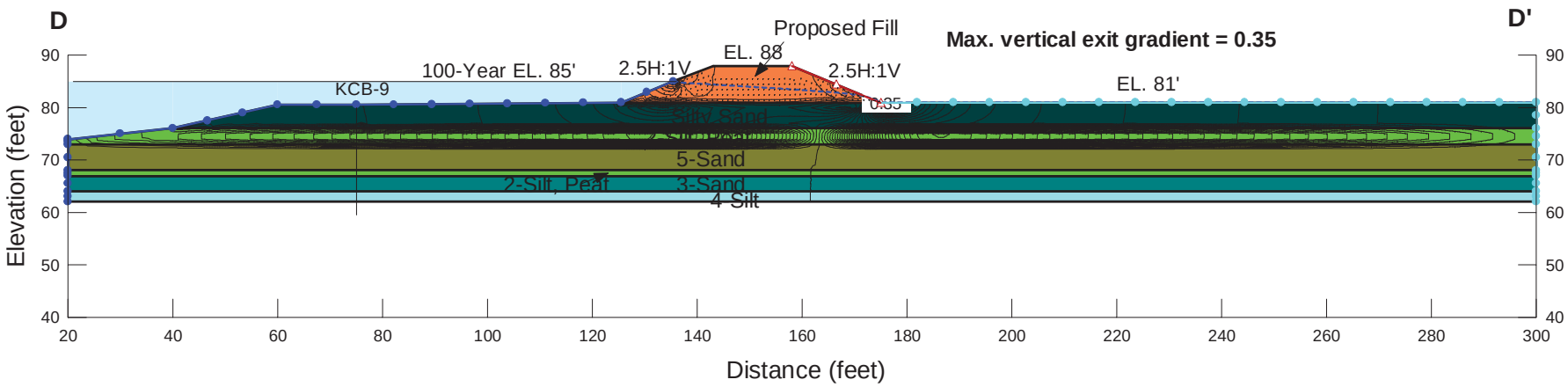


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Figure C4

**Vertical Gradient Contours, Section DD'**

Job No. 33762798

URS

White River Countyline Levee Project
King County, Washington

Name: Proposed Imported Fill (Fines.=25%) Model: Saturated / Unsaturated K-Function: Proposed Fill Vol. WC. Function: Silty Sand K-Ratio: 1 K-Direction: 0
Name: 2-Silt,Peat Model: Saturated Only K-Sat: 3.281e-007 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 3-Sand, Silty Sand Model: Saturated Only K-Sat: 9.8425e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 4-Silt Model: Saturated Only K-Sat: 9.8425e-008 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 1-Existing Fill Model: Saturated / Unsaturated K-Function: Stratum 1-Fill Vol. WC. Function: Sand K-Ratio: 0.25 K-Direction: 0
Name: On-Site Alluvium Model: Saturated / Unsaturated K-Function: On-Site Alluvium Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: Topsoil Model: Saturated / Unsaturated K-Function: Topsoil Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0

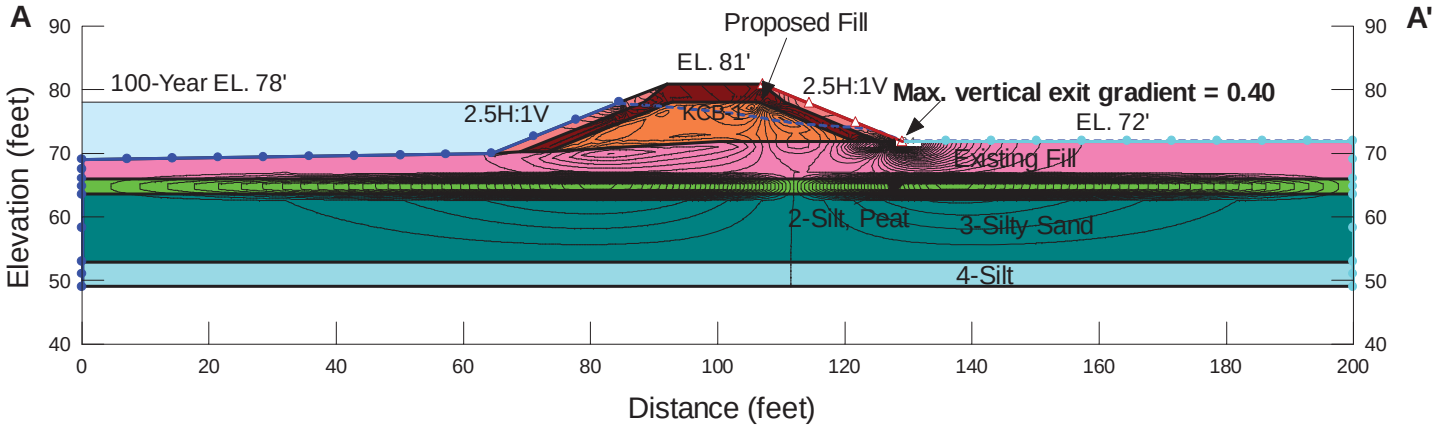


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Figure C5

Job No. 33762798

**Vertical Gradient Contours, Section AA'**

URS

White River Countyline Levee Project
King County, Washington

Name: Proposed Imported Fill (Fines.=25%) Model: Saturated / Unsaturated K-Function: Proposed Fill Vol. WC. Function: Silty Sand K-Ratio: 1 K-Direction: 0
Name: 2-Silt,Peat Model: Saturated Only K-Sat: 3.281e-007 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 3-Sand, Silty Sand Model: Saturated Only K-Sat: 9.8425e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 4-Silt Model: Saturated Only K-Sat: 9.8425e-008 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 1-Existing Fill Model: Saturated / Unsaturated K-Function: Stratum 1-Fill Vol. WC. Function: Sand K-Ratio: 0.25 K-Direction: 0
Name: On-Site Alluvium Model: Saturated / Unsaturated K-Function: On-Site Alluvium Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: Topsoil Model: Saturated / Unsaturated K-Function: Topsoil Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0

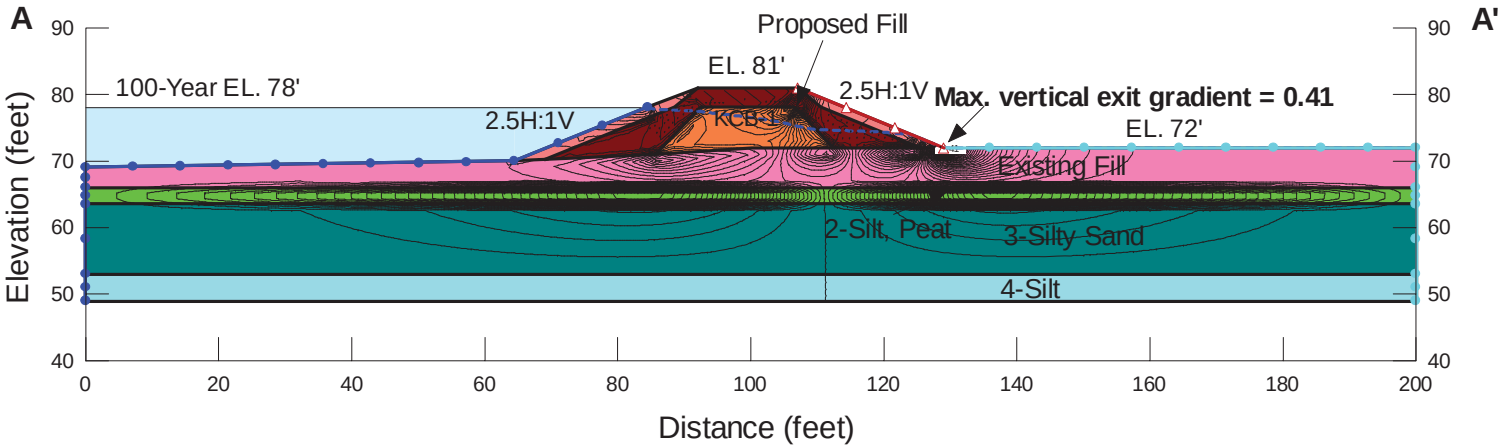


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Figure C5a

Job No. 33762798

**Vertical Gradient Contours, Section AA'**

URS

White River Countyline Levee Project
King County, Washington

Name: Proposed Imported Fill (Fines.=25%) Model: Saturated / Unsaturated K-Function: Proposed Fill Vol. WC. Function: Silty Sand K-Ratio: 1 K-Direction: 0
Name: 2-Silt,Peat Model: Saturated Only K-Sat: 3.28084e-007 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 3-Sand, Silty Sand Model: Saturated Only K-Sat: 9.8425e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: 4-Silt Model: Saturated Only K-Sat: 9.8425e-008 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: 5-Sand, Silty Sand Model: Saturated Only K-Sat: 9.8425e-005 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: Silty Sand Model: Saturated Only K-Sat: 9.8425e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 0.25 K-Direction: 0
Name: Topsoil Model: Saturated / Unsaturated K-Function: Topsoil Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0
Name: On-Site Alluvium Model: Saturated / Unsaturated K-Function: On-Site Alluvium Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0

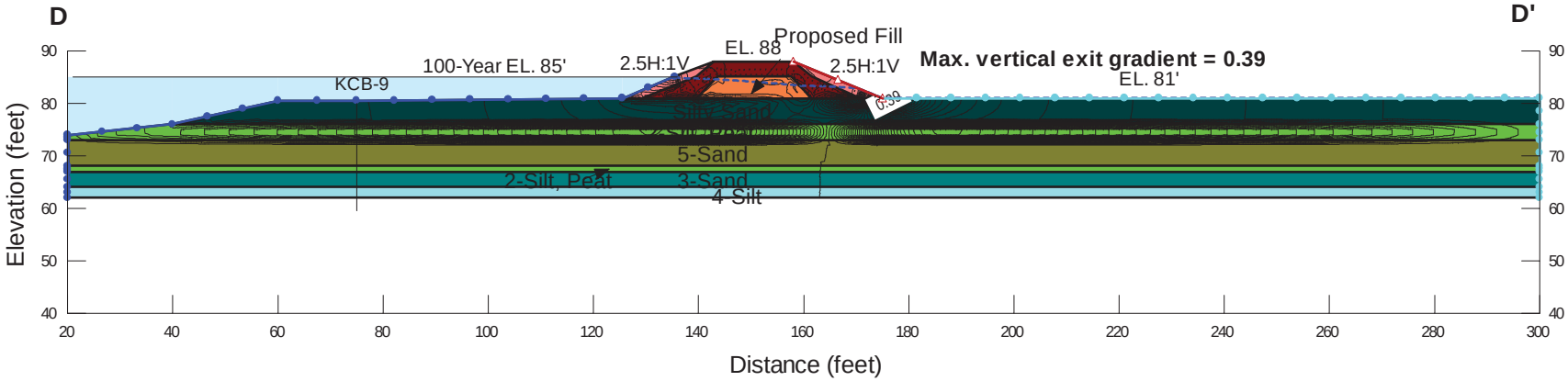


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Figure C6

Job No. 33762798

**Vertical Gradient Contours, Section DD'**

URS

White River Countyline Levee Project
King County, Washington

# Appendix D: Stability Analyses SLOPE/W Output

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.52**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

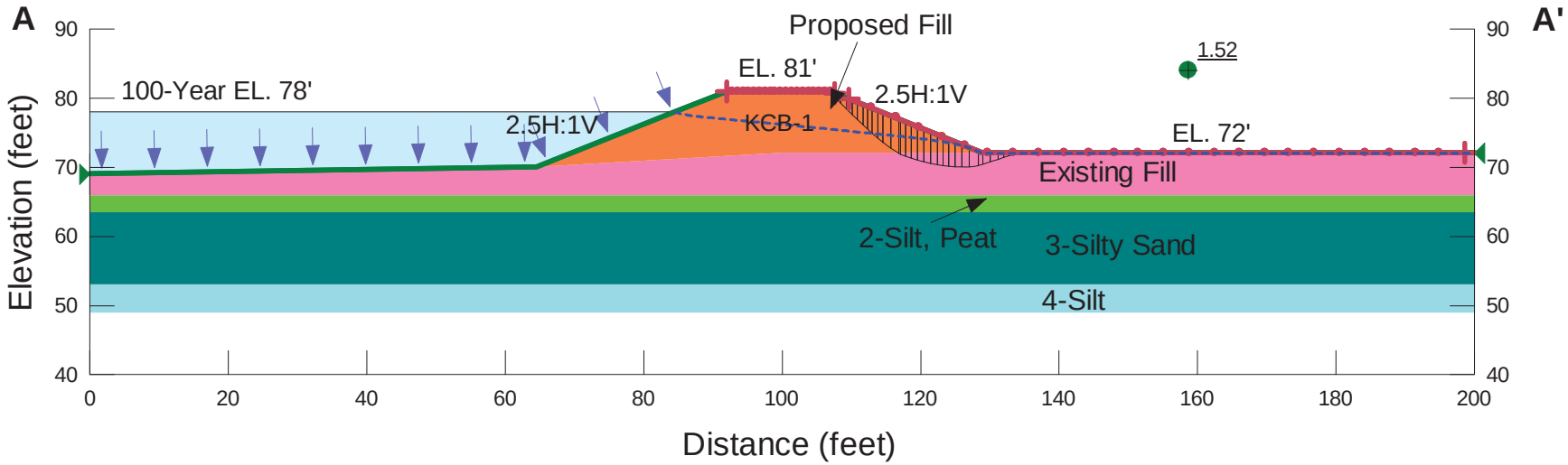


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Figure D1

Job No. 33762798

**Slope Stability – Static, Steady State, Land Side, Section AA'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.64**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 50 Phi: 35
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

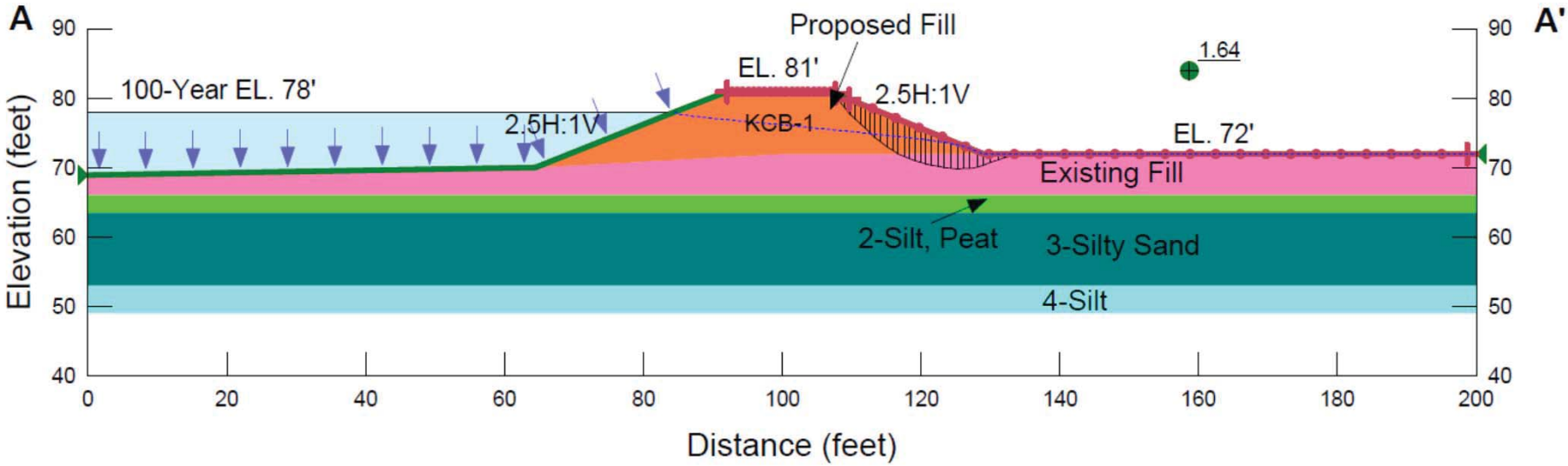


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Figure D1a

Job No. 33762798

**Slope Stability – Static, Steady State, Land Side, Section AA'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.96**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

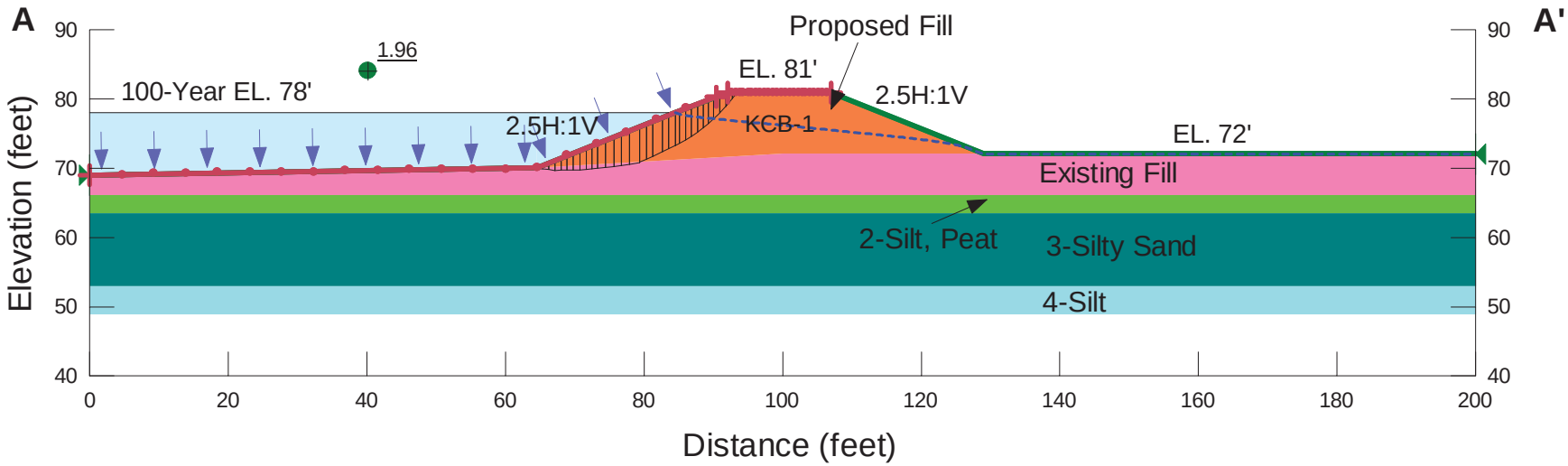


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Figure D2

Job No. 33762798

**Slope Stability – Static, Steady State, River Side, Section AA'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 2.15**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 50 Phi: 35
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

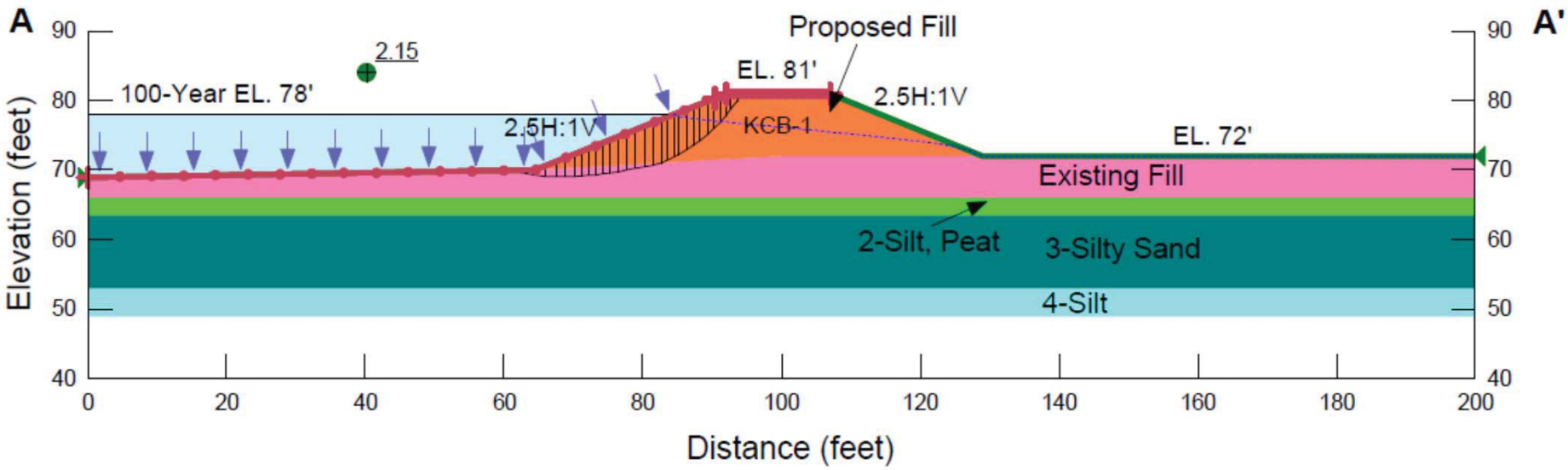


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Figure D2a

Job No. 33762798

**Slope Stability – Static, Steady State, River Side, Section AA'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.62**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

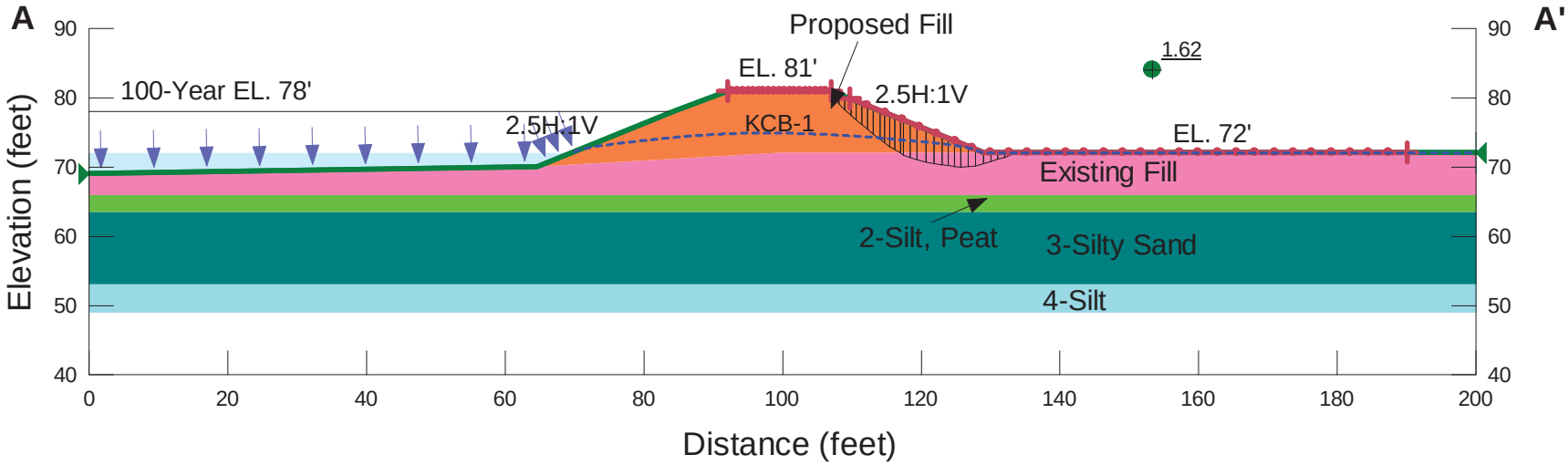


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Figure D3

Job No. 33762798

**Slope Stability – Static, Transient Seepage at 43200 Sec, Land Side, Section AA'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.52**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

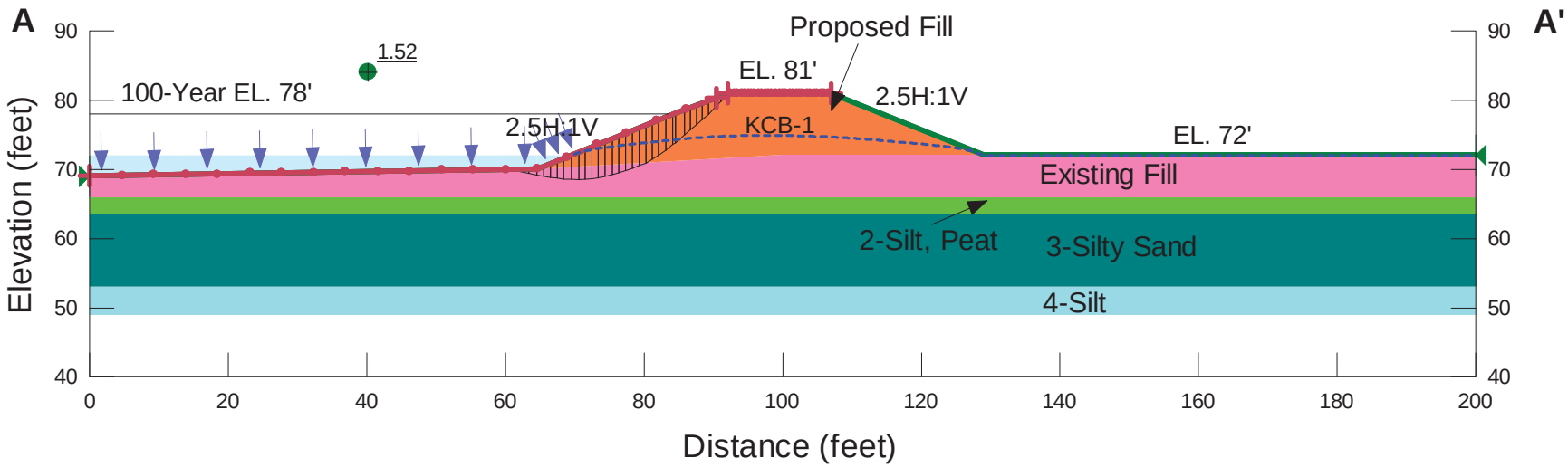


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Figure D4

Job No. 33762798

**Slope Stability – Static, Transient Seepage at 43200 Sec, River Side, Section AA'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.40**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: Riprap Model: Mohr-Coulomb Unit Weight: 140 Cohesion: 0 Phi: 40
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35

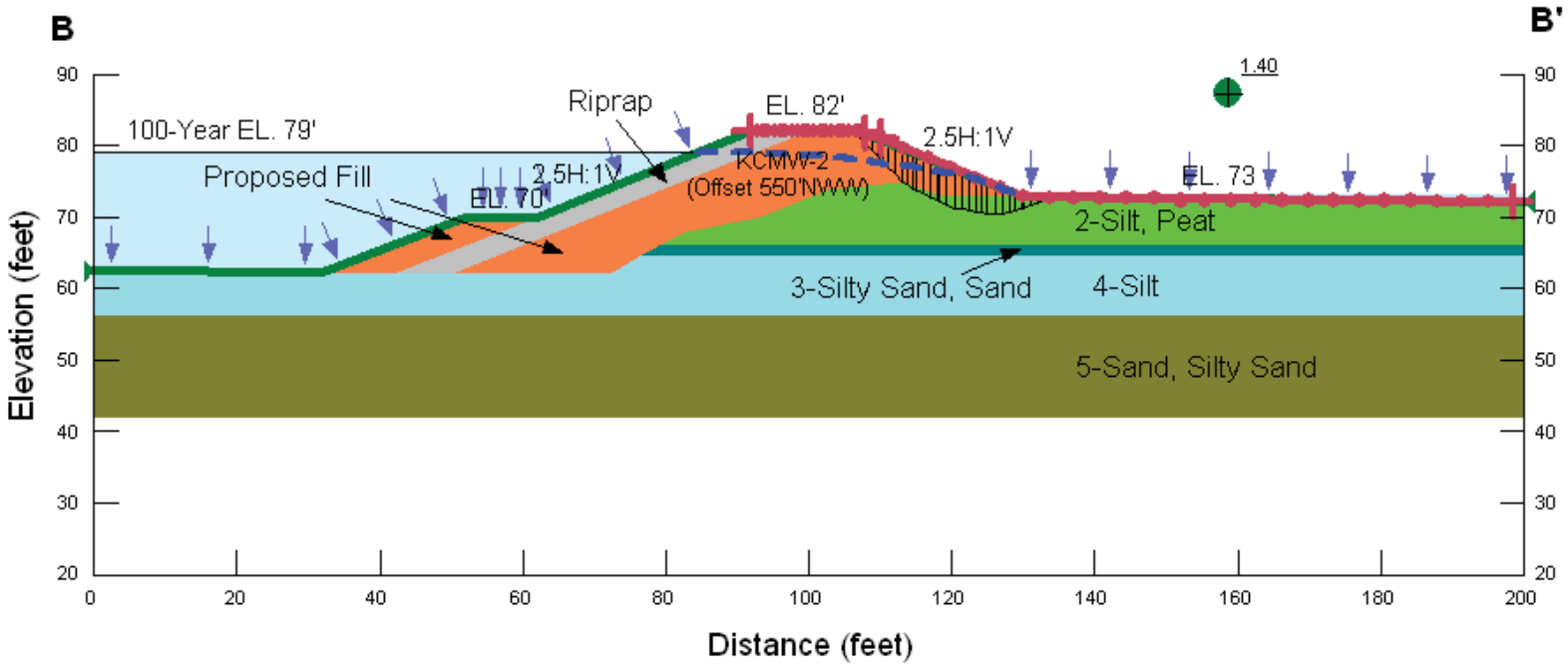


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Figure D5

Job No. 33762798

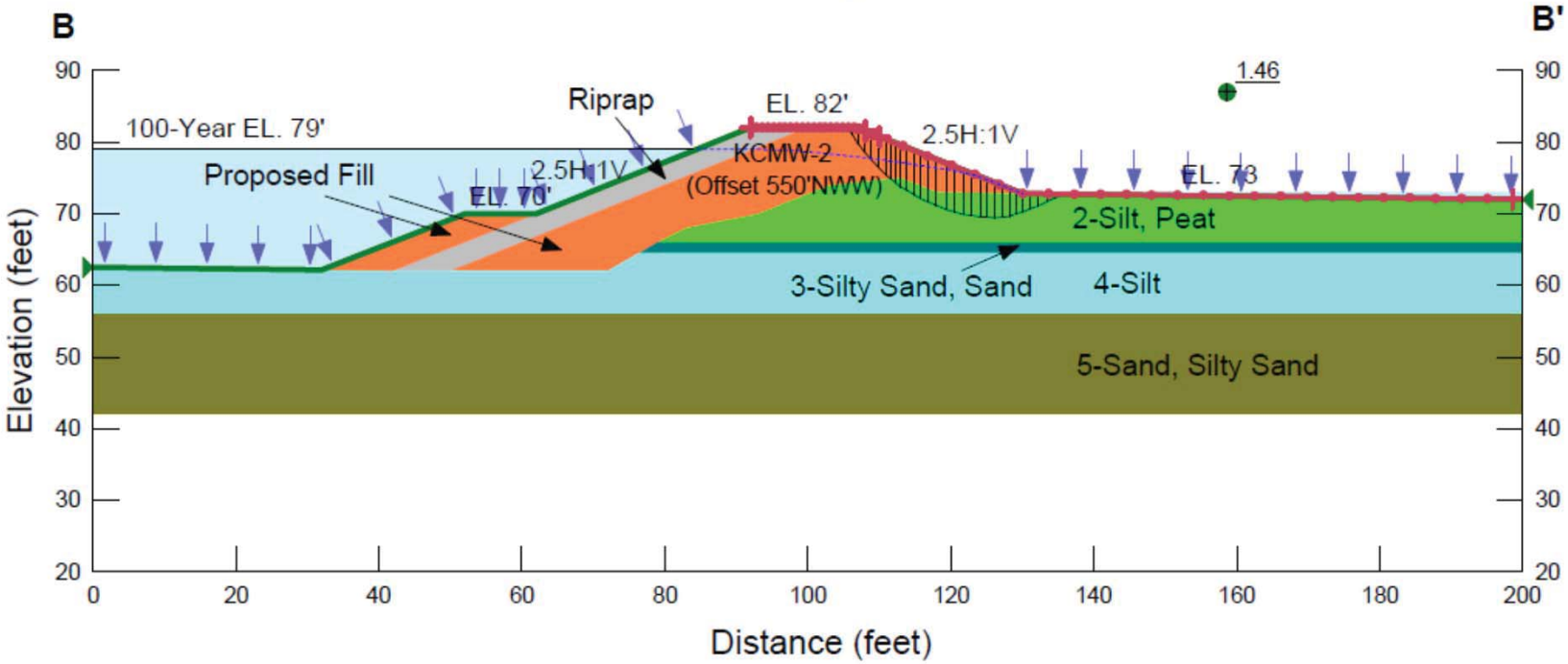
**Slope Stability – Static, Steady State, Land Side, Section BB'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.46**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 50 Phi: 35
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: Riprap Model: Mohr-Coulomb Unit Weight: 140 Cohesion: 0 Phi: 40
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35




Z:\King County White River\04 - Calculations\SeepW, SlopeW\Final\Section KCB-2 phi 35 deg.gsz

Figure D5a

Job No. 33762798

**Slope Stability – Static, Steady State, Land Side, Section BB'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 2.00**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: Riprap Model: Mohr-Coulomb Unit Weight: 140 Cohesion: 0 Phi: 40
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35

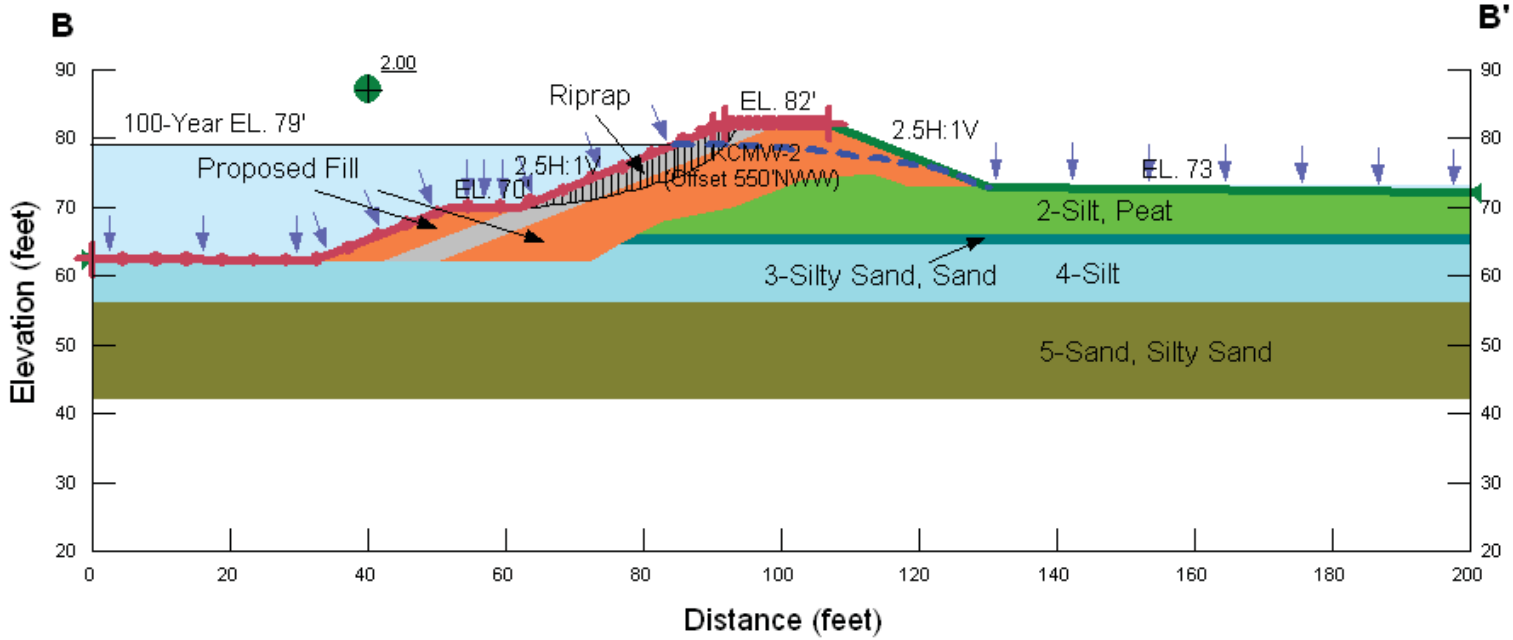



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Figure D6

**Slope Stability – Static, Steady State, River Side, Section BB'**

Job No. 33762798

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 2.19**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 50 Phi: 35
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: Riprap Model: Mohr-Coulomb Unit Weight: 140 Cohesion: 0 Phi: 40
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35

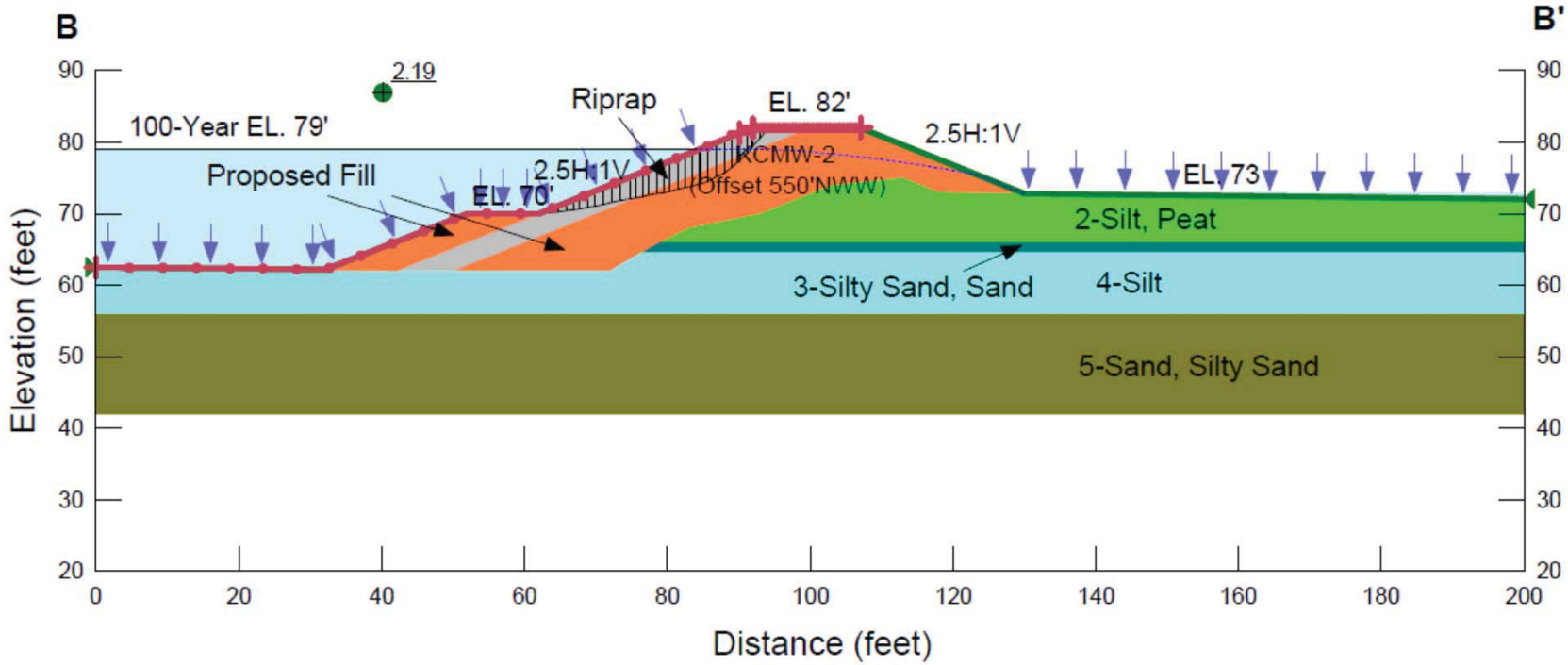


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Figure D6a

Job No. 33762798

**Slope Stability – Static, Steady State, River Side, Section BB'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.56**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: Riprap Model: Mohr-Coulomb Unit Weight: 140 Cohesion: 0 Phi: 40
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35

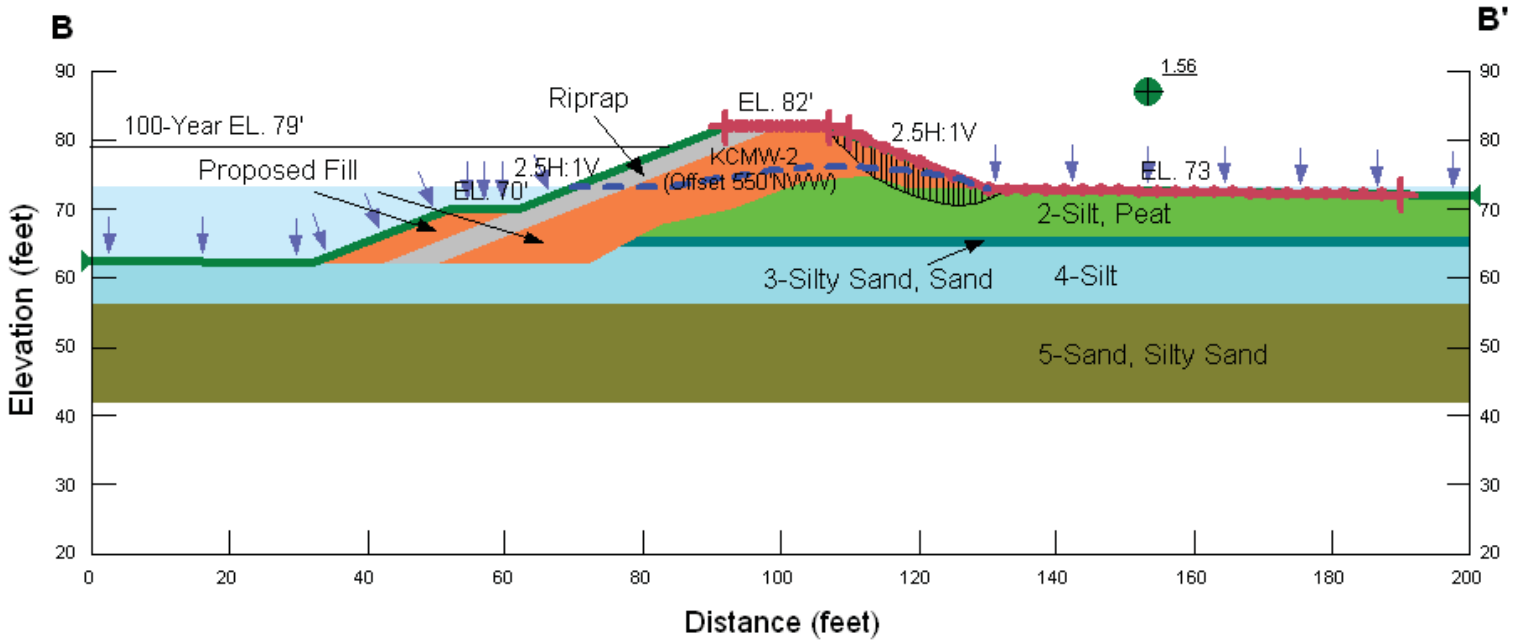


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Figure D7

Job No. 33762798

**Slope Stability – Static, Transient Seepage at 43200 Sec, Land Side, Section BB'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.91**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: Riprap Model: Mohr-Coulomb Unit Weight: 140 Cohesion: 0 Phi: 40
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35

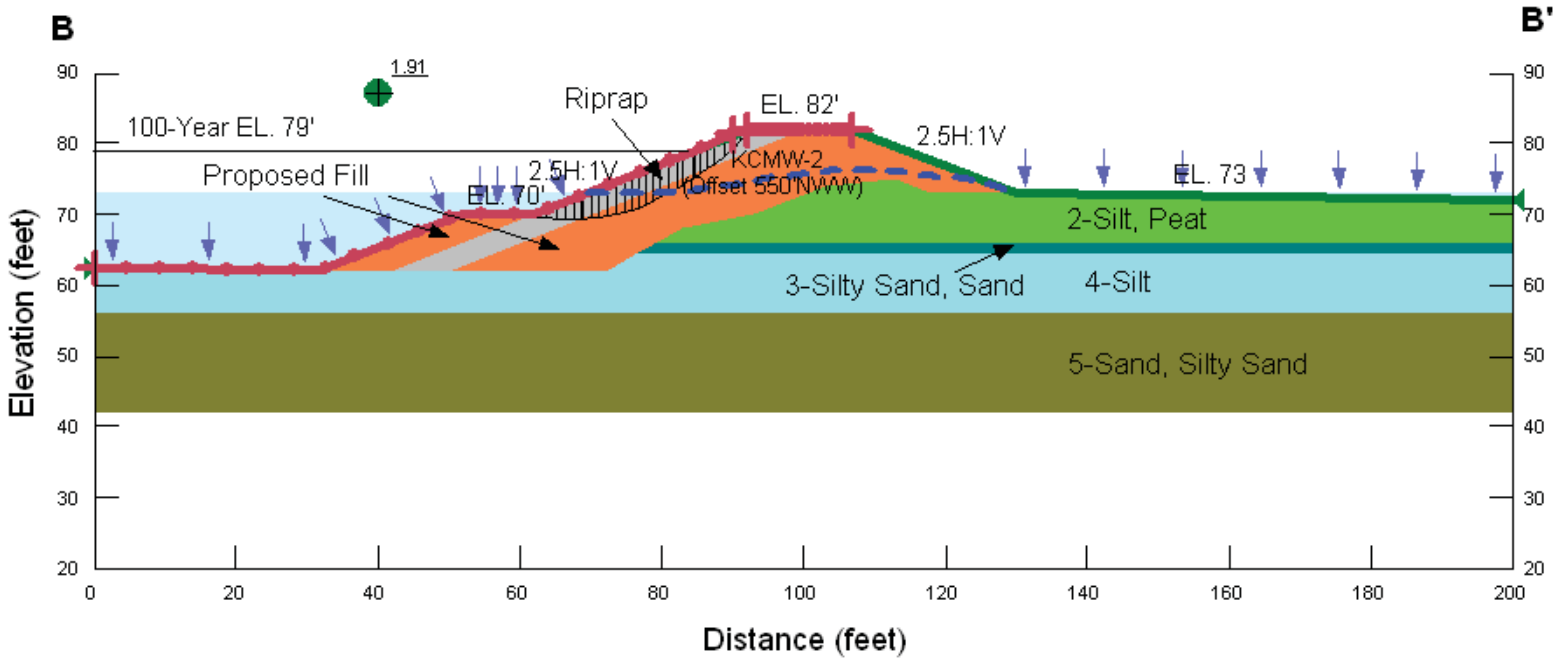


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Figure D8

Job No. 33762798

**Slope Stability – Static, Transient Seepage at 43200 Sec, River Side, Section BB'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.88**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

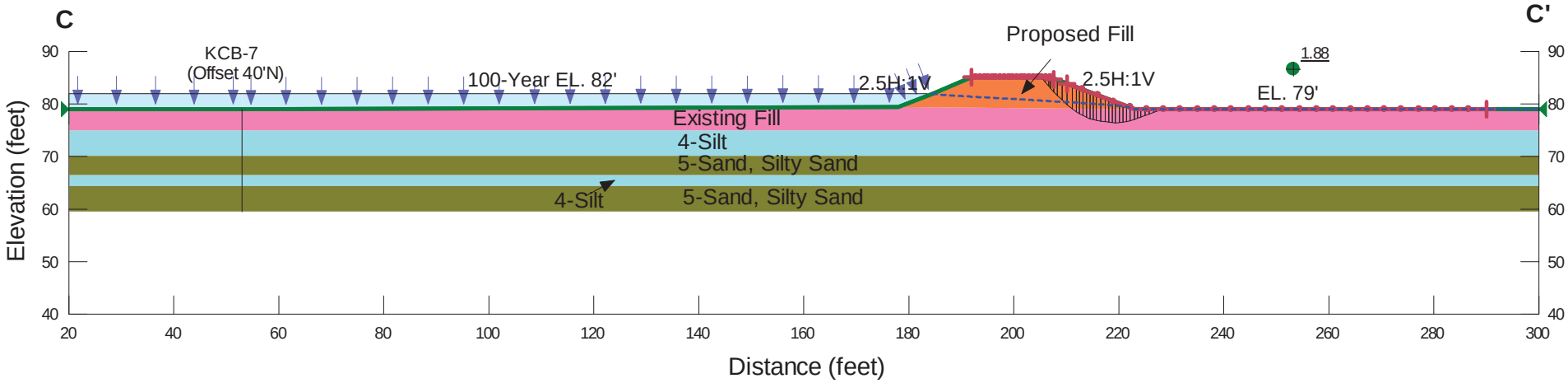


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Figure D9

Job No. 33762798

**Slope Stability – Static, Steady State, Land Side, Section CC'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 2.13**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

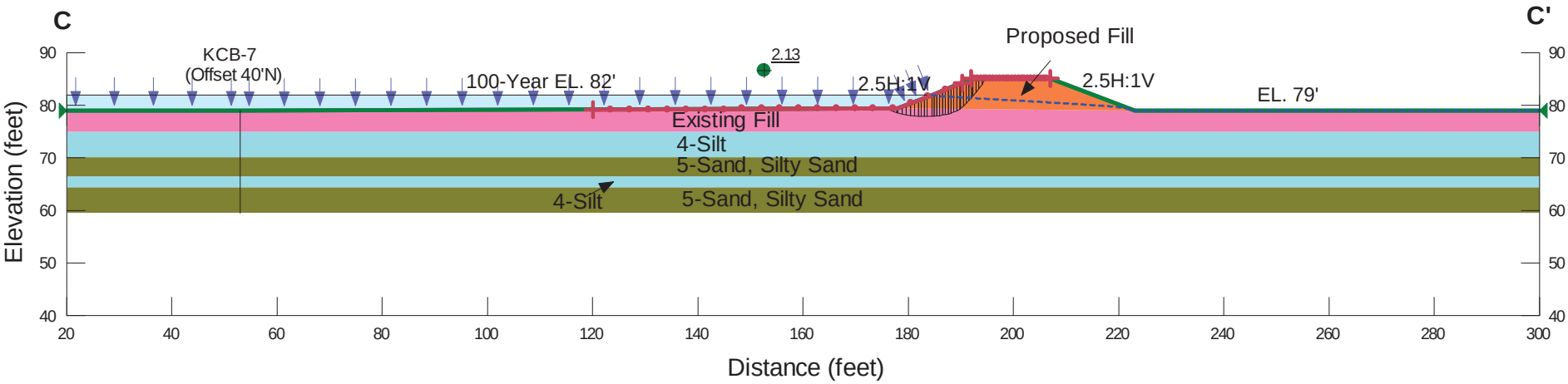


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Figure D10

Job No. 33762798

**Slope Stability – Static, Steady State, River Side, Section CC'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.91**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

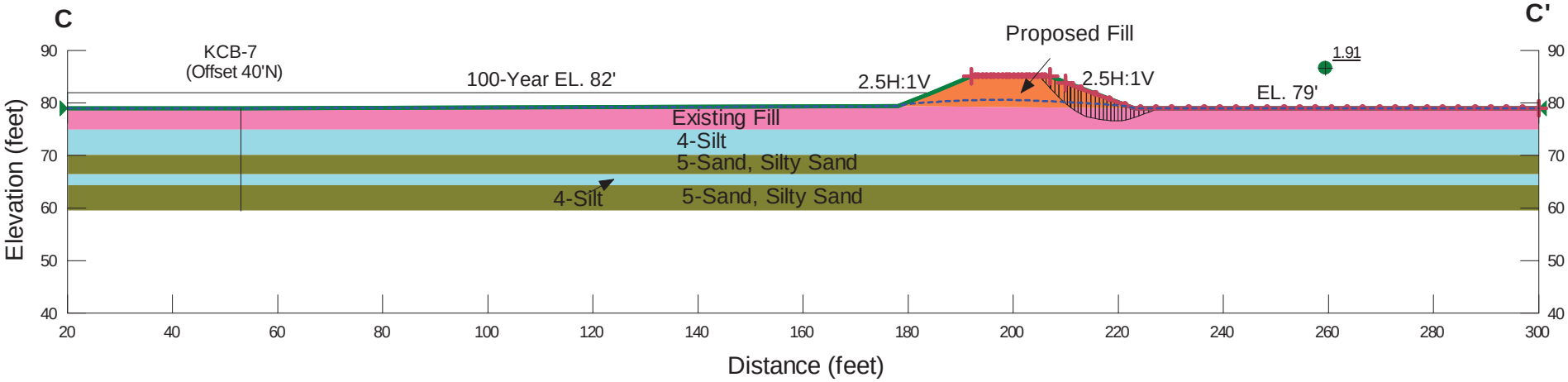


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Figure D11

Job No. 33762798

**Slope Stability – Static, Transient Seepage at 21600 Sec, Land Side, Section CC'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.90**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

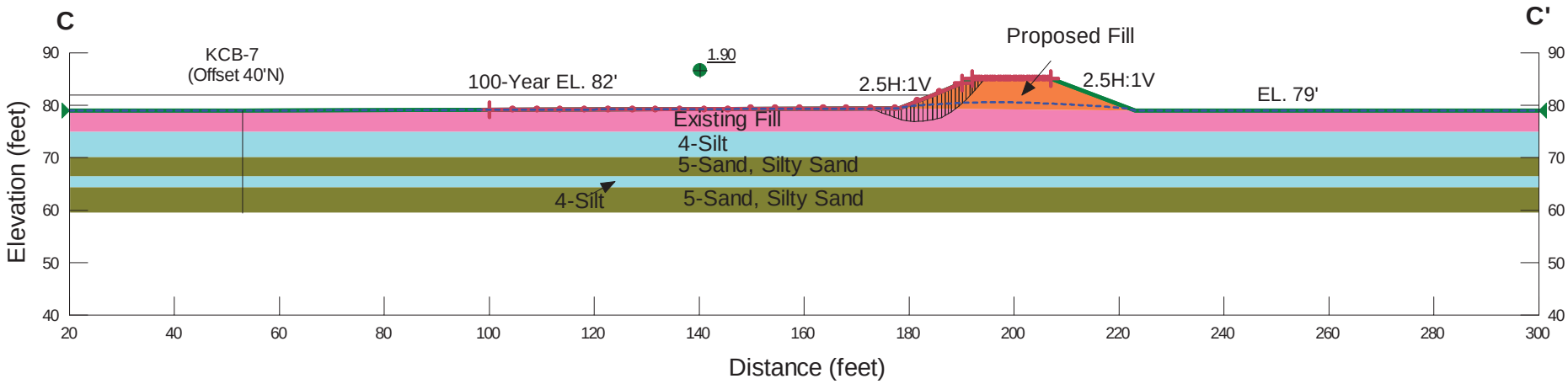


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Figure D12

Job No. 33762798

**Slope Stability – Static, Transient Seepage at 21600 Sec, River Side, Section CC'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.68**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

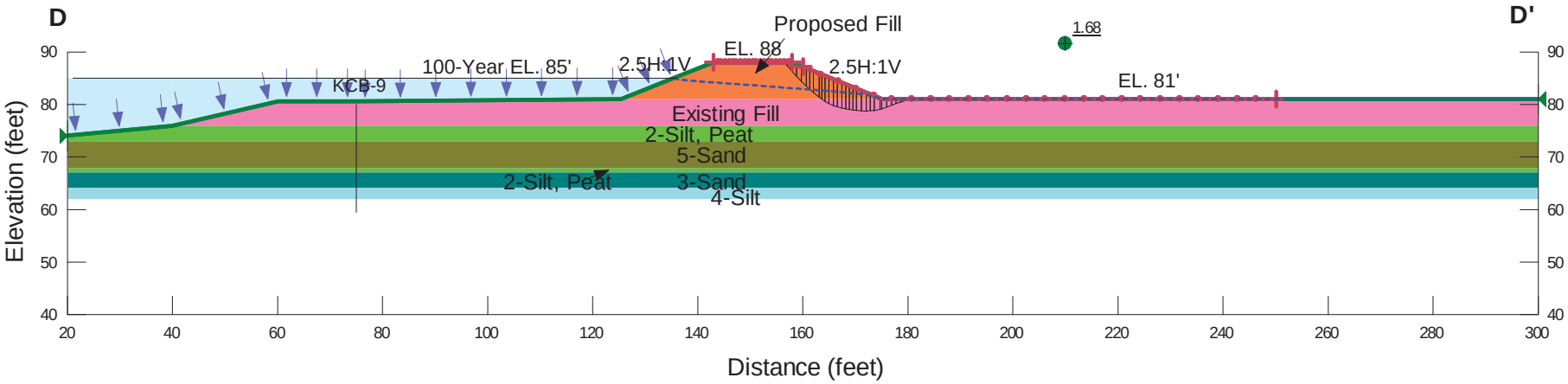


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Figure D13

Job No. 33762798

**Slope Stability – Static, Steady State, Land Side, Section DD'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 2.03**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

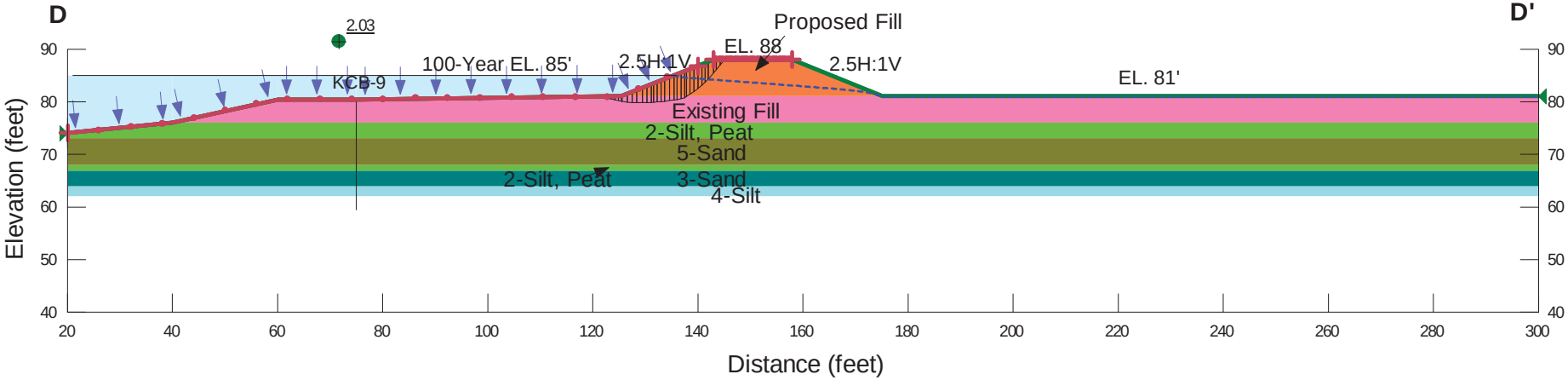


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Figure D14

Job No. 33762798

**Slope Stability – Static, Steady State, River Side, Section DD'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.74**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

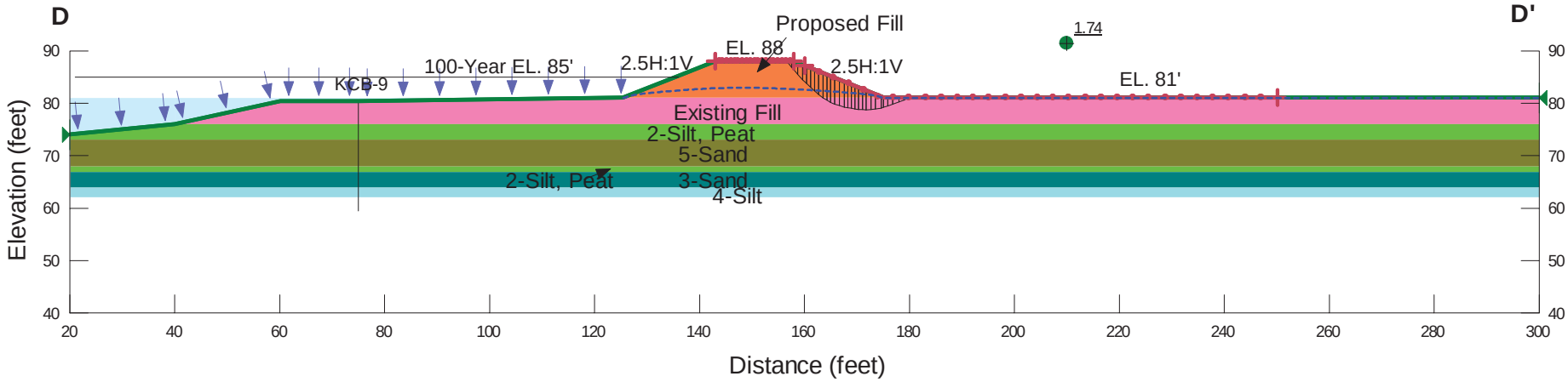


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Figure D15

Job No. 33762798

**Slope Stability – Static, Transient Seepage at 28800 Sec, Land Side, Section DD'**

URS

White River Countyline Levee Project
King County, Washington

**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.74**

Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 37
Name: 2-Silt,Peat Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 50 Phi: 28
Name: 3-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35
Name: 4-Silt Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 200 Phi: 30
Name: 5-Sand, Silty Sand Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 35
Name: 1-Existing Fill Model: Mohr-Coulomb Unit Weight: 128 Cohesion: 0 Phi: 33

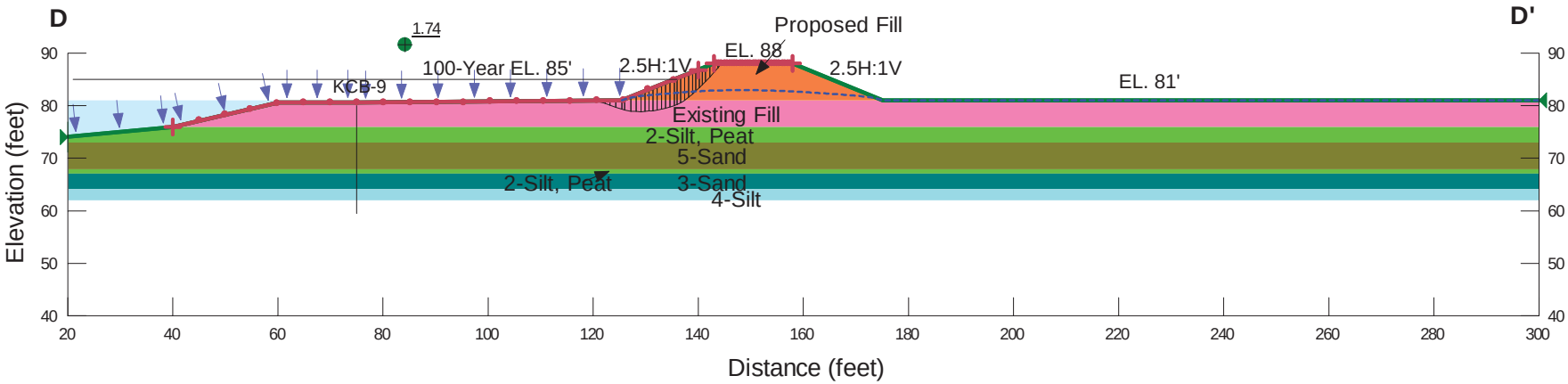


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Figure D16

Job No. 33762798

**Slope Stability – Static, Transient Seepage at 28800 Sec, River Side, Section DD'**

URS

White River Countyline Levee Project
King County, Washington

# Appendix E: Groundwater Analysis

Figure E-1: Groundwater Well Location Map

See Figure 2 for location of proposed setback levee and drill holes.

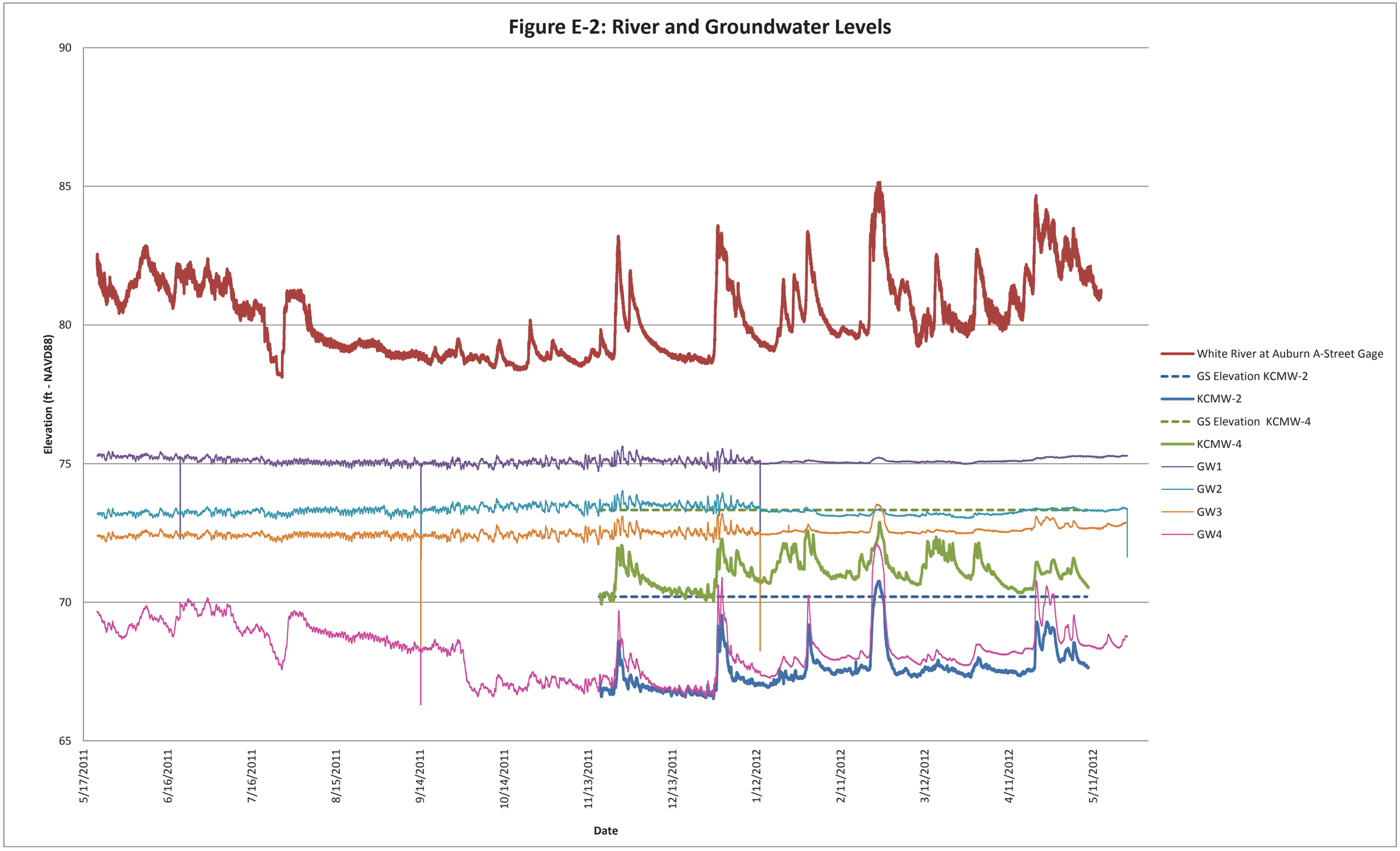


Figure E-2: River and Groundwater Levels
90
85
80
75
70
65
Elevation (ft - NAVD88)
5/17/2011
6/16/2011
7/16/2011
8/15/2011
9/14/2011
10/14/2011
11/13/2011
12/13/2011
1/12/2012
2/11/2012
3/12/2012
4/11/2012
5/11/2012
Date
White River at Auburn A-Street Gage
GS Elevation KCMW-2
KCMW-2
GS Elevation KCMW-4
KCMW-4
GW1
GW2
GW3
GW4

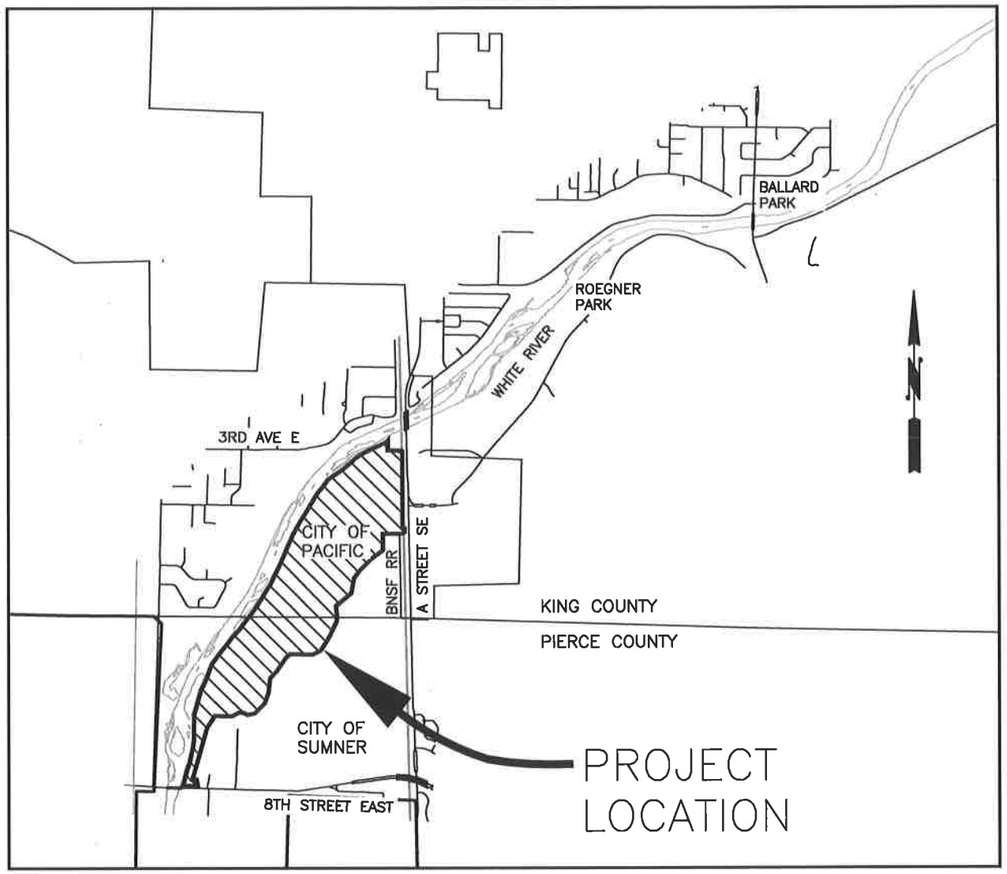
# APPENDIX I

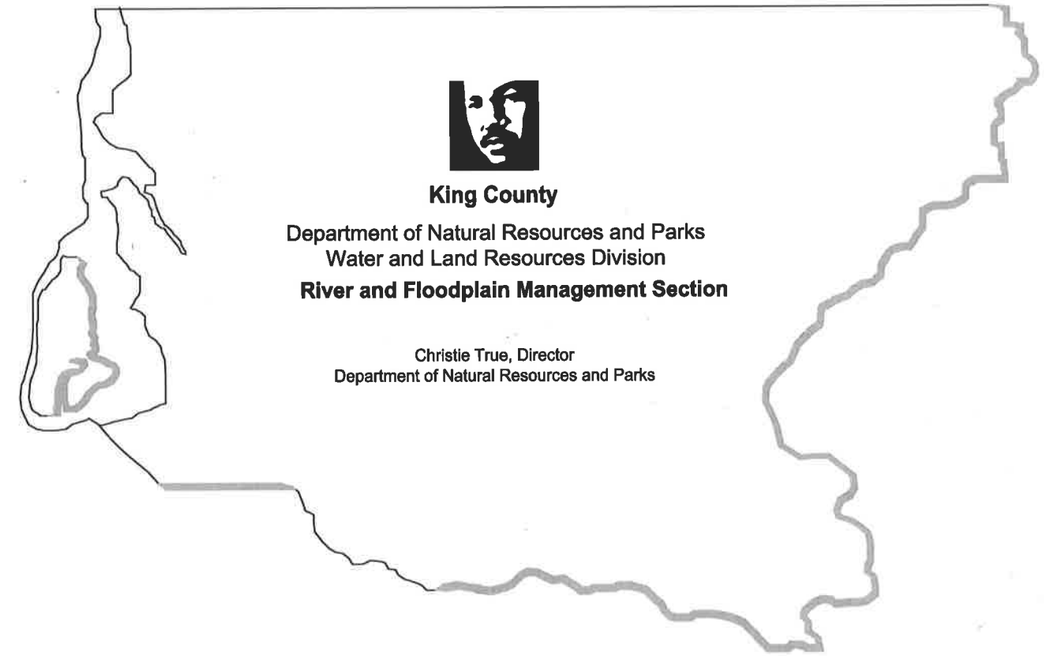
# Engineered Log Structures Design and Analysis Technical Memorandum

# APPENDIX J

# 60% Design Plans

VICINITY MAP



**King County**

Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**

Christie True, Director
Department of Natural Resources and Parks

# Countyline Levee Setback

## White River, River Mile 5.00-6.33

INDEX


| SHEET | DRAWING | DESCRIPTION |
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| 5 | GN5 | KEY SHEET |
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| 9–11 | SP1–SP3 | PROPOSED SITE PLAN |
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| 13 | TC2 | NORTH PERMANENT ACCESS PLAN |
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| 17 | ED1 | TESC DETAILS |
| 18 | ED2 | TESC DETAILS FOR ELJS 1, 2 AND 3 |
| 19 | ED3 | TESC DETAILS FOR ELJS 4 AND 5 |
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| 43–47 | LD1–LD5 | LEVEE EXCAVATION CROSS SECTIONS |
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| 51 | WD4 | SMALL APEX ELJ LAYERING PLAN |
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| 53 | WD6 | BANK DEFLECTOR ELJ LAYERING PLAN |
| 54 | WD7 | BIOREVETMENT PLAN AND SECTION |
| 55 | WD8 | BIOREVETMENT LAYERING PLAN |
| 56 | WD9 | FLOODPLAIN ROUGHENING DETAILS |
| 57 | WD10 | FLOODPLAIN ROUGHENING DETAILS |
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| 68–69 | LS7–LS8 | PLANTING DETAILS |


CALL 2 WORKING DAYS
BEFORE YOU DIG
1–800–424–5555
(UNDERGROUND UTILITY LOCATIONS ARE APPROX.)

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4–2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4–2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4–2013 |
| ECOLOGIST: | SARAH McCARTHY | 4–2013 |
| DESIGN ENTERED: | LICA DULAN | 4–2013 |

SRFB # RCO 087–1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER — STATE OF WASHINGTON — 20695 — REGISTERED PROFESSIONAL ENGINEER

JEANNE MARIE STYPULA — STATE OF WASHINGTON — 26602 — REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

COVER SHEET

SHEET 1 OF 69 SHEETS

GN1

## LINETYPES

| EXIST. | DESCRIPTION |
|---|---|
| SURFACE FEATURES: | |
| | BUILDING LINE (EXISTING) |
| | CREEK/DITCH CENTERLINE (EXIST.) |
| | CURB/PAVEMENT/SIDEWALK (EX) |
| | FENCE (EXISTING) |
| | GUARDRAIL (EXISTING) |
| | FLOODPLAIN BOUNDARY |
| FB | FLOODWAY BOUNDARY |
| | OPEN WATER |
| | INFILTRATION AREAS |
| WB | WETLAND PERIMETER |
| | WETLAND BUFFER |
| | RAILROAD |
| | RIVERBANK/SHORELINE |
| SJ | SHORELINE JURISDICTION |
| OHW | ORDINARY HIGH WATER |
| | STREAM |

## SURVEY:

| | |
|---|---|
| | CENTERLINE (EXISTING) |
| | MINOR CONTOUR (EXIST.) |
| 70 | MAJOR CONTOUR (EXIST.) |
| | MATCH LINE |
| ℄ | PROPERTY LINE (EXISTING) |
| | RIGHT-OF-WAY (CURRENT) |
| | STATE/COUNTY/CORPORATE LIMIT |
| ℄ | PROPERTY LINE (FUTURE) |

## UTILITIES (EXISTING):

| | |
|---|---|
| TV | CABLE TELEVISION |
| FM | FORCE MAIN |
| G | GAS |
| P | POWER (AERIAL) |
| P ABAN | ABANDONED POWER LINE |
| UG-P | POWER (BURIED) |
| SS | SANITARY SEWER |
| SD | STORM DRAINAGE |
| T | TELEPHONE (AERIAL) |
| UG-T | TELEPHONE (BURIED) |
| W | WATER |
| 6"G | GAS |
| 12"CMP | STORM DRAIN |

## LEGEND

| CONSTRUCT | DESCRIPTION |
|---|---|
| | CREEK/DITCH CENTERLINE |
| — X — X — X — X — X — | SILT FENCE |
| | CHAIN LINK FENCE |
| | EDGE OF OPEN WATER (APPROX.) |
| CLR | CLEARING LIMITS |
| | CENTERLINE |
| | MINOR CONTOUR (PROPOSED) |
| 70 | MAJOR CONTOURS (PROPOSED) |
| | SILT CURTAIN |
| | WORK AREA LIMITS |
| | IN-WATER WORK AREA ISOLATION |
| | LEVEE AND REVETMENT EXCAVATION |
| | ACCESS ROAD |
| | STAGING AREA |
| | ELJ ACCESS PATH AND WORK PLATFORM |
| | SETBACK LEVEE |
| | BANK DEFLECTOR ELJ |
| | LARGE APEX ELJ |
| | SMALL APEX ELJ |
| | BIOREVETMENT |
| | FLOODPLAIN ROUGHNING |
| | EX TREE |
| | EX TREE TO BE REMOVED |
| | RIPRAP TO BE REMOVED |

## GAS/POWER/TELEPHONE

| SYMBOL EXIST. | SYMBOL CONSTRUCT | DESCRIPTION |
|---|---|---|
| | | GAS METER |
| | | GAS VALVE |
| | | PAD MOUNTED TRANSFORMER |
| P | P | POWER VAULT |
| | | TRANSMISSION TOWER (SCALEABLE) |
| | | UTILITY POLE |
| | | POWER POLE |
| | | UTILITY POLE ANCHOR |
| | | TELEPHONE RISER |
| T | T | TELEPHONE VAULT |

## SURVEY

| SYMBOL | | DESCRIPTION |
|---|---|---|
| | | SOIL BORING |
| × | | SPOT ELEVATION |
| | | TAX LOT / PARCEL NUMBER |

## SOURCES OF TOPOGRAPHIC DATA

TOPOGRAPHY CREATED BY 3DI WEST OF EUGENE, OREGON
TOPOGRAPHY BASED UPON MARCH 2011 PHOTOGRAMMETRY (3DI WEST GEOTERRA INC.),
HORIZONTAL/VERTICAL CONTROL (MINISTER & GLAESER SURVEYING, INC. [MGS]), AIRBORNE
GPS (ORION GPS), AND GROUND AND BATHYMETRIC SURVEYS (MGS).
VERTICAL DATUM: NAVD 88, HORIZONTAL DATUM: NAD 83 / 91 (HARN)
COORDINATE SYSTEM: WASHINGTON STATE PLANE NORTH ZONE – US FEET

## DRAINAGE

| SYMBOL EXIST. | SYMBOL CONSTRUCT | DESCRIPTION |
|---|---|---|
| | | STORM DRAIN CATCH BASIN |
| | | STORM DRAIN INLET(NO CATCH) |
| | | STORM DRAIN CULVERT |
| | | STORM DRAIN MANHOLE |
| 25 L.F. 12" | | STORM PIPE(PROPOSED) DOUBLE LINE TO SIZE OF PIPE DIAMETER |

X — STRUCTURE DETAILS NO.
X-X — CALL OUT DESIGNATION
DWG NO.

CONTRACTOR SHALL VERIFY LOCATION AND DEPTHS OF ALL EXISTING UTILITIES PRIOR TO CONSTRUCTION

## WATER

| SYMBOL EXIST. | SYMBOL CONSTRUCT | DESCRIPTION |
|---|---|---|
| | | GUARD POST |
| FIRE HYDRANTS: | | |
| | | FH |
| | | WATER VALVE |

## ABBREVIATIONS

| | |
|---|---|
| ABAND | ABANDONED |
| AC | ASPHALT CONCRETE |
| ACP | ASPHALT CONCRETE PAVEMENT |
| ADJ | ADJUST |
| APPROX. | APPROXIMATELY |
| AVE | AVENUE |
| AVG | AVERAGE |
| BK | BACK |
| ℄ | BASELINE |
| BR | BIOREVETMENT |
| BLDG | BUILDING |
| BLVD | BOULEVARD |
| BM | BENCH MARK |
| BMP | BEST MANAGEMENT PRACTICE |
| BRG | BEARING |
| BTWN | BETWEEN |
| CB | CATCH BASIN |
| CL | CLASS |
| ℄ | CENTERLINE |
| CMP | CORRUGATED METAL PIPE |
| COMPT | COMPACTED |
| CONC | CONCRETE |
| CONST | CONSTRUCTION |
| CSTC | CRUSHED SURFACING TOP COURSE |
| CY | CUBIC YARD |
| DIAM | DIAMETER |
| DIST | DISTANCE |
| DWG | DRAWING |
| DWY | DRIVEWAY |
| E | EAST, ELECTRICAL |
| EA | EACH |
| EL | ELEVATION |
| ELEC | ELECTRICAL |
| ELJ | ENGINEERED LOG JAM |
| EMB | EMBANKMENT |
| EP | EDGE OF PAVEMENT |
| EXCL | EXCLUDE |
| EX | EXISTING |
| FB | FLOODWAY BOUNDARY |
| FH | FIRE HYDRANT |
| FT OR ' | FEET/FOOT |
| G | GAS LINE, GREEN |
| GALV | GALVANIZED |
| GB | GRADE BREAK |
| GR | GUARDRAIL |
| GRD | GROUND |
| GV | GAS VALVE |
| HORIZ | HORIZONTAL |
| HT | HEIGHT |
| HWY | HIGHWAY |
| ID | INSIDE DIAMETER |
| IE | INVERT ELEVATION |
| INV | INVERT |
| IN | INCH |
| L | LENGTH OF ARC |
| LF | LINEAL FOOT/FEET |
| LT | LEFT |
| LUMIN | LUMINAIRE |
| LW | LARGE WOOD |
| MAX | MAXIMUM |
| MH | MANHOLE |
| MIN | MINIMUM |
| MISC | MISCELLANEOUS |
| MON | MONUMENT |
| MUTCD | MANUAL ON UNIFORM TRAFFIC CONTROL DIVICES |
| N | NORTH |
| NO | NUMBER |
| NST | NOT STEEPER THAN |
| NTS | NOT TO SCALE |
| O-XING | OVERHEAD CROSSING |
| O.C. | ON CENTER |
| OD | OUTSIDE DIAMETER |
| OP | OVERHEAD POWER |
| OT | OVERHEAD TELEPHONE |
| P | POLE, POWER |
| PAV'T | PAVEMENT |
| PC | POINT OF CURVATURE |
| PCC | POINT OF COMPOUND CURVE |
| PED | PEDESTRIAN |
| PI | POINT OF INTERSECTION |
| ℄ | PROPERTY LINE |
| PP | POWER POLE |
| PRC | POINT OF REVERSE CURVE |
| PSI | POUND PER SQ IN |
| PT | POINT OF TANGENT |
| PVC | POLYVINYL CHLORIDE |
| PVCC | POINT OF VERTICAL COMPOUND CURVE |
| PVI | POINT OF VERTICAL INTERSECTION |
| PVRC | POINT OF VERTICAL REVERSE CURVE |
| QTY | QUANTITY |
| R | RADIUS |
| RD | ROAD |
| REINF | REINFORCED |
| REQ'D | REQUIRED |
| RT | RIGHT |
| R/W | RIGHT-OF-WAY |
| S | SOUTH/SLOPE |
| SAN | SANITARY |
| SCHED | SCHEDULE |
| SD | STORM DRAIN |
| SECT | SECTION |
| SF | SQUARE FEET/FOOT |
| SHLD | SHOULDER |
| SHT | SHEET |
| SJ | SHORELINE JURISDICTION |
| SPEC | SPECIAL |
| SPECS | SPECIFICATIONS |
| SQ | SQUARE |
| SR | STATE ROUTE |
| SS | SANITARY SEWER |
| ST | STREET |
| STA | STATION |
| S/W | SIDEWALK |
| T | TELEPHONE, TANGENT, TON |
| TAN | TANGENT |
| TBM | TEMPORARY BENCHMARK |
| TCE | TEMPORARY CONSTRUCTION EASEMENT |
| TEMP | TEMPORARY |
| TP | TELEPHONE POLE |
| TYP | TYPICAL |
| UD | UNDERDRAIN PIPE |
| UG | UNDERGROUND |
| VAR | VARIES |
| VC | VERTICAL CURVE |
| VERT. | VERTICAL |
| W | WEST, WATER |
| W/ | WITH |
| WBR | WETLAND BUFFER |
| WB | WETLAND BOUNDARY |
| WM | WATER METER |
| WM | WATERMAIN |
| W/O | WITHOUT |
| WV | WATER VALVE |
| WSE | WATER SURFACE ELEVATION |
| YDS | YARDS |
| & | AND |

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER — STATE OF WASHINGTON — 40695 — REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

LEGEND

SHEET 2 OF 69 SHEETS

GN2

## CONSTRUCTION SEQUENCE NOTES:

1. CONSTRUCTION WILL BE DIVIDED INTO TWO CONSTRUCTION YEARS. THIS PLAN SET DESCRIBES THE PROJECT AS CONSTRUCTED AT COMPLETION OF CONSTRUCTION YEAR 2. THE CONSTRUCTION SEQUENCING DESCRIBED HERE WILL BE REFINED AND MODIFIED FOR THE FINAL CONSTRUCTION DRAWINGS TO MEET PERMIT REQUIREMENTS, FLOOD PROTECTION NEEDS, AND CONSTRUCTABILITY GOALS. THE CONTRACTOR SHALL SUBMIT A DETAILED CONSTRUCTION SEQUENCING PLAN MEETING PERMIT, FLOOD PROTECTION, AND CONSTRUCTABILITY REQUIREMENTS.

2. WATER MANAGEMENT METHODS SHALL BE USED TO DIVERT FLOW, ISOLATE WORK AREAS, PUMP CONSTRUCTION WATER, ESTABLISH INFILTRATION AREAS, MANAGE CONSTRUCTION WATER STORAGE AND DISCHARGE, AND AVOID IMPACTS TO WATER QUALITY. WATER PUMPED FROM EXCAVATIONS SHALL BE PUMPED TO APPROVED INFILTRATION AREAS OR ON-SITE STORAGE TANKS. AT NO TIME SHALL CONSTRUCTION WATER BE DISCHARGED TO THE WHITE RIVER, WETLANDS, OR OTHER WATER BODIES. PRIOR TO CONSTRUCTION THE CONTRACTOR SHALL SUBMIT A WORK AREA ISOLATION AND CONSTRUCTION WATER MANAGEMENT PLAN ADDRESSING SITE-SPECIFIC TECHNIQUES AND METHODS FOR EACH PHASE OF WORK THAT IS CONSISTENT WITH THE CONSTRUCTION SEQUENCING PLAN.

3. THE EXISTING LEVEE SHALL REMAIN INTACT DURING THE WINTER SEASON BETWEEN CONSTRUCTION YEARS 1 AND 2 IN ORDER TO MAINTAIN THE EXISTING LEVEL OF FLOOD PROTECTION.

4. CONSTRUCTION YEAR 1 WILL INCLUDE CONSTRUCTION OF MOST INTERIOR PROJECT ELEMENTS, INCLUDING; ACCESS ROADS, SETBACK LEVEE, BIOREVETMENT, BANK ROUGHENING STRUCTURES, ELJs, REVEGETATION OF THE WETLAND BUFFER, AND RELOCATION OF UTILITIES. WORK IN YEAR 1 MAY ALSO INCLUDE LIMITED EXCAVATION OF THE LANDWARD EDGE OF THE EXISTING LEVEE PRISM (FOR RE-USE AS BACKFILL), CONSTRUCTION OF POTENTIAL FLOODPLAIN ROUGHENING STRUCTURES, REMOVAL OF THE EXISTING CULVERT, AND DEMOLITION. CONSTRUCTION OF ELJs MAY SPAN TWO CONSTRUCTION SEASONS DUE TO IN-WATER CONSTRUCTION WORK WINDOW PERMIT REQUIREMENTS.

5. YEAR 2 CONSTRUCTION WILL INCLUDE THE COMPLETION OF ELJ AND SETBACK LEVEE CONSTRUCTION NOT COMPLETED IN YEAR 1, THE REMOVAL OF THE EXISTING LEVEE AND RIPRAP REVETMENT, CULVERT REMOVAL AND CONSTRUCTION OF THE OUTLET CHANNEL, ADDITIONAL REVEGETATION OF THE WETLAND BUFFER, AND RESTORATION ACTIVITIES NEEDED TO COMPLETE THE WORK.

## EROSION AND SEDIMENTATION CONTROL NOTES:

1. THE BOUNDARIES OF WORK AREA LIMITS SHOWN ON THIS PLAN SHALL BE CLEARLY FLAGGED BY SURVEY TAPE OR FENCING PRIOR TO CONSTRUCTION. TREES TO BE LEFT UNDISTURBED OR SALVAGED SHALL BE TAGGED AND MARKED PRIOR TO CONSTRUCTION DURING THE CONSTRUCTION PERIOD, NO DISTURBANCE BEYOND THE WORK AREA LIMITS SHALL BE PERMITTED. THE WORK AREA SHALL BE MAINTAINED BY THE CONTRACTOR FOR THE DURATION OF CONSTRUCTION, INCLUDING PERIODS OF WORK STOPPAGE BETWEEN CONSTRUCTION YEARS 1 AND 2.

2. STABILIZED CONSTRUCTION ENTRANCES SHALL BE INSTALLED AT THE BEGINNING OF CONSTRUCTION AND MAINTAINED FOR THE DURATION OF THE PROJECT. ADDITIONAL MEASURES, SUCH AS CONSTRUCTED WHEEL WASH SYSTEMS OR WASH PADS, MAY BE REQUIRED TO ENSURE THAT ALL PAVED AREAS ARE KEPT CLEAN AND TRACK OUT TO ROAD RIGHT OF WAY DOES NOT OCCUR FOR THE DURATION OF THE PROJECT.

3. THE EROSION AND SEDIMENTATION CONTROL FACILITIES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. EROSION AND SEDIMENT CONTROL FOR IN-WATER WORK ELEMENTS INCLUDING LEVEE EXCAVATION, OUTLET CHANNEL EXCAVATION, BIOREVETMENT, FLOODPLAIN ROUGHENING, AND ELJ's WILL BE REFINED FOR THE FINAL CONSTRUCTION DRAWINGS. THESE FACILITIES SHALL BE UPGRADED AS NEEDED FOR UNEXPECTED STORM EVENTS AND MODIFIED TO ACCOUNT FOR CHANGING SITE CONDITIONS (E.G. ADDITIONAL COVER MEASURES, RELOCATION OF DITCHES AND SILT FENCES, PERIMETER PROTECTION, ETC.) AS DIRECTED BY THE PROJECT REPRESENTATIVE.

4. ANY AREAS OF EXPOSED SOILS, INCLUDING ROADWAY EMBANKMENTS, THAT WILL NOT BE DISTURBED FOR TWO CONSECUTIVE DAYS DURING THE WET SEASON OR SEVEN (7) DAYS DURING THE DRY SEASON SHALL BE IMMEDIATELY STABILIZED WITH THE APPROVED ESC METHODS (E.G., SEEDING, MULCHING, PLASTIC COVERING, ETC.)

5. ANY AREA NEEDING ESC MEASURES THAT DO NOT REQUIRE IMMEDIATE ATTENTION SHALL BE ADDRESSED WITHIN SEVEN (7) DAYS.

6. THE ESC FACILITIES ON INACTIVE SITES SHALL BE INSPECTED AND MAINTAINED A MINIMUM OF ONCE A MONTH DURING THE DRY SEASON, BI-MONTHLY DURING THE WET SEASON, OR WITHIN TWENTY FOUR (24) HOURS FOLLOWING A STORM EVENT.

7. COVER MEASURES WILL BE APPLIED IN CONFORMANCE WITH APPENDIX D OF THE KING COUNTY SURFACE WATER DESIGN MANUAL.

8. PRIOR TO THE BEGINNING OF THE WET SEASON (OCT. 1) ALL DISTURBED AREAS SHALL BE REVIEWED TO IDENTIFY WHICH ONES CAN BE SEEDED IN PREPARATION FOR WINTER RAINS. DISTURBED AREAS SHALL BE SEEDED WITHIN ONE WEEK OF THE BEGINNING OF THE WET SEASON. A SKETCH MAP OF THOSE AREAS TO BE SEEDED AND THOSE AREAS TO REMAIN UNCOVERED SHALL BE SUBMITTED BY THE CONTRACTOR.

## CONSTRUCTION GENERAL NOTES:

1. THE WORK INCLUDES THE CONSTRUCTION OF ENGINEERED LOGJAMS (ELJs), LOG BIOREVETMENT, AND SETBACK LEVEE; THE REMOVAL OF AN EXISTING LEVEE; DEMOLITION; AND REVEGETATION. THE PROJECT ELEMENTS SHOWN ON THE PLANS ARE APPROXIMATE. ACTUAL LOCATIONS, ORIENTATION, AND DIMENSIONS WILL BE REFINED FOR FINAL CONSTRUCTION DRAWINGS BASED ON FURTHER ANALYSES, PERMIT REQUIREMENTS, AND CONSTRUCTABILITY REVIEW.

2. THE WORK SHOWN ON THE PLANS SHALL BE SEQUENCED AND PERFORMED IN A MANNER THAT MINIMIZES IMPACTS TO SURFACE WATERS, EXISTING VEGETATION, THE WORK SITE, AND ADJACENT PRIVATE PROPERTY AND PUBLIC INFRASTRUCTURE.

3. THE OWNER MAY DECIDE HOW TO SEQUENCE THE WORK. THIS PROJECT WILL BE CONSTRAINED BY AN IN-WATER WORK WINDOW SET FORTH IN THE PROJECT HPA PERMIT AND THE 404 PERMIT, OUTSIDE OF WHICH NO IN-WATER WORK MAY OCCUR.

4. THE CONTRACTOR SHALL STAKE FOR APPROVAL BY THE PROJECT REPRESENTATIVE PRIOR TO INITIATING CONSTRUCTION ACTIVITIES, THE LOCATIONS OF EACH ELJ STRUCTURE INCLUDING LENGTHS, WIDTHS, ORIENTATION, AND ELEVATIONS; TEMPORARY CONSTRUCTION ACCESS ROADS; TEMPORARY WATER MANAGEMENT FACILITIES; AND ALL GRADING/EXCAVATION EXTENTS.

5. THE CONTRACTOR SHALL STAKE CLEARING LIMITS FOR APPROVAL BY THE PROJECT REPRESENTATIVE AT LEAST 5 WORKING DAYS PRIOR TO COMMENCING CLEARING ACTIVITIES. CLEARING LIMITS FOR CONSTRUCTION SHALL BE LIMITED TO THE AREA REQUIRED FOR SAFE EQUIPMENT OPERATION AND TO MINIMIZE THE AREA OF DISTURBANCE. CLEARING LIMITS SHALL NOT BE EXPANDED UNLESS APPROVED IN WRITING BY THE OWNER OR ENGINEER.

6. TREES AND BRUSH NOT SHOWN ON THE DRAWINGS WILL BE ENCOUNTERED DURING CONSTRUCTION ACTIVITIES. THE OWNER SHALL IDENTIFY AND FLAG ALL TREES TO BE PROTECTED FROM DAMAGE PRIOR TO CONSTRUCTION. FOLLOWING CLEARING OF ALLOWED VEGETATION, THE CONTRACTOR SHALL STOCKPILE ALL TREES AND BRUSH IDENTIFIED BY THE PROJECT REPRESENTATIVE, PRIOR TO AND DURING CONSTRUCTION ACTIVITIES, FOR USE AS RACKING AND SLASH MATERIALS IN THE ELJ STRUCTURES, FOR USE IN AREAS AS SHOWN ON THE DRAWINGS, AND AS DIRECTED BY THE OWNER OR ENGINEER TO CREATE ROUGH FINISHED GRADED SURFACES. CERTAIN VEGETATION MAY BE FLAGGED BY THE PROJECT REPRESENTATIVE FOR SALVAGE, AND CARE SHALL BE TAKEN TO PROTECT THOSE PLANTS FROM DISTURBANCE DURING CONSTRUCTION. NOXIOUS WEEDS AND OTHER VEGETATION UNSUITABLE FOR SALVAGE AND REUSE SHALL BE SEGREGATED AS DIRECTED BY THE PROJECT REPRESENTATIVE AND HAULED OFF-SITE FOR PROPER DISPOSAL.

7. ALTERATION OR DISTURBANCE OF THE CHANNEL, FLOODPLAIN, AND ANY BANK AND FLOODPLAIN VEGETATION SHALL BE MINIMIZED TO THAT NECESSARY TO CONSTRUCT THE PROJECT. THE CONTRACTOR SHALL KEEP DISTURBED AREAS WITHIN THE WORK AREA LIMITS SHOWN ON THE DRAWINGS, AND SHALL NOT EXTEND THESE LIMITS UNLESS APPROVED BY THE PROJECT REPRESENTATIVE.

8. THE CONTRACTOR SHALL PROVIDE 24 HOURS ADVANCE NOTICE TO THE PROJECT REPRESENTATIVE PRIOR TO ANY REQUIRED INSPECTION.

9. CONSTRUCTION MATERIAL AND EQUIPMENT STAGING AREAS SHALL BE LOCATED AS SHOWN OR DESCRIBED ON THE DRAWINGS. CONSTRUCTION MATERIALS AND EQUIPMENT SHALL NOT BE STORED OUTSIDE OF IDENTIFIED STAGING AREAS UNLESS APPROVED BY THE PROJECT REPRESENTATIVE. THE CONTRACTOR SHALL PROTECT ALL CONSTRUCTION MATERIALS AND EQUIPMENT FROM DAMAGE AT ALL TIMES

10. NO EQUIPMENT SHALL BE STORED AT ANY TIME BELOW THE ORDINARY HIGH WATER (OHW) LINE.

11. EQUIPMENT USED FOR THIS PROJECT SHALL BE FREE OF EXTERNAL PETROLEUM-BASED PRODUCTS WHILE WORKING NEAR ANY SURFACE WATER OR WETLANDS. ACCUMULATION OF SOILS OR DEBRIS SHALL BE REMOVED FROM THE DRIVE MECHANISMS (WHEELS, TRACKS, TIRES, ETC.) AND UNDERCARRIAGE OF EQUIPMENT PRIOR TO ITS WORKING BELOW THE OHW LINE.

12. ALL EQUIPMENT OPERATING IN AREAS OTHER THAN EXISTING UNIMPROVED ACCESS ROADS SHALL USE ONLY BIODEGRADABLE, VEGETABLE-BASED HYDRAULIC FLUIDS OR APPROVED OTHER.

13. EQUIPMENT SHALL BE CHECKED AT THE BEGINNING OF EACH WORK SHIFT FOR LEAKS, AND ANY NECESSARY REPAIRS SHALL BE COMPLETED PRIOR TO COMMENCING WORK ACTIVITIES.

14. THE CONTRACTOR IS RESPONSIBLE TO ENSURE THAT NO PETROLEUM PRODUCTS, HYDRAULIC FLUID, SEDIMENTS, SEDIMENT-LADEN WATER, CHEMICALS, OR ANY OTHER TOXIC OR DELETERIOUS MATERIALS ARE ALLOWED TO ENTER OR LEACH FROM EQUIPMENT OR SUPPLIES USED DURING CONSTRUCTION INTO THE PROJECT SITE OR ADJACENT WETLANDS AND OTHER ENVIRONMENTALLY SENSITIVE AREAS.

15. CONTRACTOR SHALL LIMIT MACHINERY MOVEMENT TO THE PROJECT CONSTRUCTION LIMITS DEFINED ON THE DRAWINGS OR IDENTIFIED AS ACCEPTABLE BY THE PROJECT REPRESENTATIVE.

16. IF AT ANY TIME, AS A RESULT OF PROJECT ACTIVITIES, FISH ARE OBSERVED IN DISTRESS, A FISH KILL OCCURS, OR WATER QUALITY PROBLEMS DEVELOP (INCLUDING EQUIPMENT LEAKS OR SPILLS), OPERATIONS SHALL CEASE AND THE OWNER SHALL BE NOTIFIED IMMEDIATELY. WASHINGTON DEPARTMENT OF FISH AND WILDLIFE AND WASHINGTON STATE DEPARTMENT OF ECOLOGY SHALL BE CONTACTED IMMEDIATELY BY THE PROJECT REPRESENTATIVE. WORK SHALL NOT RESUME UNTIL FURTHER APPROVAL BY THE OWNER.

17. WOOD MATERIAL USED FOR CONSTRUCTING ELJs, THE BIOREVETMENT, AND FLOODPLAIN ROUGHING STRUCTURES SHALL BE DECKED IN THE STAGING AREAS FOR INSPECTION BY THE PROJECT REPRESENTATIVE AND ORGANIZED BY LOG TYPE, DIAMETER AND LENGTH. LOG TYPE IDENTIFICATION SHALL BE PAINTED ON ALL LOGS WITH LEAD-FREE, BLAZE-ORANGE SURVEY MARKING PAINT AND BE VISIBLE FOR INSPECTION BY THE PROJECT REPRESENTATIVE PRIOR TO PLACEMENT WITHIN THE ENGINEERED LOG STRUCTURES.

**DEWATERING NOTES:**

1. THE DEWATERING PLAN AND NOTES WILL BE DEVELOPED FOR THE FINAL CONSTRUCTION PLANS TO MEET LOCAL, STATE, AND FEDERAL PERMIT REQUIREMENTS.

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

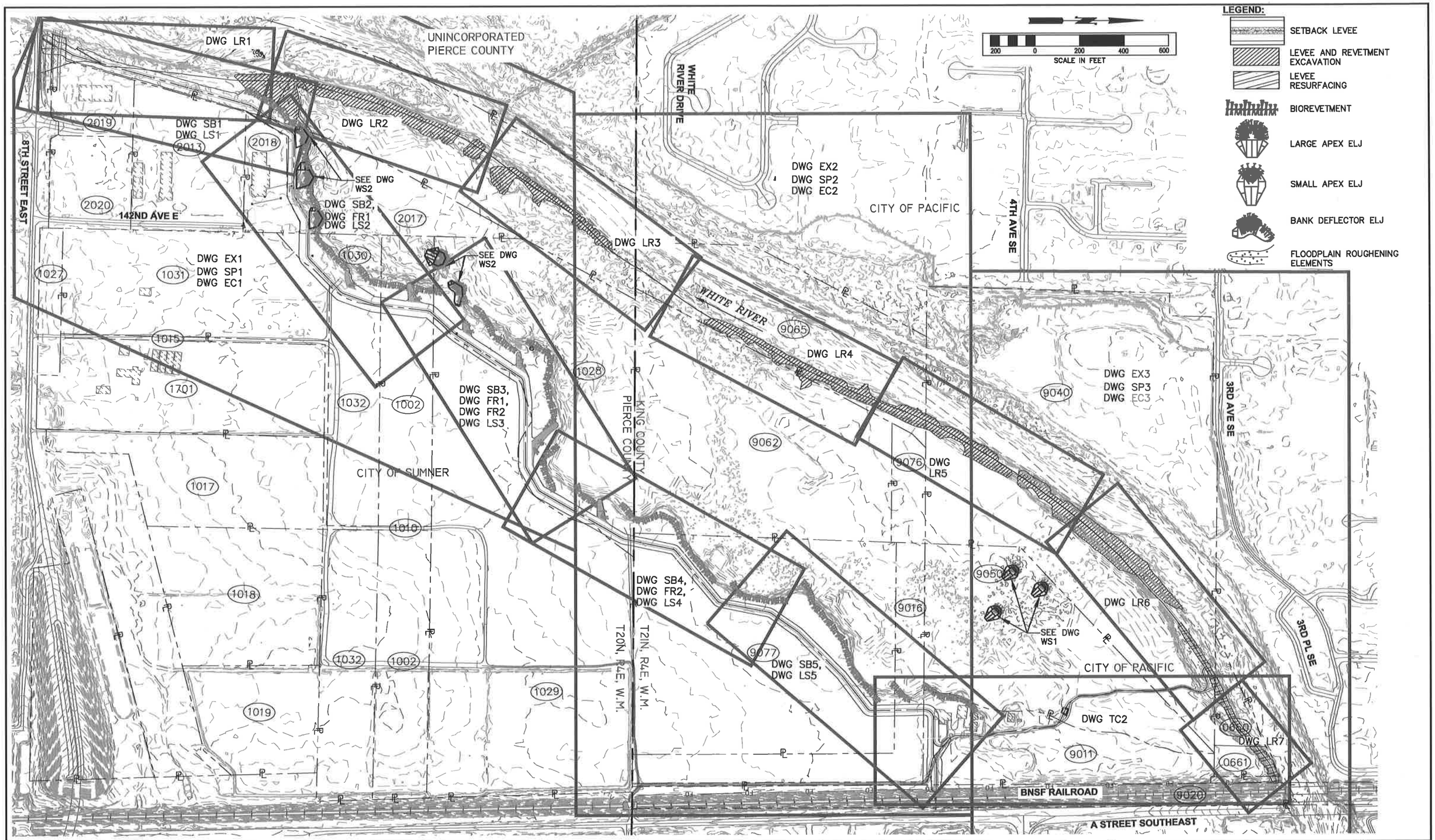
CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40885 REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION
CONSTRUCTION NOTES

SHEET 4 OF 69 SHEETS

GN4




| | | | | |
|---|---|---|---|---|
| FIELD BOOK: | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C | |
| SURVEYED: | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) | |
| SURVEY BASE MAP: | DESIGNED: CHRIS BRUMMER, PE | 4-2013 | | |
| CHECKED: | ECOLOGIST: SARAH McCARTHY | 4-2013 | | |
| | DESIGN ENTERED: LICA DULAN | 4-2013 | | |

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

CHRISTOPHER JON BRUMMER, STATE OF WASHINGTON, 40855, REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

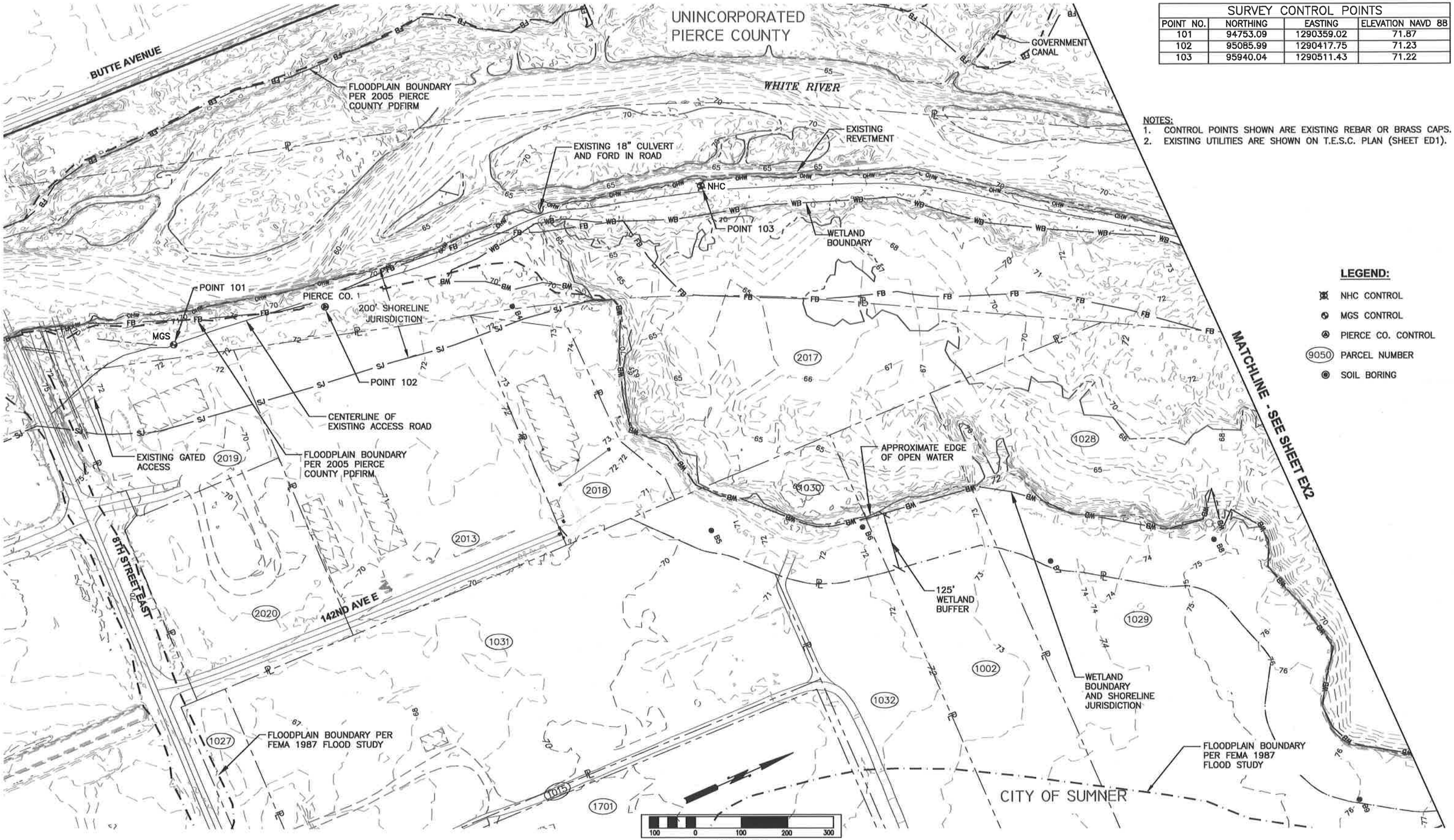
KEY SHEET

SHEET 5 OF 69 SHEETS

GN5

| SURVEY CONTROL POINTS | | | |
|---|---|---|---|
| POINT NO. | NORTHING | EASTING | ELEVATION NAVD 88 |
| 101 | 94753.09 | 1290359.02 | 71.87 |
| 102 | 95085.99 | 1290417.75 | 71.23 |
| 103 | 95940.04 | 1290511.43 | 71.22 |

NOTES:
1. CONTROL POINTS SHOWN ARE EXISTING REBAR OR BRASS CAPS.
2. EXISTING UTILITIES ARE SHOWN ON T.E.S.C. PLAN (SHEET ED1).




**LEGEND:**

- NHC CONTROL
- MGS CONTROL
- PIERCE CO. CONTROL
- (9050) PARCEL NUMBER
- SOIL BORING

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60% 5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40695 REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

EXISTING SITE PLAN AND SURVEY CONTROL

SHEET 6 OF 69 SHEETS

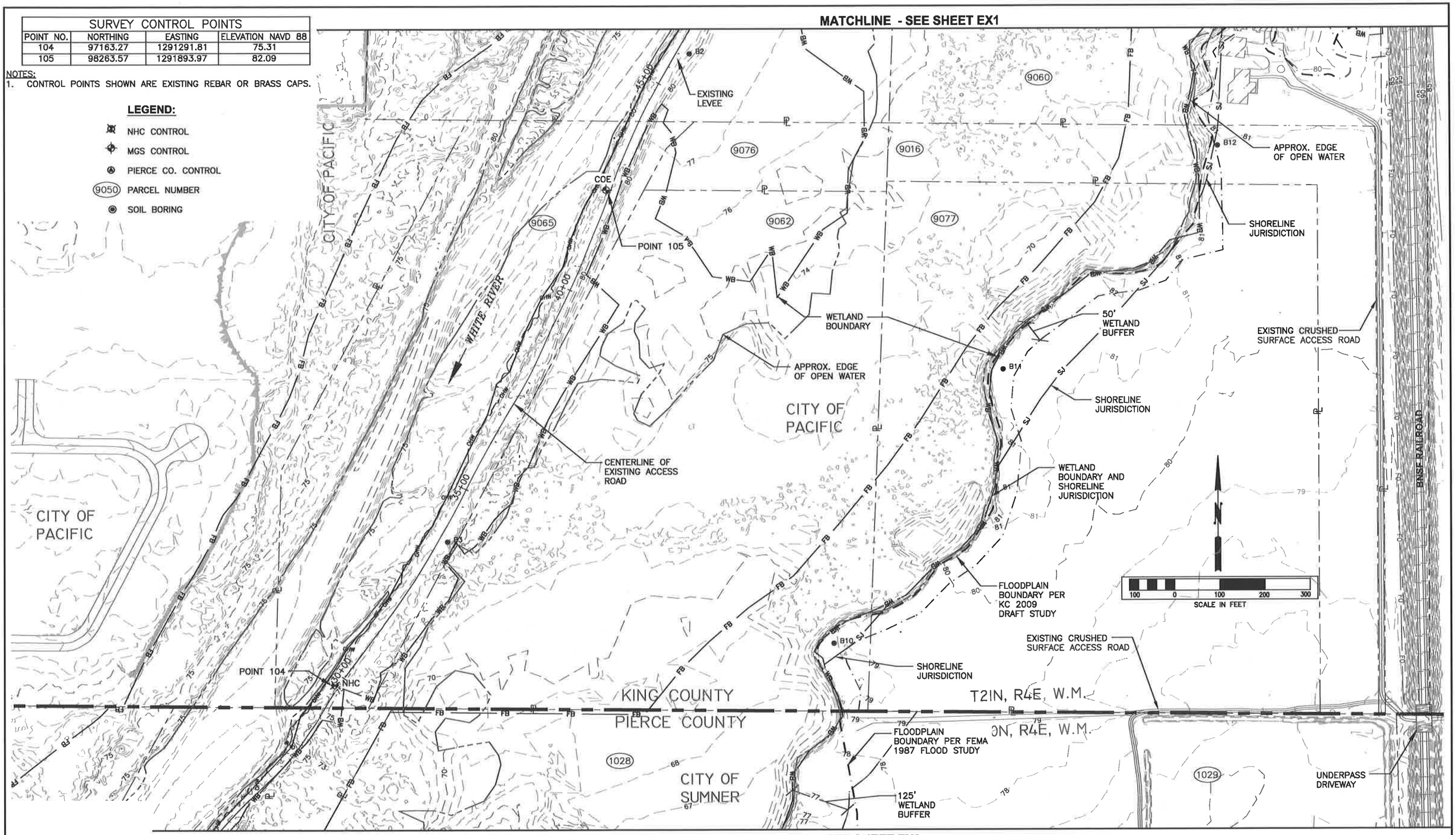
EX1

| SURVEY CONTROL POINTS | | | |
|---|---|---|---|
| POINT NO. | NORTHING | EASTING | ELEVATION NAVD 88 |
| 104 | 97163.27 | 1291291.81 | 75.31 |
| 105 | 98263.57 | 1291893.97 | 82.09 |

NOTES:
1. CONTROL POINTS SHOWN ARE EXISTING REBAR OR BRASS CAPS.

**LEGEND:**

- NHC CONTROL
- MGS CONTROL
- PIERCE CO. CONTROL
- (9050) PARCEL NUMBER
- SOIL BORING




FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
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| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER, STATE OF WASHINGTON, 40993, REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

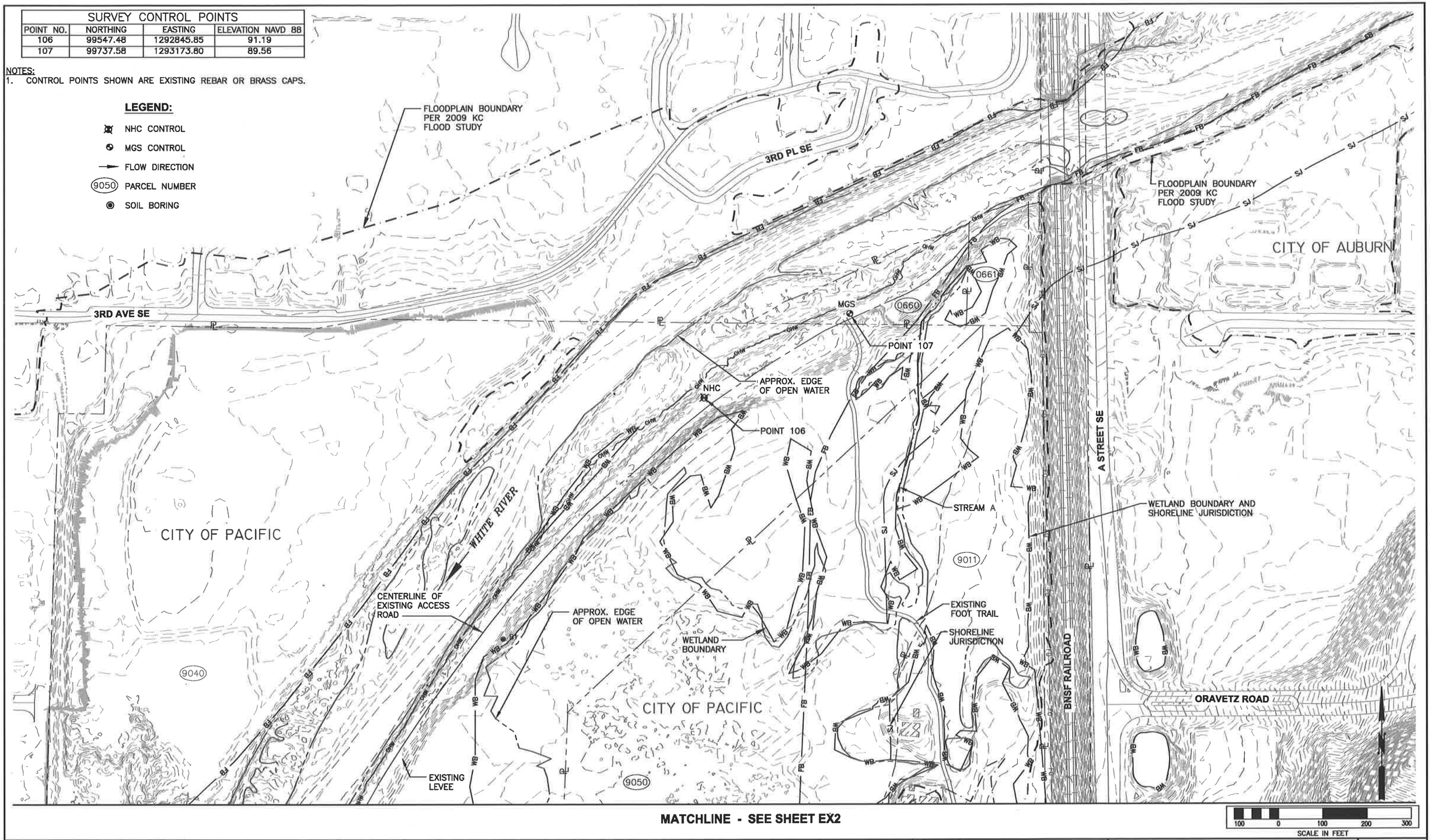
EXISTING SITE PLAN AND SURVEY CONTROL

SHEET 7 OF 69 SHEETS

EX2

| SURVEY CONTROL POINTS | | | |
|---|---|---|---|
| POINT NO. | NORTHING | EASTING | ELEVATION NAVD 88 |
| 106 | 99547.48 | 1292845.85 | 91.19 |
| 107 | 99737.58 | 1293173.80 | 89.56 |

NOTES:
1. CONTROL POINTS SHOWN ARE EXISTING REBAR OR BRASS CAPS.

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| NUM. | REVISION | BY | DATE |
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| | CADD / 60% 5-2013 | | |

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|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER, STATE OF WASHINGTON, 40693, REGISTERED PROFESSIONAL ENGINEER

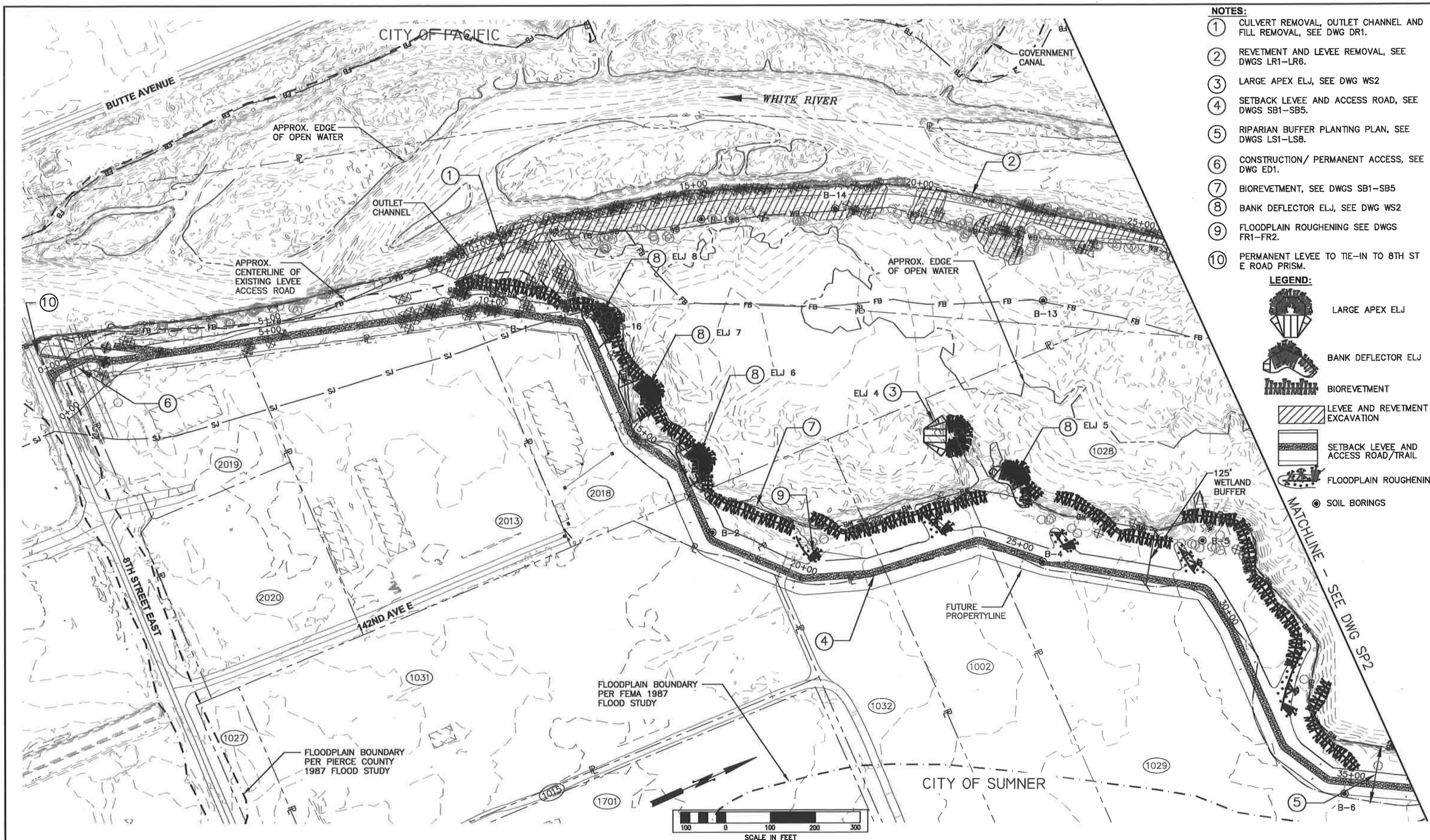
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

EXISTING SITE PLAN AND SURVEY CONTROL

SHEET 8 OF 69 SHEETS

EX3




**NOTES:**

1. CULVERT REMOVAL, OUTLET CHANNEL AND FILL REMOVAL, SEE DWG DR1.
2. REVETMENT AND LEVEE REMOVAL, SEE DWGS LR1–LR6.
3. LARGE APEX ELJ, SEE DWG WS2
4. SETBACK LEVEE AND ACCESS ROAD, SEE DWGS SB1–SB5.
5. RIPARIAN BUFFER PLANTING PLAN, SEE DWGS LS1–LS8.
6. CONSTRUCTION/ PERMANENT ACCESS, SEE DWG ED1.
7. BIOREVETMENT, SEE DWGS SB1–SB5
8. BANK DEFLECTOR ELJ, SEE DWG WS2
9. FLOODPLAIN ROUGHENING SEE DWGS FR1–FR2.
10. PERMANENT LEVEE TO TIE-IN TO 8TH ST E ROAD PRISM.

**LEGEND:**

- LARGE APEX ELJ
- BANK DEFLECTOR ELJ
- BIOREVETMENT
- LEVEE AND REVETMENT EXCAVATION
- SETBACK LEVEE AND ACCESS ROAD/TRAIL
- FLOODPLAIN ROUGHENING
- SOIL BORINGS

FIELD BOOK:
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| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER, STATE OF WASHINGTON, 40895, REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

PROPOSED SITE PLAN

SHEET 9 OF 69 SHEETS

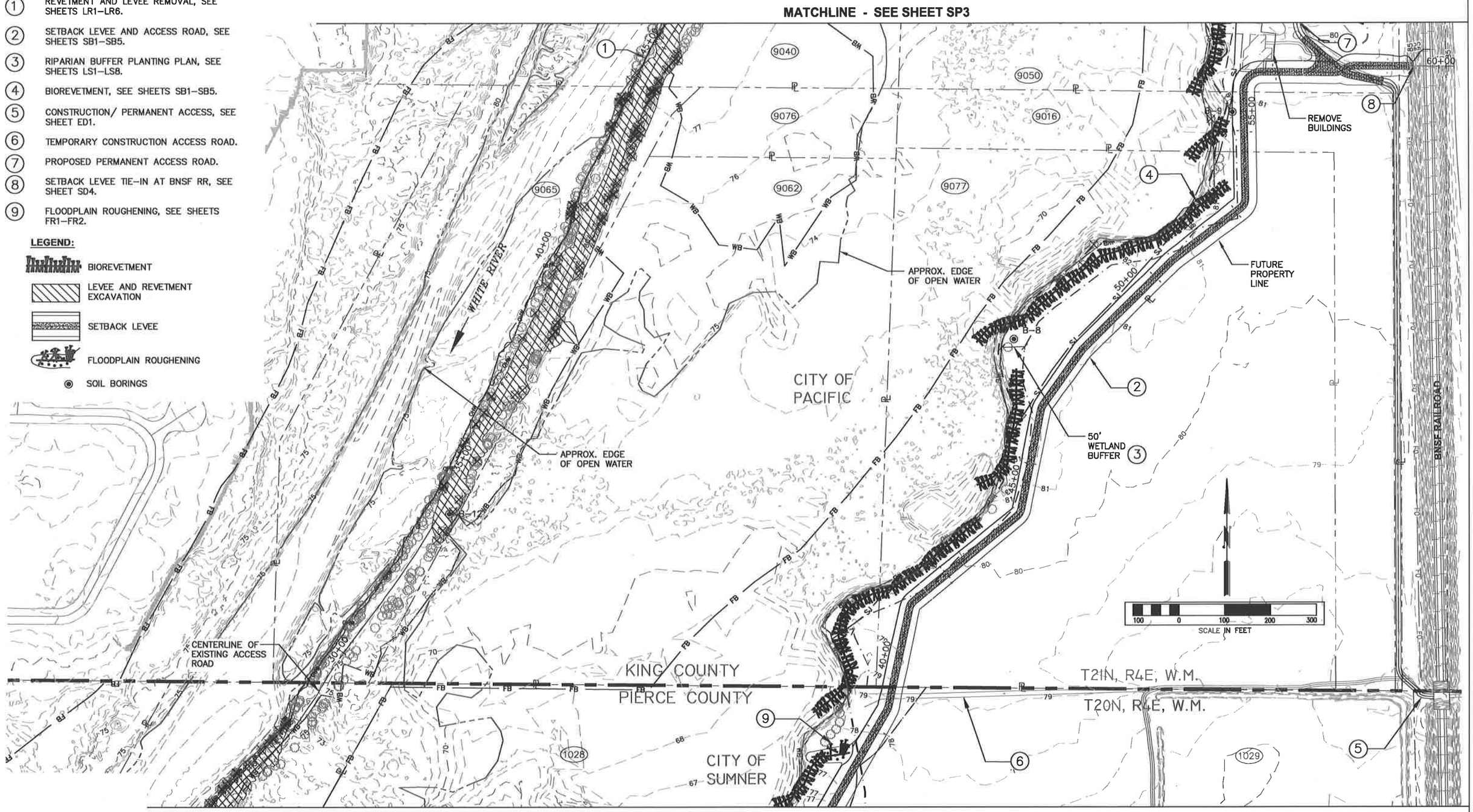
SP1

**NOTES:**

1. REVETMENT AND LEVEE REMOVAL, SEE SHEETS LR1–LR6.
2. SETBACK LEVEE AND ACCESS ROAD, SEE SHEETS SB1–SB5.
3. RIPARIAN BUFFER PLANTING PLAN, SEE SHEETS LS1–LS8.
4. BIOREVETMENT, SEE SHEETS SB1–SB5.
5. CONSTRUCTION/ PERMANENT ACCESS, SEE SHEET ED1.
6. TEMPORARY CONSTRUCTION ACCESS ROAD.
7. PROPOSED PERMANENT ACCESS ROAD.
8. SETBACK LEVEE TIE–IN AT BNSF RR, SEE SHEET SD4.
9. FLOODPLAIN ROUGHENING, SEE SHEETS FR1–FR2.

**LEGEND:**

- BIOREVETMENT
- LEVEE AND REVETMENT EXCAVATION
- SETBACK LEVEE
- FLOODPLAIN ROUGHENING
- SOIL BORINGS

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| FIELD BOOK: | | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4–2013 | SRFB # RCO 087–1910C | | King County Department of Natural Resources and Parks Water and Land Resources Division River and Floodplain Management Section Christie True, Director | COUNTYLINE LEVEE SETBACK WHITE RIVER, RIVER MILE 5.00–6.33 LEVEE MODIFICATION |
| SURVEYED: | | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4–2013 | PROJECT No. 1112049 (FL9001) | | | PROPOSED SITE PLAN |
| SURVEY BASE MAP: | | | | | | DESIGNED: CHRIS BRUMMER, PE | 4–2013 | | | | |
| CHECKED: | | | | | | ECOLOGIST: SARAH McCARTHY | 4–2013 | | | | |
| | | | | | | DESIGN ENTERED: LICA DULAN | 4–2013 | | | | |

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CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40665 REGISTERED PROFESSIONAL ENGINEER

SHEET 10 OF 69 SHEETS

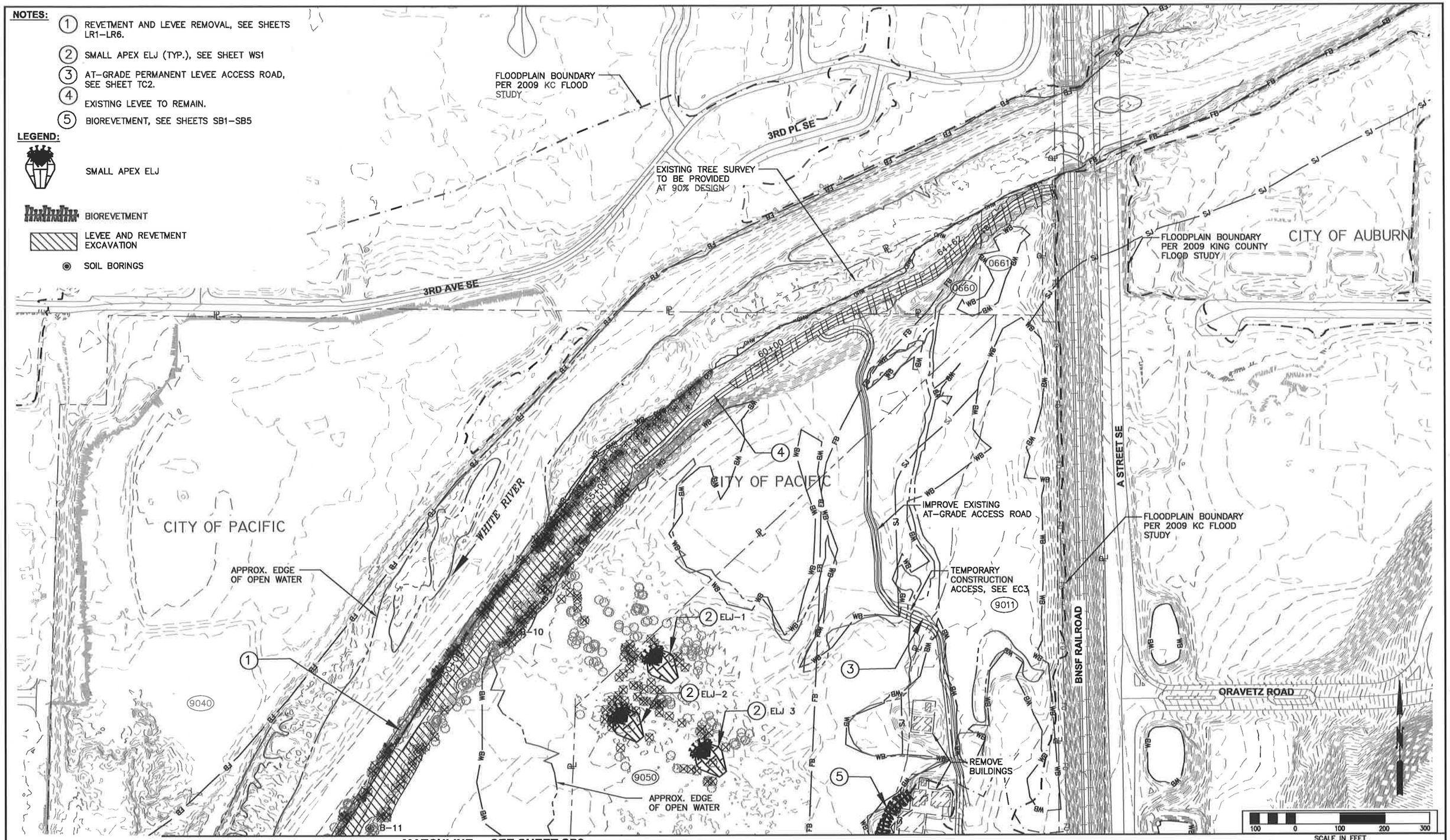
SP2

**NOTES:**

1. REVETMENT AND LEVEE REMOVAL, SEE SHEETS LR1–LR6.
2. SMALL APEX ELJ (TYP.), SEE SHEET WS1
3. AT–GRADE PERMANENT LEVEE ACCESS ROAD, SEE SHEET TC2.
4. EXISTING LEVEE TO REMAIN.
5. BIOREVETMENT, SEE SHEETS SB1–SB5

**LEGEND:**

- SMALL APEX ELJ
- BIOREVETMENT
- LEVEE AND REVETMENT EXCAVATION
- SOIL BORINGS




**MATCHLINE - SEE SHEET SP2**

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

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|---|---|---|---|
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| APPROVED: | JEANNE STYPULA, PE | 4–2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4–2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4–2013 |
| ECOLOGIST: | SARAH McCARTHY | 4–2013 |
| DESIGN ENTERED: | LICA DULAN | 4–2013 |

SRFB # RCO 087–1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER — STATE OF WASHINGTON — 40895 — REGISTERED PROFESSIONAL ENGINEER

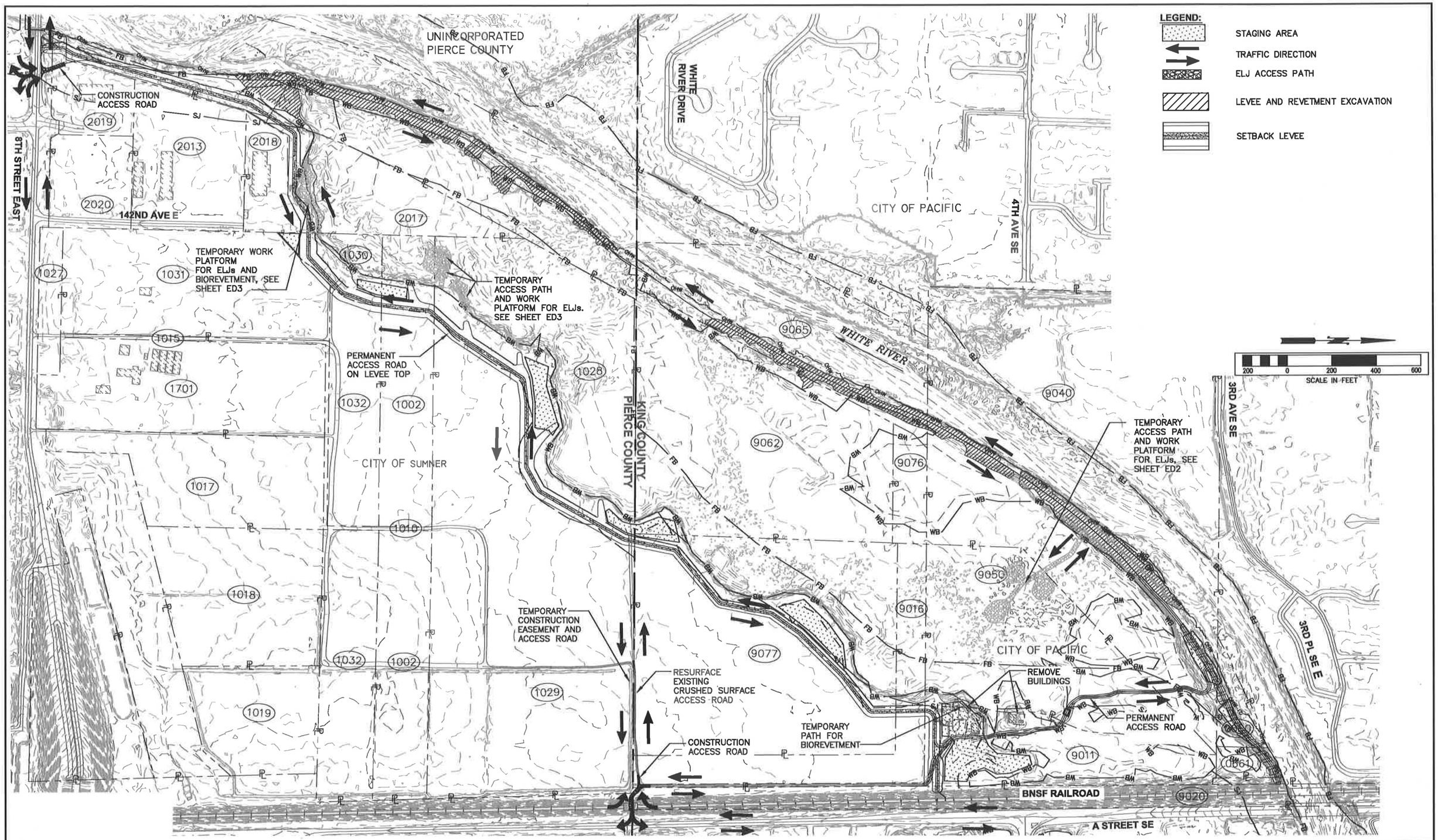
King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

PROPOSED SITE PLAN

SHEET 11 OF 69 SHEETS

SP3

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| SURVEYED: | PROJECT MANAGER: CHRIS BRUMMER, PE | 4–2013 | PROJECT No. 1112049 (FL9001) | | TRAFFIC, ACCESS AND STAGING PLAN |
| SURVEY BASE MAP: | DESIGNED: CHRIS BRUMMER, PE | 4–2013 | | | SHEET 12 OF 69 SHEETS |
| CHECKED: | ECOLOGIST: SARAH McCARTHY | 4–2013 | | | TC1 |
| | DESIGN ENTERED: LICA DULAN | 4–2013 | | | |

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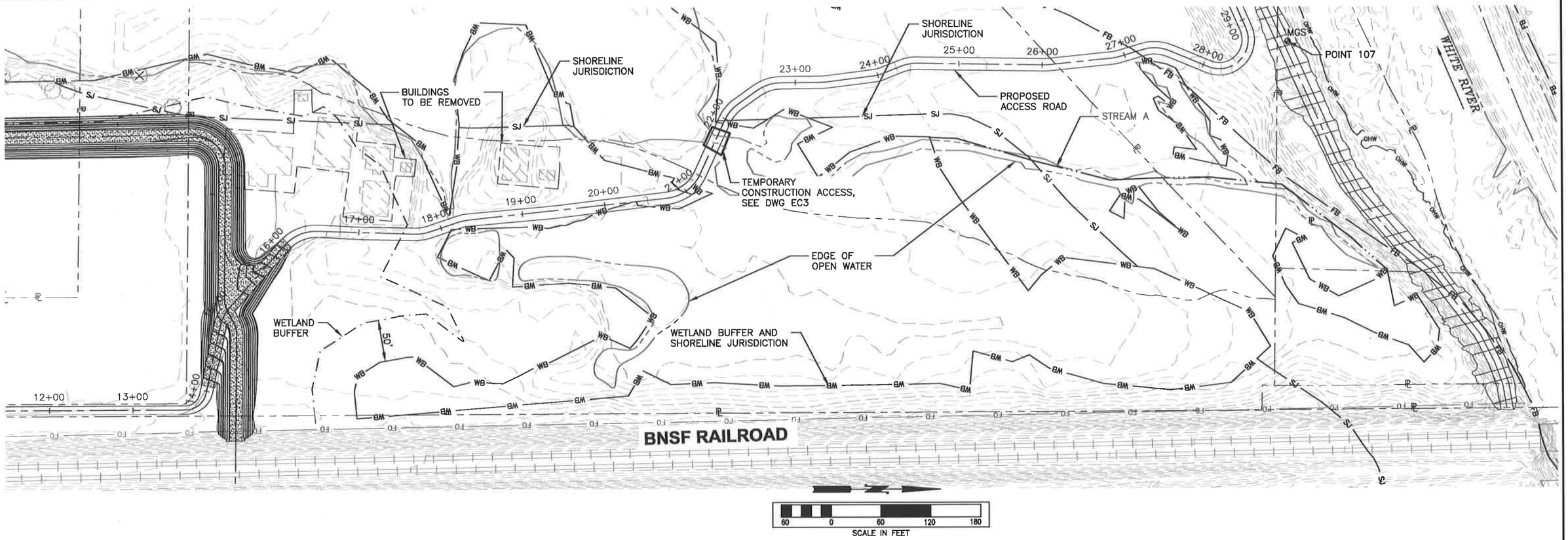


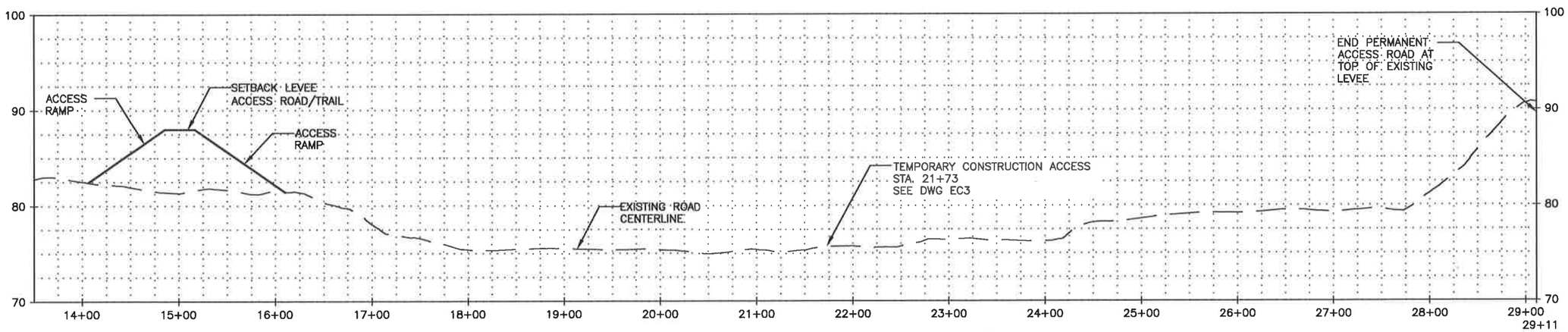


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| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
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| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40995 REGISTERED PROFESSIONAL ENGINEER

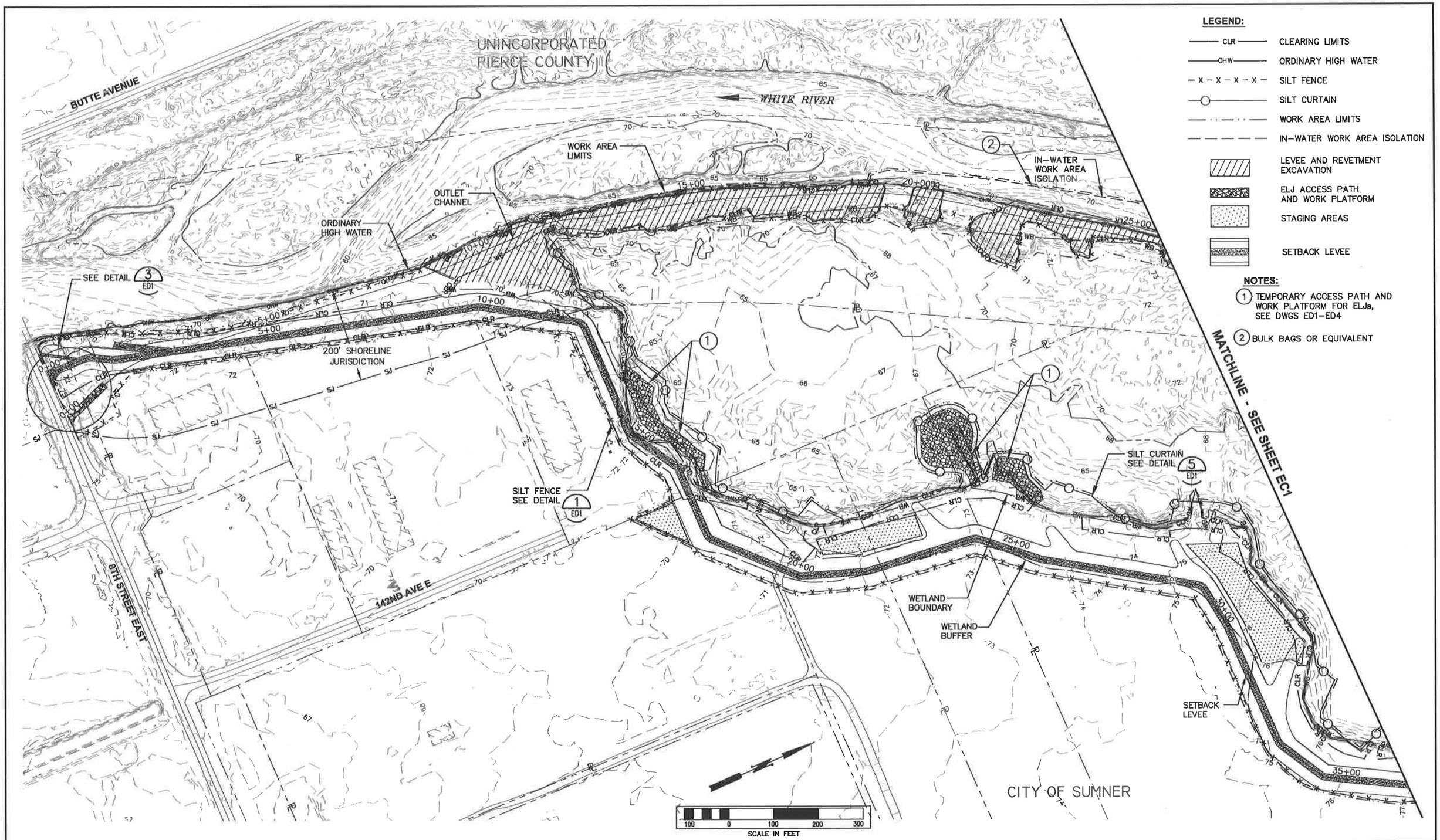
King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

NORTH PERMANENT ACCESS PLAN, TYPICAL SECTIONS AND DETAILS

SHEET 13 OF 69 SHEETS

TC2




**LEGEND:**

- CLR — CLEARING LIMITS
- OHW — ORDINARY HIGH WATER
- SILT FENCE
- SILT CURTAIN
- WORK AREA LIMITS
- IN-WATER WORK AREA ISOLATION
- LEVEE AND REVETMENT EXCAVATION
- ELJ ACCESS PATH AND WORK PLATFORM
- STAGING AREAS
- SETBACK LEVEE

**NOTES:**

1. TEMPORARY ACCESS PATH AND WORK PLATFORM FOR ELJs, SEE DWGS ED1–ED4
2. BULK BAGS OR EQUIVALENT

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
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| ECOLOGIST: | SARAH McCARTHY | 4–2013 |
| DESIGN ENTERED: | LICA DULAN | 4–2013 |

SRFB # RCO 087–1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER — STATE OF WASHINGTON — 40695 — REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

T.E.S.C. PLAN

SHEET 14 OF 69 SHEETS

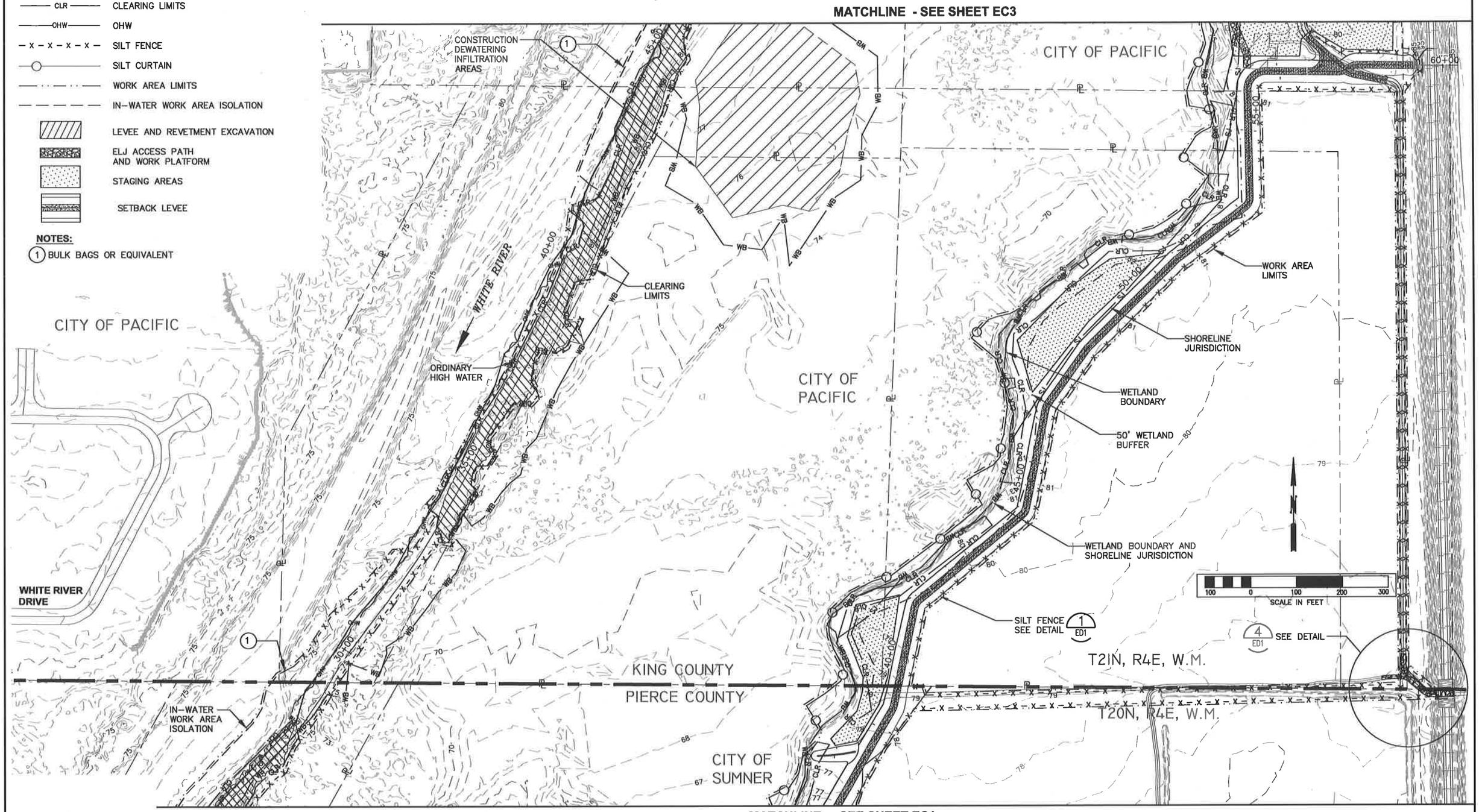
EC1

**LEGEND:**

- CLR — CLEARING LIMITS
- OHW — OHW
- X – X – X – X — SILT FENCE
- SILT CURTAIN
- WORK AREA LIMITS
- IN-WATER WORK AREA ISOLATION
- LEVEE AND REVETMENT EXCAVATION
- ELJ ACCESS PATH AND WORK PLATFORM
- STAGING AREAS
- SETBACK LEVEE

**NOTES:**

1. BULK BAGS OR EQUIVALENT

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CADD / 60% 5-2013 EC1

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| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
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King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

T.E.S.C. PLAN

SHEET 15 OF 69 SHEETS

EC2

**LEGEND:**

- CLR — CLEARING LIMITS
- OHW — ORDINARY HIGH WATER
- X – X – X – X — SILT FENCE
- WORK AREA LIMITS
- IN-WATER WORK AREA ISOLATION
- LEVEE AND REVETMENT EXCAVATION
- ELJ ACCESS PATH AND WORK PLATFORM
- STAGING AREAS

**NOTES:**

1. TEMPORARY ACCESS PATH AND WORK PLATFORM FOR ELJs, SEE SHEETS ED1–ED2
2. BULK BAGS OR EQUIVALENT

**MATCHLINE - SEE SHEET EC2**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FIELD BOOK: | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4–2013 | SRFB # RCO 087–1910C | King County Department of Natural Resources and Parks Water and Land Resources Division River and Floodplain Management Section Christie True, Director | COUNTYLINE LEVEE SETBACK WHITE RIVER, RIVER MILE 5.00–6.33 LEVEE MODIFICATION |
| SURVEYED: | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4–2013 | PROJECT No. 1112049 (FL9001) | | T.E.S.C. PLAN |
| SURVEY BASE MAP: | | | | | DESIGNED: CHRIS BRUMMER, PE | 4–2013 | | | SHEET 16 OF 69 SHEETS |
| CHECKED: | | | | | ECOLOGIST: SARAH McCARTHY | 4–2013 | | | EC3 |
| | | | | | DESIGN ENTERED: LICA DULAN | 4–2013 | | | |

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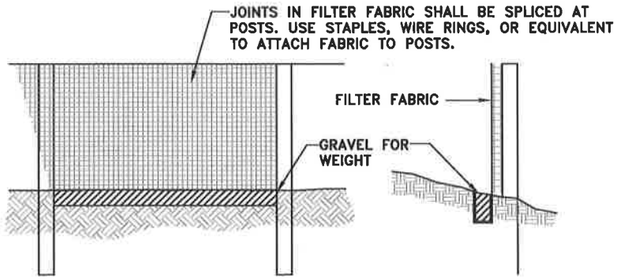
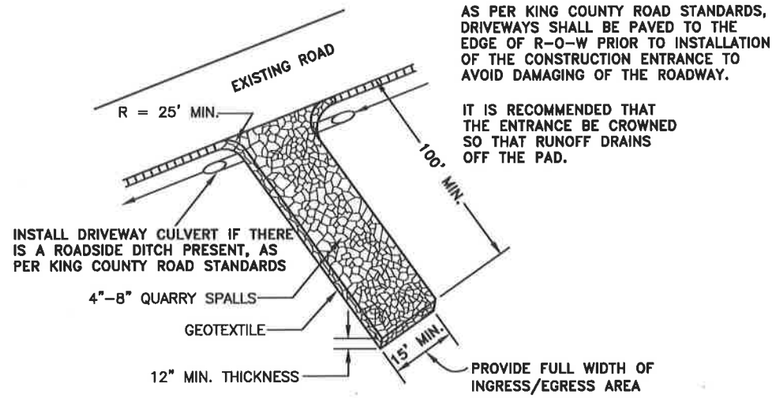



WEIGHTED SILT FENCE (1 / EC1–EC3)
NTS



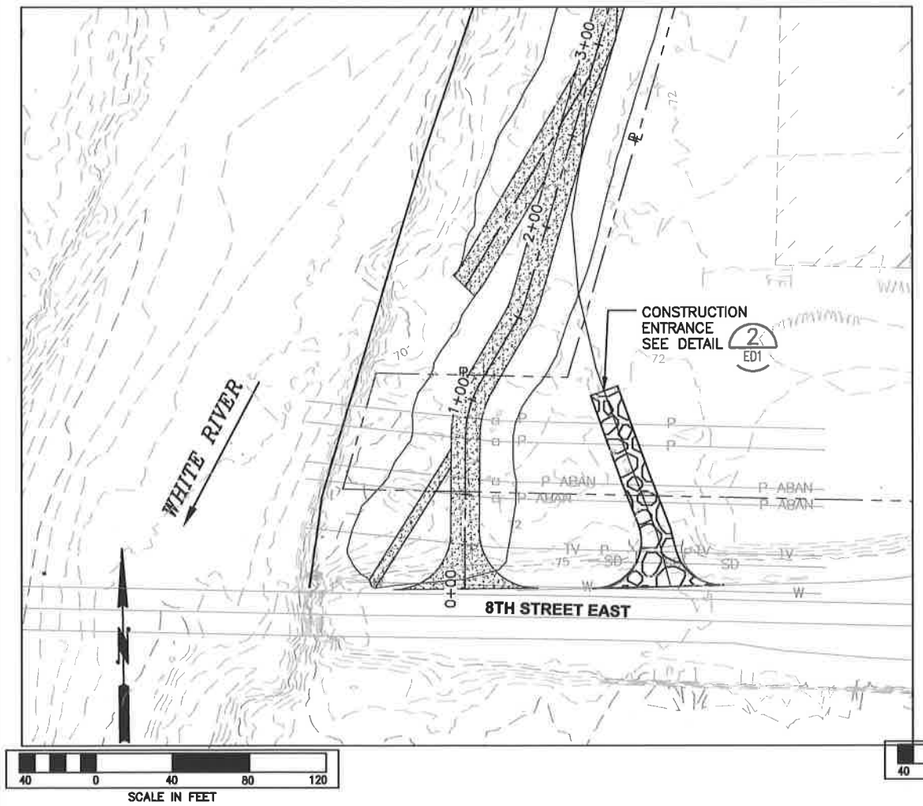

AS PER KING COUNTY ROAD STANDARDS, DRIVEWAYS SHALL BE PAVED TO THE EDGE OF R–O–W PRIOR TO INSTALLATION OF THE CONSTRUCTION ENTRANCE TO AVOID DAMAGING OF THE ROADWAY.

IT IS RECOMMENDED THAT THE ENTRANCE BE CROWNED SO THAT RUNOFF DRAINS OFF THE PAD.

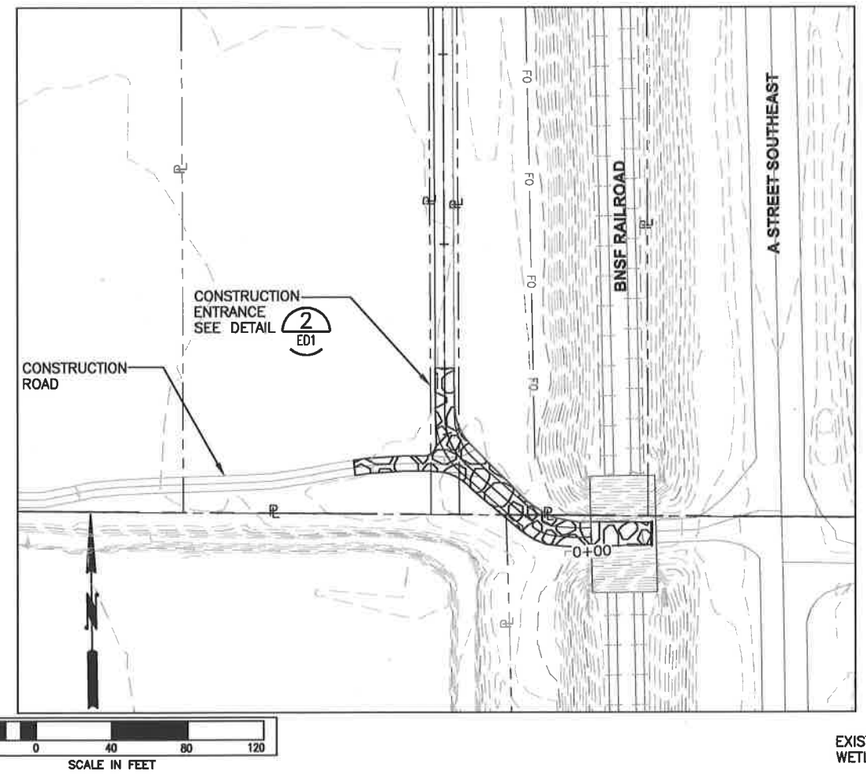
STABILIZED CONSTRUCTION ENTRANCE (2 / SP1,SP2)
NTS

## NOTES FOR TEMPORARY ACCESS PATH TO ELJs

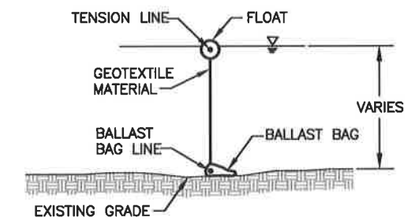
1. CLEARED ACCESS PATH TO BE ROUTED TO MINIMIZE VEGETATION DISTURBANCE AND FOREST CLEARING.
2. CONTRACTOR SHALL MARK CLEARING LIMITS WITH FLAGGING. CLEARING LIMITS TO BE APPROVED BY ENGINEER OR OWNER PRIOR TO ANY CLEARING ACTIVITIES.
3. NO STANDING TREES GREATER THAN 4 INCHES DIAMETER AT BREAST HEIGHT SHALL BE REMOVED WITHOUT THE APPROVAL OF THE ENGINEER.
4. TREES WITH MARKED FOR REUSE CLEARED FOR ACCESS PATH CONSTRUCTION SHALL BE STOCKPILED FOR USE AS RACKING IN ELJ CONSTRUCTION. SHRUBS CLEARED FOR ACCESS PATH CONSTRUCTION SHALL BE STOCKPILED FOR USE AS SLASH IN ELJ CONSTRUCTION.
5. ACCESS PATH SHALL BE MAINTAINED BY MINOR GRADING AND IMPORTATION OF ALLUVIUM FROM THE EXIST LEVEE AS NECESSARY, OR AS DIRECTED BY THE ENGINEER. NON–NATIVE ANGULAR ROCK IS NOT ALLOWED TO BE PLACED ON TEMPORARY ACCESS PATHS.
6. CLEARED ACCESS PATH SHALL BE DECOMPACTED AT THE TERMINATION OF WORK.
7. ALL VEGETATION CLEARED FOR ACCESS PATH AND ELJ CONSTRUCTION THAT IS NOT USED IN THE ELJs SHALL BE PLACED ON THE DECOMPACTED PATH AND OTHER DISTURBED AREAS AS DIRECTED BY THE ENGINEER.
8. SOIL REMOVED AS PART OF ACCESS PATH CONSTRUCTION SHALL BE STOCKPILED AND THEN SPREAD BACK ONTO TEMPORARY ACCESS PATH ALIGNMENT FOLLOWING COMPLETION OF WORK. EXISTING GRADE OF ACCESS PATH SHALL BE RESTORED AS PART OF WORK TO REMOVE ACCESS PATH.

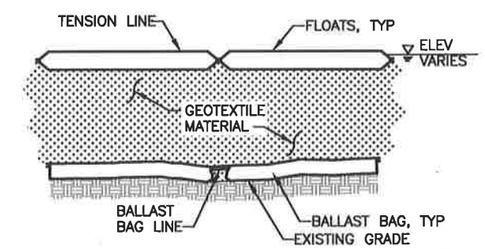



CONSTRUCTION ACCESS FROM 8TH ST E (3 / EC1)

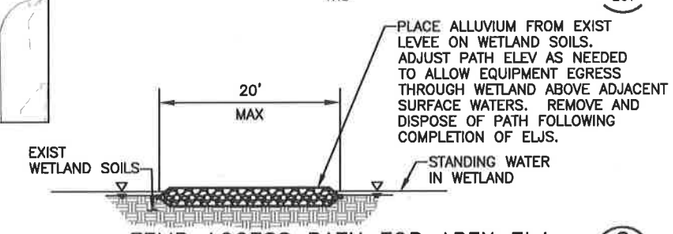



CONSTRUCTION ACCESS FROM A ST SE (4 / EC2)




SILT CURTAIN (5 / EC1)
NTS




TEMP ACCESS PATH FOR APEX ELJ (6 / EC1, EC3)
NTS

FIELD BOOK:
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|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4–2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4–2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4–2013 |
| ECOLOGIST: | SARAH McCARTHY | 4–2013 |
| DESIGN ENTERED: | LICA DULAN | 4–2013 |

SRFB # RCO 087–1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER, STATE OF WASHINGTON, 40695, REGISTERED PROFESSIONAL ENGINEER

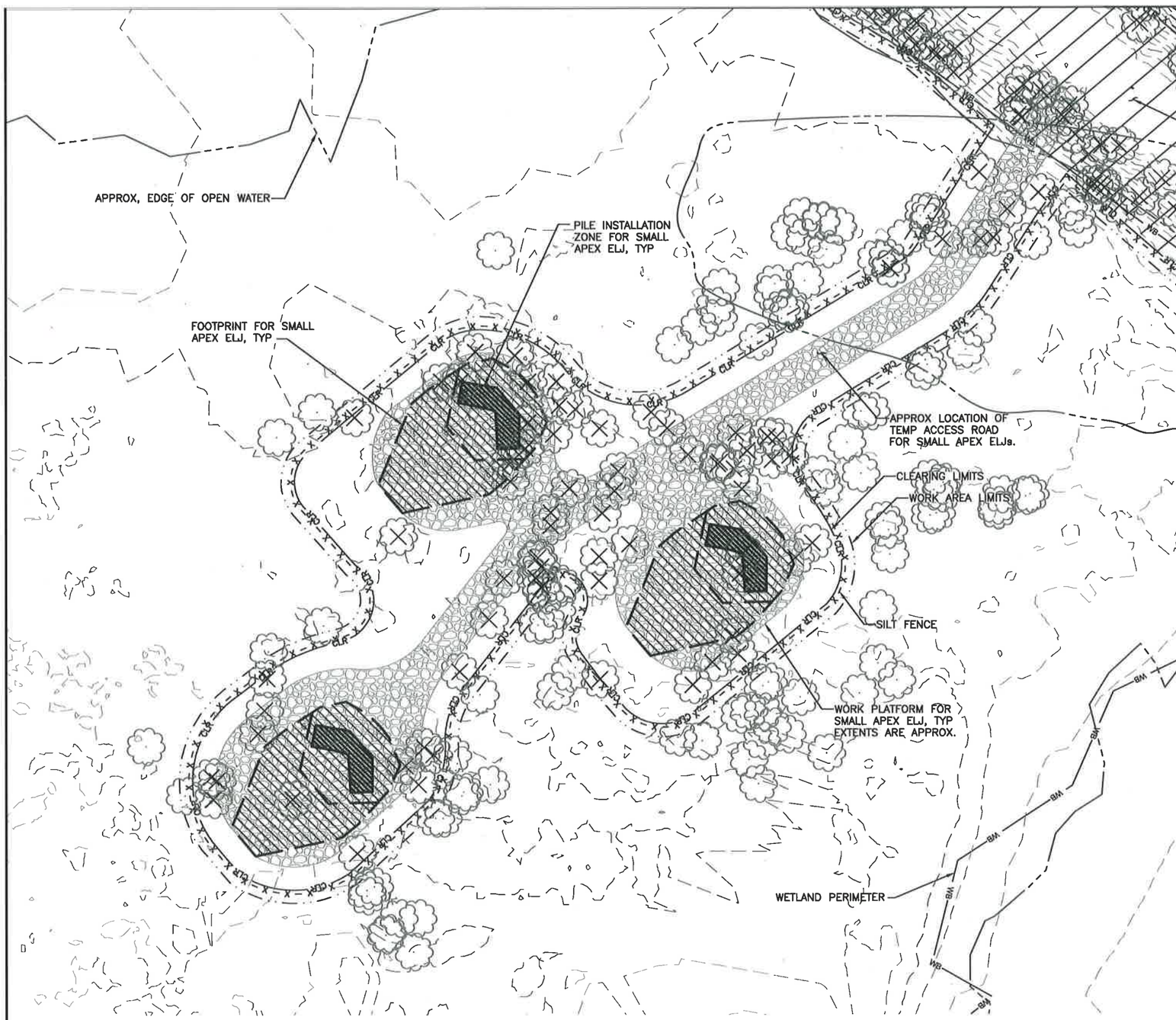
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

T.E.S.C. DETAILS

SHEET 17 OF 69 SHEETS

ED1




30 0 30 60 90
SCALE IN FEET

**NOTES:**

1. FOR ELJ PILE INSTALLATION CONSTRUCT WORK PLATFORM IN LOCATION SHOWN TO ALLOW PILE INSTALLATION TO OCCUR IN THE DRY. USE ALLUVIUM EXCAVATED FROM EXIST LEVEE AND PLACE SPOILS BY END-DUMPING AND COMPACT BY ROUTING EQUIPMENT OVER SPOILS. SPOILS WILL SLOPE FROM PILE PLACEMENT ZONE AT MATERIAL'S ANGLE OF REPOSE DOWN TO BOTTOM OF WETLAND. CONSTRUCT WORK PLATFORM ABOVE THE WSE AT THE TIME OF CONSTRUCTION.
2. ISOLATE ELJs FROM STANDING WATER IN WETLAND WITH A SILT CURTAIN OR APPROVED OTHER TO CONTAIN TURBID WATER WHILE CONSTRUCTING STRUCTURES.
3. FOLLOWING PILE INSTALLATION, EXCAVATE THROUGH WORK PLATFORM AS NEEDED TO COMPLETE STRUCTURE CONSTRUCTION. WORK PLATFORM MATERIAL MAY BE REUSED AS STRUCTURE BACKFILL MATERIAL.
4. IF NECESSARY TO COMPLETE CONSTRUCTION OF ELJs, PUMP WATER FROM EXCAVATION AND DISCHARGE TO INFILTRATION AREA OUTSIDE OF WETLAND BOUNDARY OR TO PORTABLE WATER TREATMENT SYSTEM PER PROJECT PERMIT REQUIREMENTS.
5. WORK AREA LIMITS SHOWN AROUND ELJ WORK AREAS REPRESENT THE MAXIMUM ALLOWABLE CLEARING LIMITS. THE CONTRACTOR SHALL MINIMIZE CLEARING WHERE POSSIBLE TO PRESERVE AS MUCH EXISTING VEGETATION AS POSSIBLE AND NOT DAMAGE OR DISTURB VEGETATION MARKED BY THE OWNER OR PROJECT REPRESENTATIVE FOR PRESERVATION. AT THE DISCRETION OF THE PROJECT REPRESENTATIVE CLEARING DEBRIS MAY BE USED AS SLASH IN THE ELJs EXCLUDING NON-NATIVE, INVASIVE AND NOXIOUS VEGETATION.

**LEGEND:**

- LEVEE AND REVETMENT EXCAVATION
- TEMPORARY ACCESS ROAD AND ELJ WORK PLATFORM
- WORK AREA LIMITS
- CLR — CLEARING LIMITS
- SILT FENCE
- EDGE OF OPEN WATER
- ELJ FOOTPRINT
- ELJ PILE INSTALLATION ZONE
- EXISTING TREE (TO REMAIN)
- EXISTING TREE (TO BE REMOVED)

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

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5-2013

| NUM. | REVISION | BY | DATE |
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| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN R. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

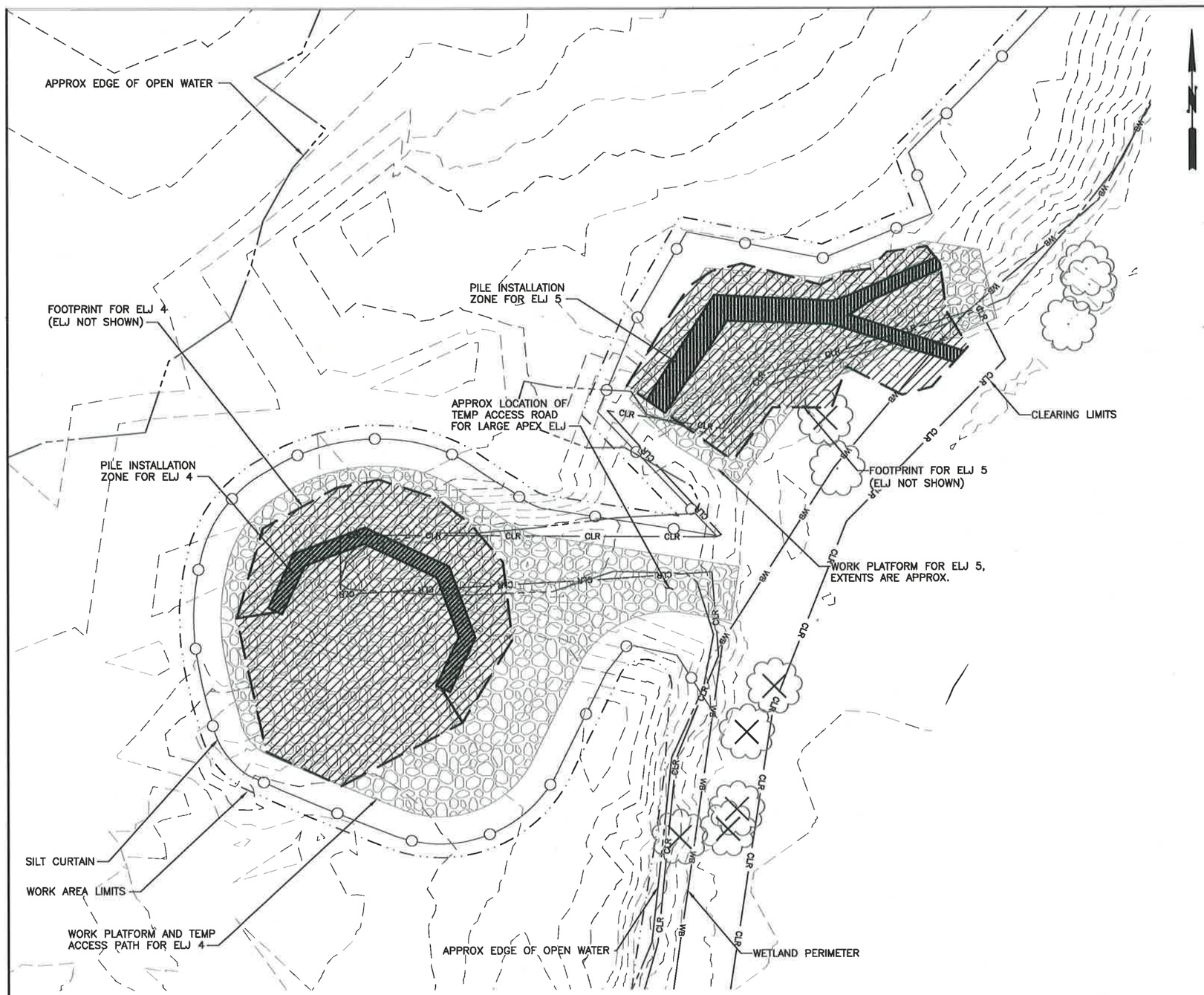
HERRERA

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION
TESC DETAILS FOR ELJs 1, 2, AND 3

SHEET 18 OF 69 SHEETS

ED2




20 0 20 40 60
SCALE IN FEET

**NOTES:**

1. FOR ELJ PILE INSTALLATION CONSTRUCT WORK PLATFORM IN LOCATION SHOWN TO ALLOW PILE INSTALLATION TO OCCUR IN THE DRY. USE ALLUVIUM EXCAVATED FROM EXIST LEVEE AND PLACE SPOILS BY END–DUMPING AND COMPACT BY ROUTING EQUIPMENT OVER SPOILS. SPOILS WILL SLOPE FROM PILE PLACEMENT ZONE AT MATERIAL'S ANGLE OF REPOSE DOWN TO BOTTOM OF WETLAND. CONSTRUCT WORK PLATFORM ABOVE THE WSE AT THE TIME OF CONSTRUCTION.
2. ISOLATE ELJs FROM STANDING WATER IN WETLAND WITH A SILT CURTAIN OR APPROVED OTHER TO CONTAIN TURBID WATER WHILE CONSTRUCTING STRUCTURES.
3. FOLLOWING PILE INSTALLATION, EXCAVATE THROUGH WORK PLATFORM AS NEEDED TO COMPLETE STRUCTURE CONSTRUCTION. WORK PLATFORM MATERIAL MAY BE REUSED AS STRUCTURE BACKFILL MATERIAL.
4. IF NECESSARY TO COMPLETE CONSTRUCTION OF ELJs, PUMP WATER FROM EXCAVATION AND DISCHARGE TO INFILTRATION AREA OUTSIDE OF WETLAND BOUNDARY OR TO PORTABLE WATER TREATMENT SYSTEM PER PROJECT PERMIT REQUIREMENTS.
5. WORK AREA LIMITS SHOWN AROUND ELJ WORK AREAS REPRESENT THE MAXIMUM ALLOWABLE CLEARING LIMITS. THE CONTRACTOR SHALL MINIMIZE CLEARING WHERE POSSIBLE TO PRESERVE AS MUCH EXISTING VEGETATION AS POSSIBLE AND NOT DAMAGE OR DISTURB VEGETATION MARKED BY THE OWNER OR PROJECT REPRESENTATIVE FOR PRESERVATION. AT THE DISCRETION OF THE PROJECT REPRESENTATIVE CLEARING DEBRIS MAY BE USED AS SLASH IN THE ELJs EXCLUDING NON–NATIVE, INVASIVE AND NOXIOUS VEGETATION.

**LEGEND:**

- TEMPORARY ACCESS ROAD AND ELJ WORK PLATFORM
- WORK AREA LIMITS
- CLR — CLEARING LIMITS
- SILT CURTAIN
- EDGE OF OPEN WATER
- ELJ FOOTPRINT
- ELJ PILE INSTALLATION ZONE
- EXISTING TREE (TO REMAIN)
- EXISTING TREE (TO BE REMOVED)

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

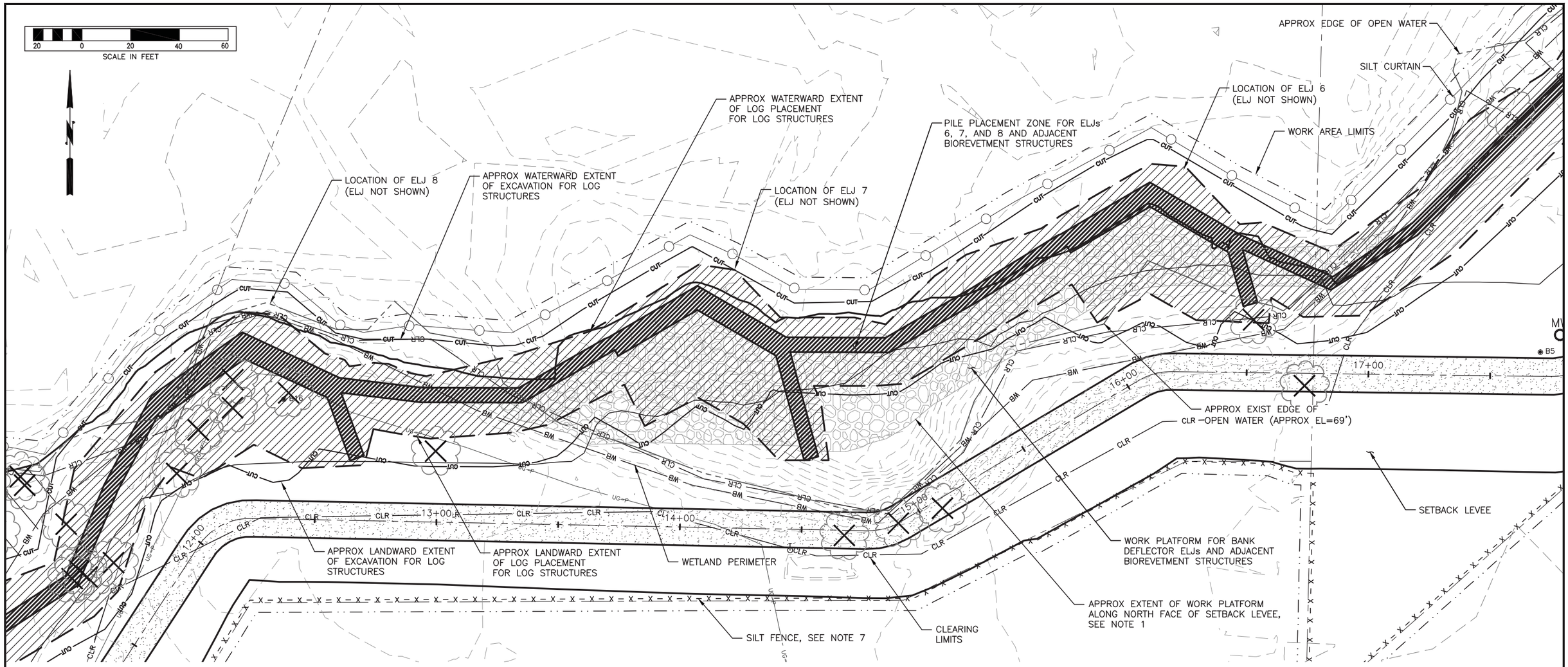
King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

TESC DETAILS FOR ELJs 4 AND 5

SHEET 19 OF 69 SHEETS

ED3




**NOTES:**

1. FOR LOG STRUCTURE PILE INSTALLATION CONSTRUCT WORK PLATFORM BETWEEN PILE PLACEMENT ZONE AND NORTH FACE OF SETBACK LEVEE TO DISPLACE STANDING WATER AND ALLOW PILE INSTALLATION TO OCCUR IN THE DRY IN THE VICINITY OF ELJs 6, 7, AND 8, AND ADJACENT BIOREVETMENT STRUCTURES. USE ALLUVIUM EXCAVATED FROM EXIST LEVEE AND PLACE SPOILS BY END–DUMPING AND COMPACT BY ROUTING EQUIPMENT OVER SPOILS. SPOILS WILL SLOPE FROM PILE PLACEMENT ZONE AT MATERIAL'S ANGLE OF REPOSE DOWN TO BOTTOM OF WETLAND. CONSTRUCT WORK PLATFORM ABOVE THE WSE AT THE TIME OF CONSTRUCTION.
2. USE THE SETBACK LEVEE AS A TEMPORARY ACCESS ROAD AND STAGING AREA TO CONSTRUCT ELJs 6, 7, AND 8, AND ADJACENT BIOREVETMENT STRUCTURES.
3. ISOLATE ELJs AND BIOREVETMENT WORK AREAS FROM STANDING WATER IN WETLAND WITH A SILT CURTAIN OR APPROVED OTHER TO CONTAIN TURBID WATER WHILE CONSTRUCTING STRUCTURES. ISOLATE INDIVIDUAL AREAS AS NEEDED TO COMPLETE CONSTRUCTION AND CONTAIN TURBID WATER.
4. FOLLOWING PILE INSTALLATION, EXCAVATE THROUGH WORK PLATFORM AS NEEDED TO COMPLETE STRUCTURE CONSTRUCTION. WORK PLATFORM MATERIAL MAY BE REUSED AS STRUCTURE BACKFILL MATERIAL.
5. IF NECESSARY TO COMPLETE CONSTRUCTION OF LOG STRUCTURES, PUMP WATER FROM EXCAVATION AND DISCHARGE TO INFILTRATION AREA OUTSIDE OF WETLAND BOUNDARY OR TO PORTABLE WATER TREATMENT SYSTEM PER PROJECT PERMIT REQUIREMENTS.
6. WORK AREA LIMITS SHOWN AROUND ELJ WORK AREAS REPRESENT THE MAXIMUM ALLOWABLE CLEARING LIMITS. THE CONTRACTOR SHALL MINIMIZE CLEARING WHERE POSSIBLE TO PRESERVE AS MUCH EXISTING VEGETATION AS POSSIBLE AND NOT DAMAGE OR DISTURB VEGETATION MARKED BY THE OWNER OR PROJECT REPRESENTATIVE FOR PRESERVATION. AT THE DISCRETION OF THE PROJECT REPRESENTATIVE CLEARING DEBRIS MAY BE USED AS SLASH IN THE ELJs EXCLUDING NON–NATIVE, INVASIVE AND NOXIOUS VEGETATION.
7. SILT FENCE ALONG SETBACK LEVEE SHOWN OUTSIDE OF PROPERTY LINE FOR CLARITY AND SHALL BE PLACED WITHIN PROPERTY LINE.

**LEGEND:**

- ELJ WORK PLATFORM
- WORK AREA LIMITS
- CLR — CLEARING LIMITS
- x – x – x — SILT FENCE
- SILT CURTAIN
- CUT — ELJ EXCAVATION EXTENTS (APPROX)
- EDGE OF OPEN WATER
- ELJ FOOTPRINT
- ELJ PILE INSTALLATION ZONE
- EXISTING TREE (TO REMAIN)
- EXISTING TREE (TO BE REMOVED)

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5–2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5–2013 |
| DESIGNED: | BRIAN SCOTT | 5–2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5–2013 |

SRFB # RCO 087–1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO — STATE OF WASHINGTON — 36069 — REGISTERED PROFESSIONAL ENGINEER

HERRERA

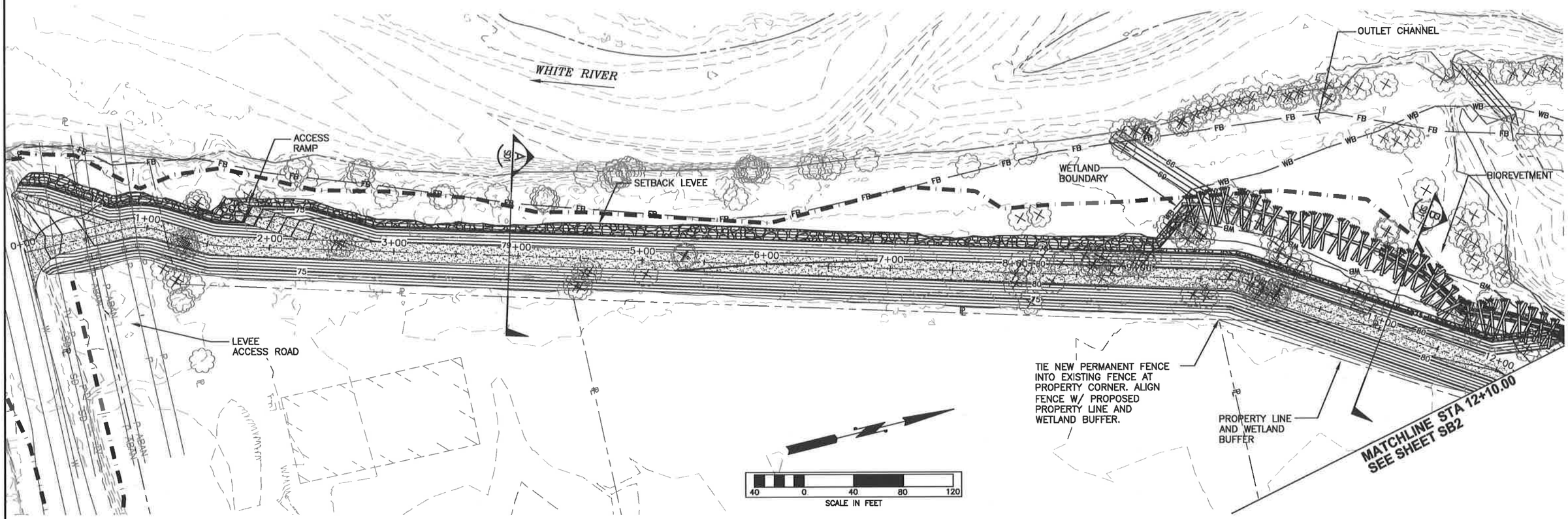
King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

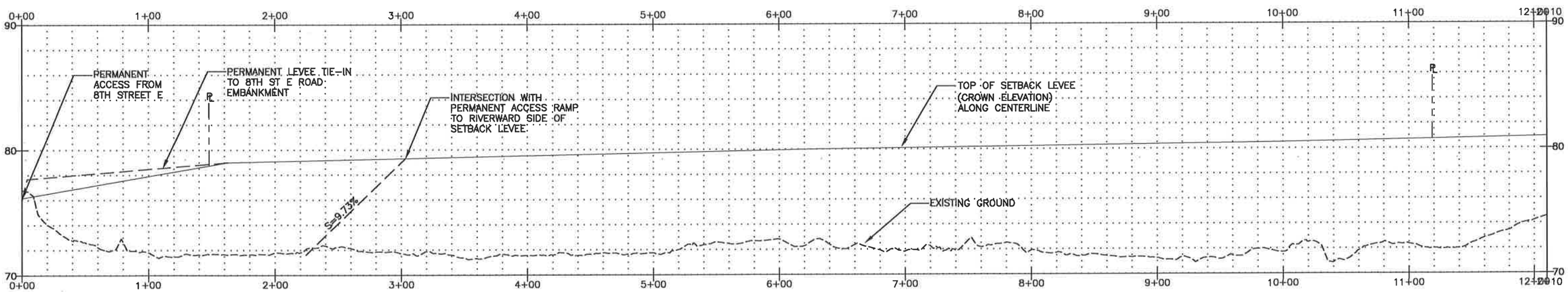
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

TESC DETAILS FOR ELJs 6, 7, AND 8

SHEET 20 OF 69 SHEETS

ED4

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| FIELD BOOK: | | | | | |
| SURVEYED: | | | | | |
| SURVEY BASE MAP: | | | | | |
| CHECKED: | | | | | |

CADD / 60% 5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER — STATE OF WASHINGTON — 40695 — REGISTERED PROFESSIONAL ENGINEER

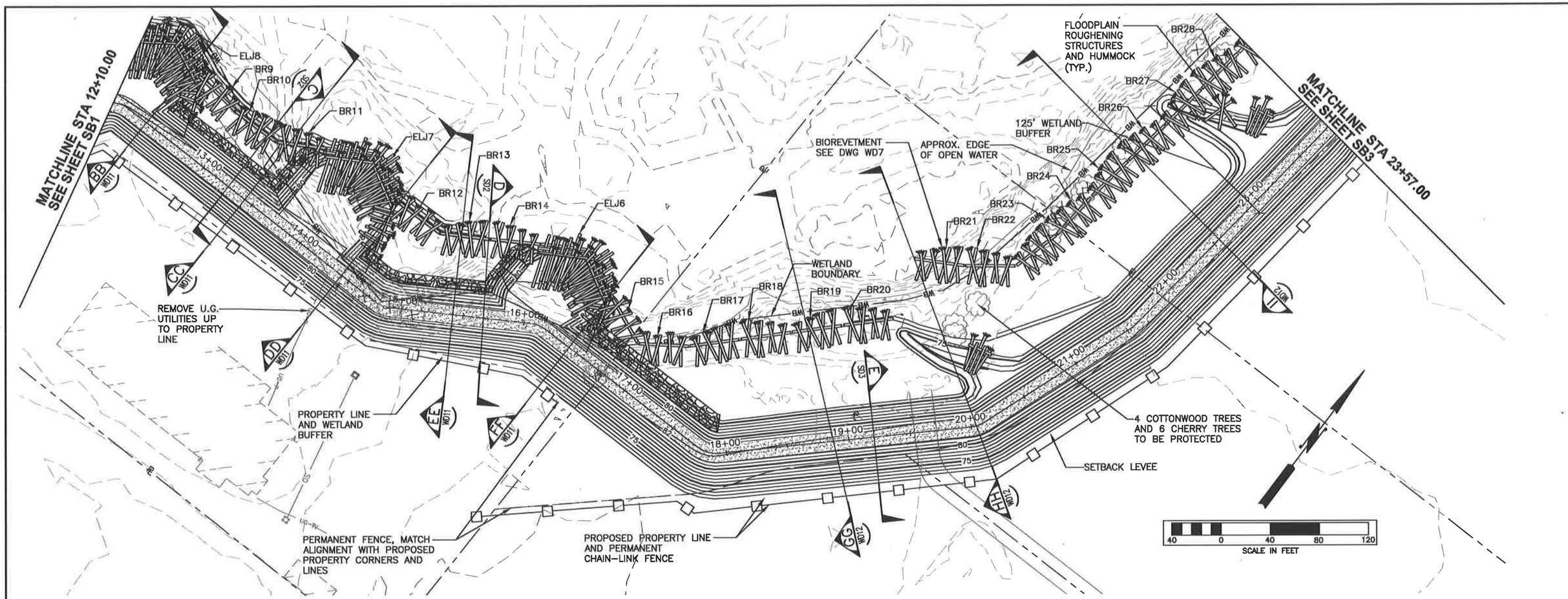
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

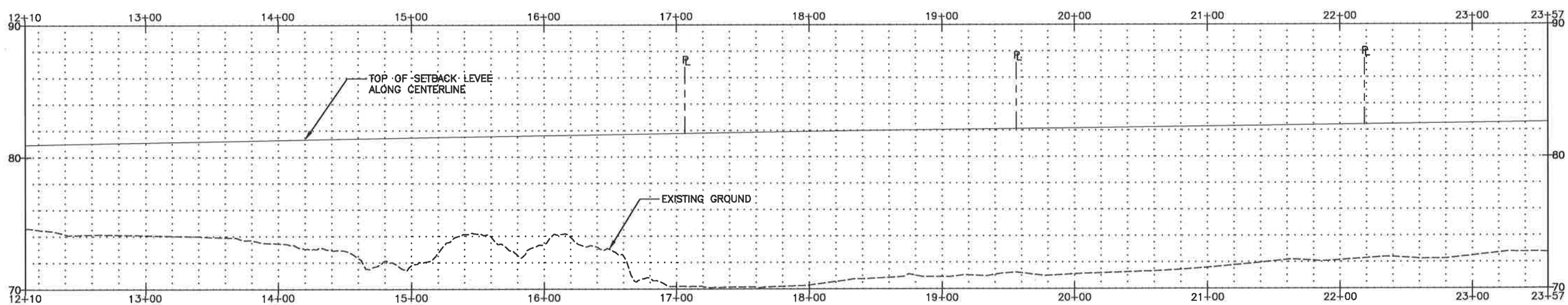
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

SITE PLAN AND PROFILE FOR SETBACK LEVEE AND BIOREVETMENT

SHEET 21 OF 69 SHEETS

SB1

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|---|---|---|---|---|---|---|---|
| FIELD BOOK: | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C |
| SURVEYED: | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) |
| SURVEY BASE MAP: | | | | | DESIGNED: CHRIS BRUMMER, PE | 4-2013 | |
| CHECKED: | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | |
| | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | |

CADD / 60%
5-2013

CHRISTOPHER JON BRUMMER
STATE OF WASHINGTON
40695
REGISTERED
PROFESSIONAL ENGINEER

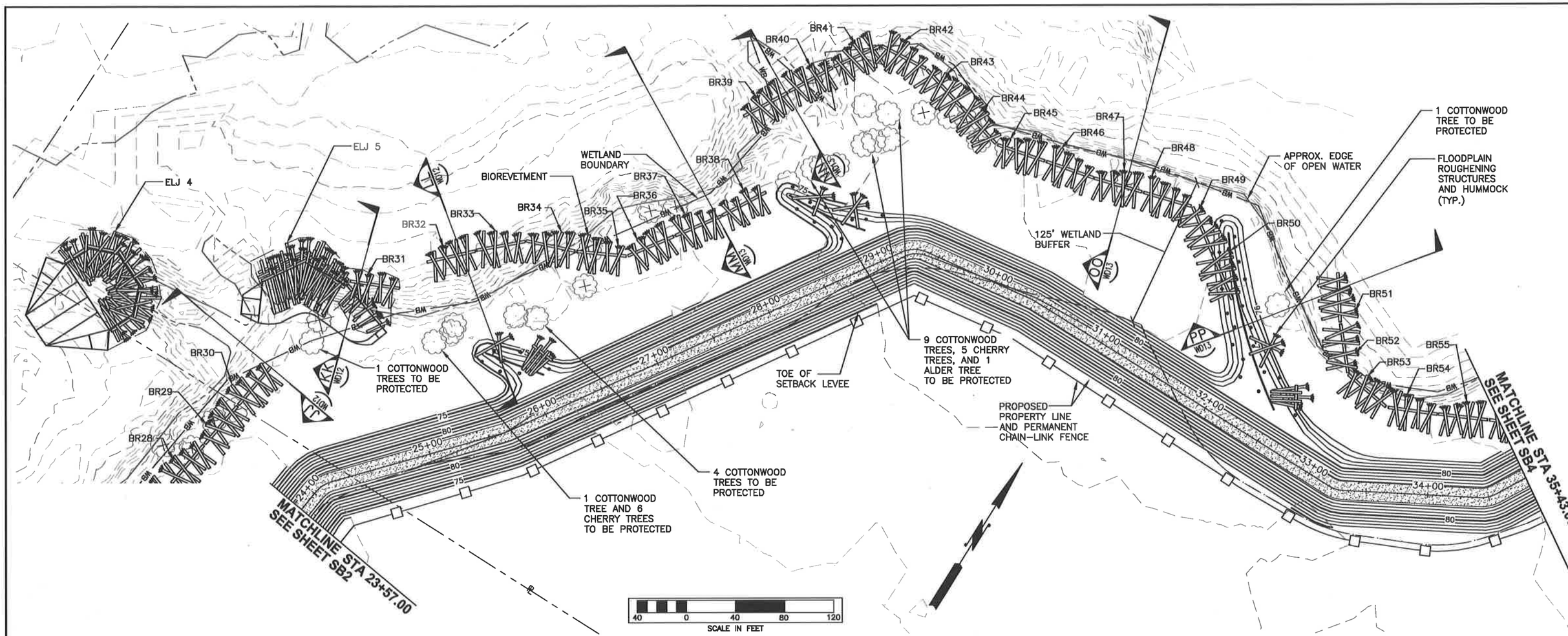
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

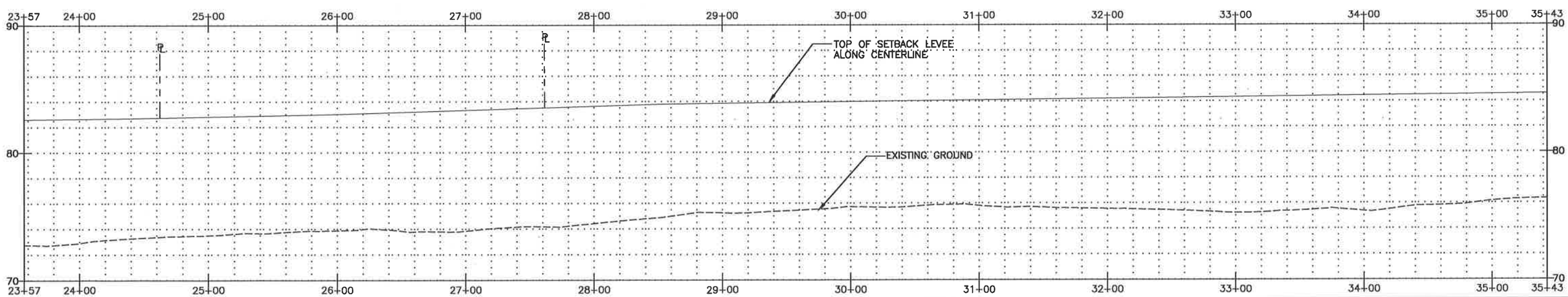
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

SITE PLAN AND PROFILE FOR SETBACK LEVEE AND BIOREVETMENT

SHEET 22 OF 69 SHEETS

SB2




FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

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|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40855 REGISTERED PROFESSIONAL ENGINEER

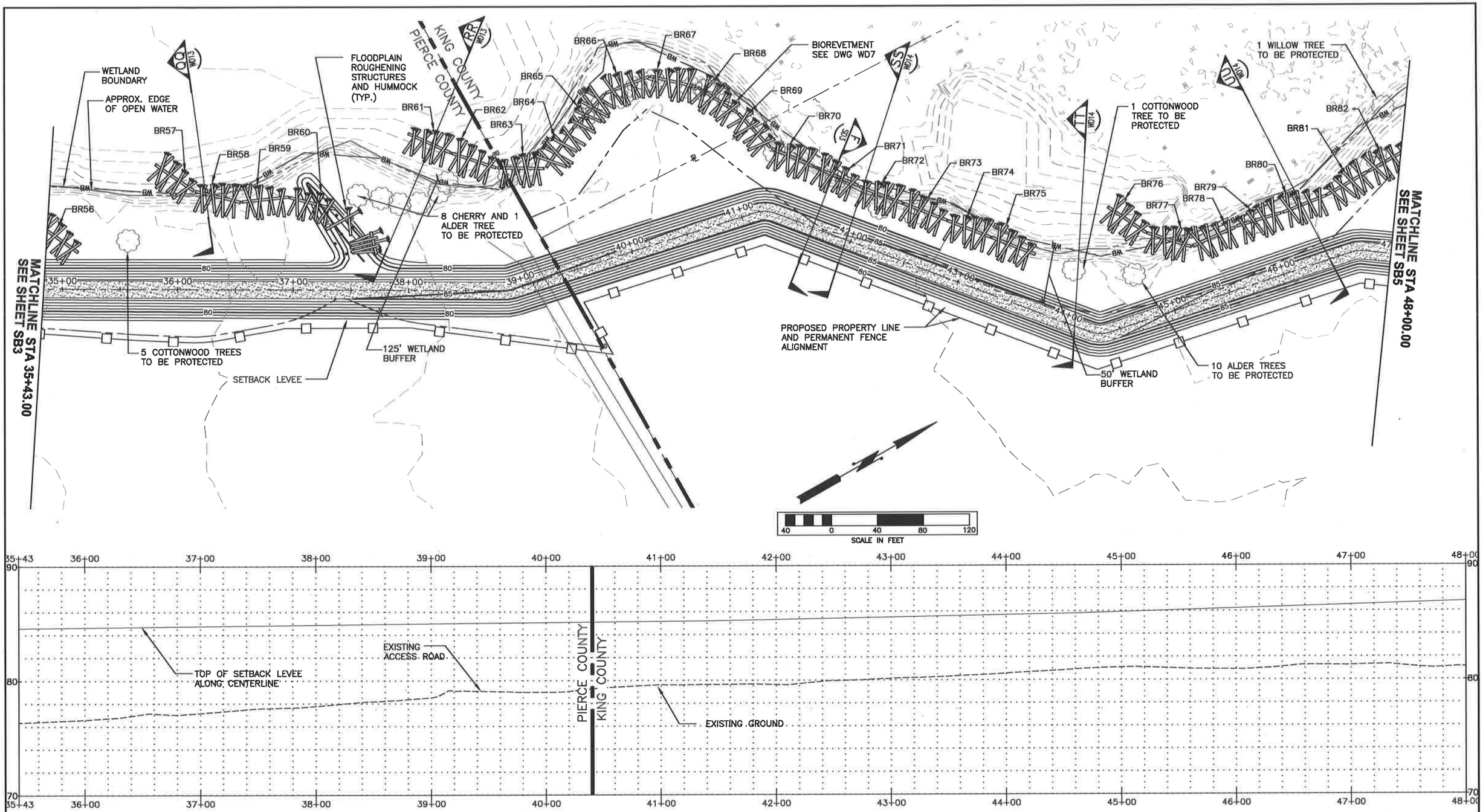
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

SITE PLAN AND PROFILE FOR SETBACK LEVEE AND BIOREVETMENT

SHEET 23 OF 69 SHEETS

SB3

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|---|---|---|---|---|---|---|---|
| FIELD BOOK: | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C |
| SURVEYED: | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) |
| SURVEY BASE MAP: | | | | | DESIGNED: CHRIS BRUMMER, PE | 4-2013 | |
| CHECKED: | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | |
| | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | |

CADD / 60% 5-2013

CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40695 REGISTERED PROFESSIONAL ENGINEER

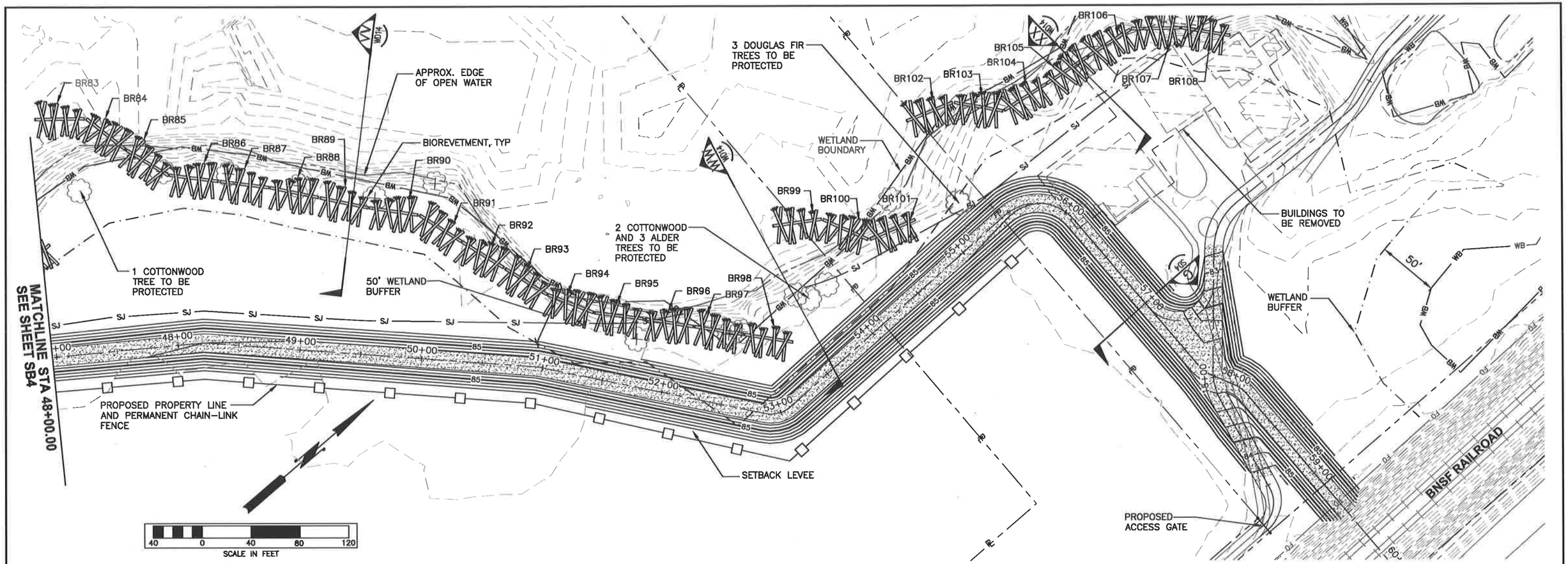
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

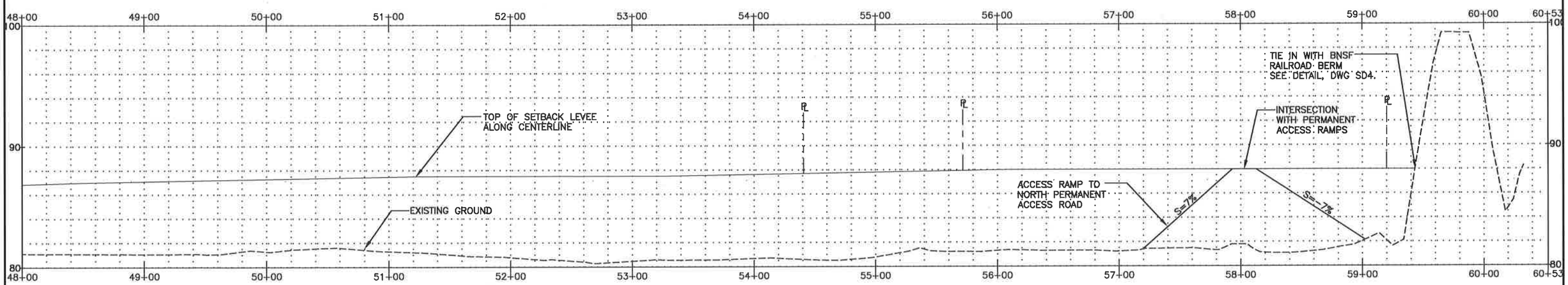
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

SITE PLAN AND PROFILE FOR SETBACK LEVEE AND BIOREVETMENT

SHEET 24 OF 69 SHEETS

SB4

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| FIELD BOOK: | | | | | |
| SURVEYED: | | | | | |
| SURVEY BASE MAP: | | | | | |
| CHECKED: | | | | | |

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER
STATE OF WASHINGTON
40895
REGISTERED PROFESSIONAL ENGINEER

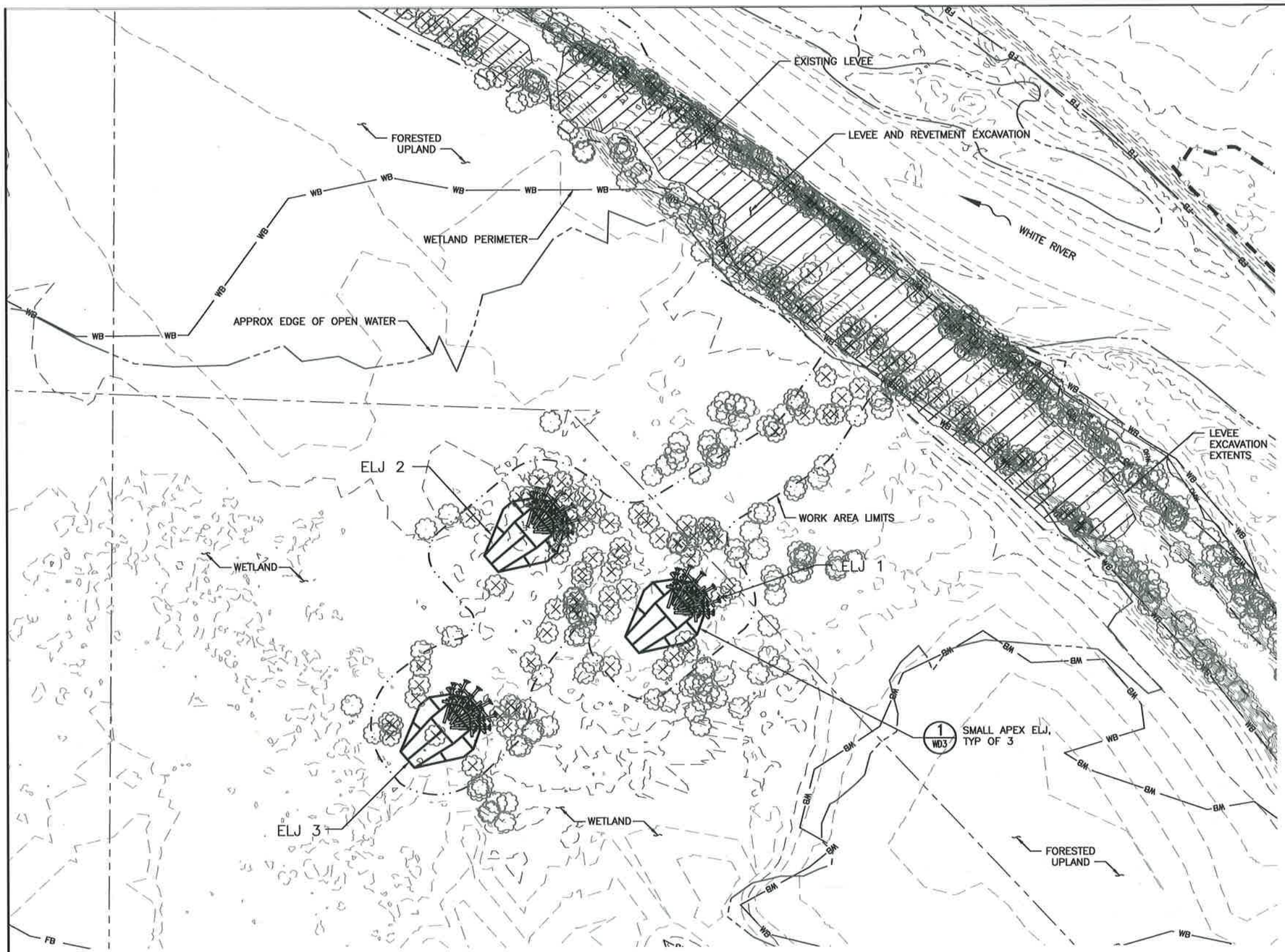
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

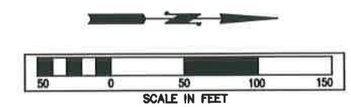
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

SITE PLAN AND PROFILE FOR SETBACK LEVEE AND BIOREVETMENT

SHEET 25 OF 69 SHEETS

SB5




**NOTES:**

1. SEE STRUCTURE LAYERING PLAN ON DWG WD4 FOR LOCATION OF CONTROL POINTS ON EACH STRUCTURE.
2. TEMPORARY ACCESS PATH FROM EXISTING LEVEE THROUGH WETLAND TO ELJs 1, 2 AND 3 SHOWN ON DWG ED2. ADJUST ELEVATION OF PATH AS NEEDED TO ALLOW EQUIPMENT EGRESS THROUGH WETLAND ABOVE ADJACENT SURFACE WATERS. REMOVE PATH FOLLOWING COMPLETION OF ELJ CONSTRUCTION. ADJUST SLOPE OF ACCESS PATH FROM EXISTING LEVEE TO WETLAND AS NEEDED TO ALLOW SAFE EQUIPMENT EGRESS.
3. PLACE VEGETATION THAT IS CLEARED FOR ELJ AND TEMPORARY ACCESS PATH CONSTRUCTION WITHIN LIMITS OF DISTURBED AREAS AND AS DIRECTED BY THE PROJECT REPRESENTATIVE.
4. WORK PLATFORM FOR ELJs 1, 2 AND 3 SHOWN ON DWG ED2. ISOLATE ELJ WORK AREA TO CONTAIN TURBID SURFACE WATER USING A SILT FENCE OR SILT CURTAIN AS SHOWN ON DWG ED2. SILT FENCE/CURTAIN NOT SHOWN FOR CLARITY. REMOVE WORK PLATFORM OUTSIDE OF FOOTPRINT OF ELJ FOLLOWING COMPLETION OF ELJ CONSTRUCTION.

**SMALL APEX ELJ CONTROL POINT TABLE:**

| ITEM | CP | NORTHING | EASTING |
|---|---|---|---|
| ELJ 1 | 1 | | |
| | 2 | | |
| ELJ 2 | 1 | | |
| | 2 | | |
| ELJ 3 | 1 | | |
| | 2 | | |

NOTE: TABLE TO BE COMPLETED FOR FINAL DESIGN.

**LEGEND:**

- LEVEE AND REVETMENT EXCAVATION
- WORK AREA LIMITS
- EDGE OF OPEN WATER
- EXISTING TREE (TO REMAIN)
- EXISTING TREE (TO BE REMOVED)

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
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| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION
ELJ SITE PLAN (SHEET 1 OF 2)

SHEET 26 OF 69 SHEETS

WS1

SCALE IN FEET: 50 0 50 100 150

**NOTES:**

1. SEE STRUCTURE LAYERING PLANS ON DWGS WD2, WD6, AND WD8 FOR LOCATION OF CONTROL POINTS ON EACH STRUCTURE.
2. SEE DWGS SB1 THROUGH SB5 FOR DESIGN RELATED INFORMATION FOR THE BIOREVETMENT.
3. TEMPORARY ACCESS PATH FOR ELJ 4 SHOWN ON DWG ED3. ADJUST ELEVATION OF PATH AS NEEDED TO ALLOW EQUIPMENT EGRESS THROUGH WETLAND ABOVE ADJACENT SURFACE WATERS. REMOVE PATH FOLLOWING COMPLETION OF ELJ CONSTRUCTION.
4. WORK PLATFORM FOR ELJs 4, 5, 6, 7 AND 8 SHOWN ON DWGS ED3 AND ED4. ISOLATE ELJ WORK AREA TO CONTAIN TURBID SURFACE WATER USING A SILT FENCE OR SILT CURTAIN AS SHOWN ON DWGS ED3 AND ED4. SILT FENCE/CURTAIN NOT SHOWN FOR CLARITY. REMOVE WORK PLATFORM OUTSIDE OF FOOTPRINT OF EACH ELJ FOLLOWING COMPLETION OF ELJ CONSTRUCTION.
5. FINAL GRADE OVER BIOREVETMENT BETWEEN ELJs 5, 6, 7, AND 8 IS 73'.

**LARGE APEX AND BANK DEFLECTOR ELJ CONTROL POINT TABLE:**

| ITEM | CP | NORTHING | EASTING |
|---|---|---|---|
| ELJ 4 | 1 | | |
| | 2 | | |
| ELJ 5 | 1 | | |
| | 2 | | |
| | 3 | | |
| | 4 | | |
| | 5 | | |
| ELJ 6 | 1 | | |
| | 2 | | |
| | 3 | | |
| | 4 | | |
| | 5 | | |
| ELJ 7 | 1 | | |
| | 2 | | |
| | 3 | | |
| | 4 | | |
| | 5 | | |
| ELJ 8 | 1 | | |
| | 2 | | |
| | 3 | | |
| | 4 | | |
| | 5 | | |

NOTE: TABLE TO BE COMPLETED FOR FINAL DESIGN.

**LEGEND:**

- LEVEE AND REVETMENT EXCAVATION
- WORK AREA LIMITS
- EDGE OF OPEN WATER
- EXISTING TREE (TO REMAIN)
- EXISTING TREE (TO BE REMOVED)

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN R. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

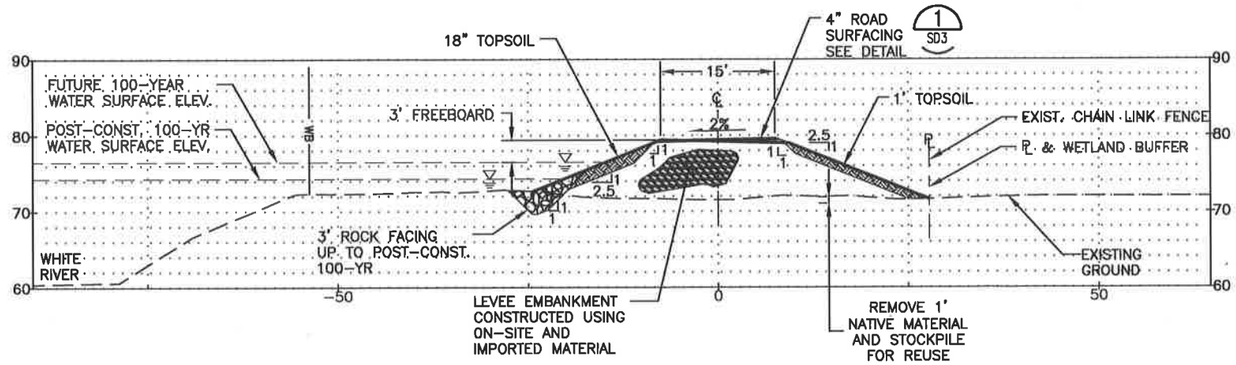
HERRERA

King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

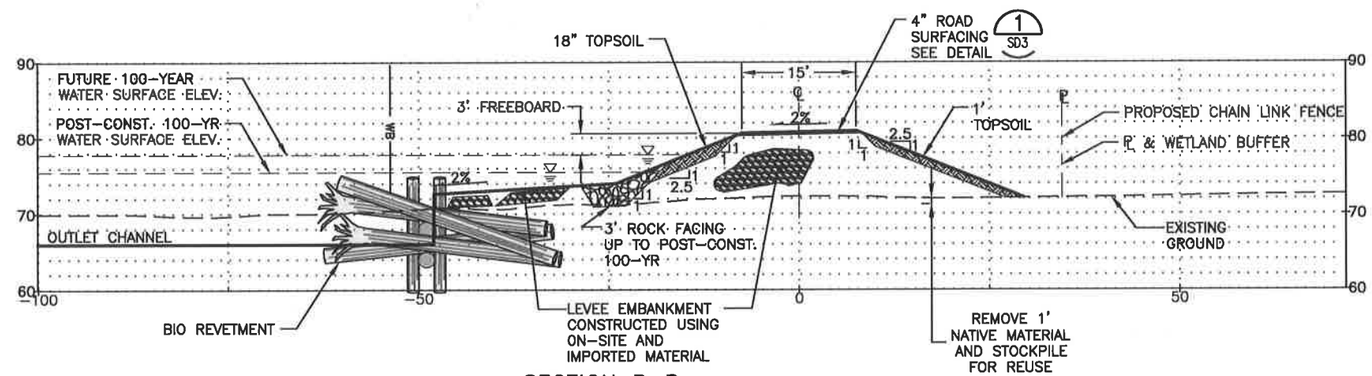
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION
ELJ SITE PLAN (SHEET 2 OF 2)

SHEET 27 OF 69 SHEETS

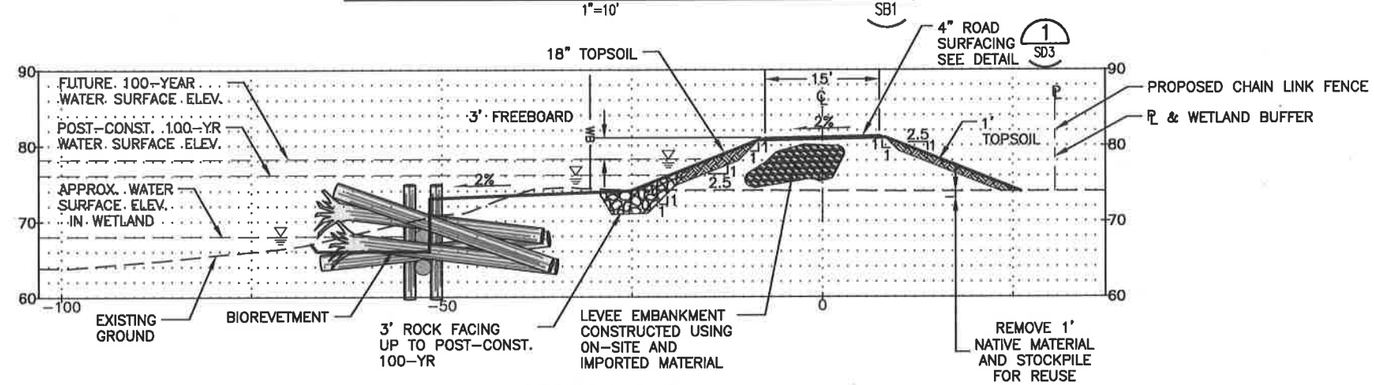
WS2



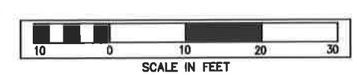

SECTION A-A
STA. 3+93
1"=10'
A SB1




SECTION B-B
STA. 11+04
1"=10'
B SB1




SECTION C-C
STA. 13+25
1"=10'
C SB2

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|---|---|---|---|---|
| FIELD BOOK: | | | | |
| SURVEYED: | | | | |
| SURVEY BASE MAP: | | | | |
| CHECKED: | | | | |
| NUM. | REVISION | BY | DATE | |

CADD / 60%
5-2013

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER
STATE OF WASHINGTON
40893
REGISTERED
PROFESSIONAL ENGINEER

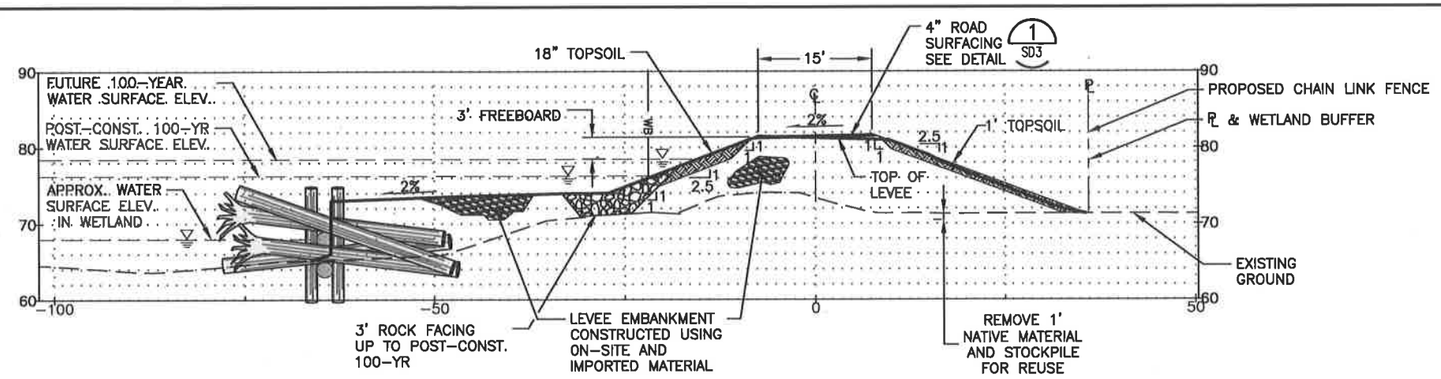
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

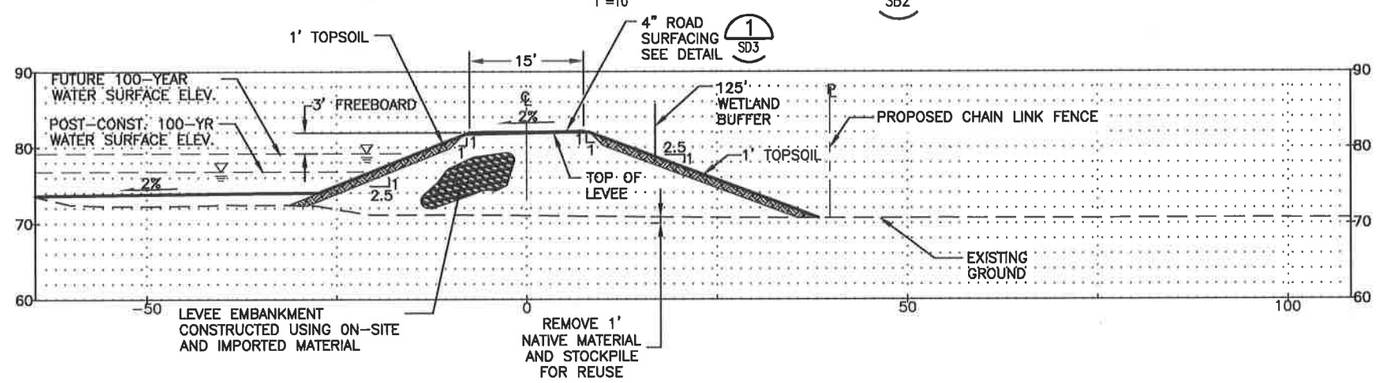
SETBACK LEVEE CROSS SECTIONS AND DETAILS

SHEET 28 OF 69 SHEETS

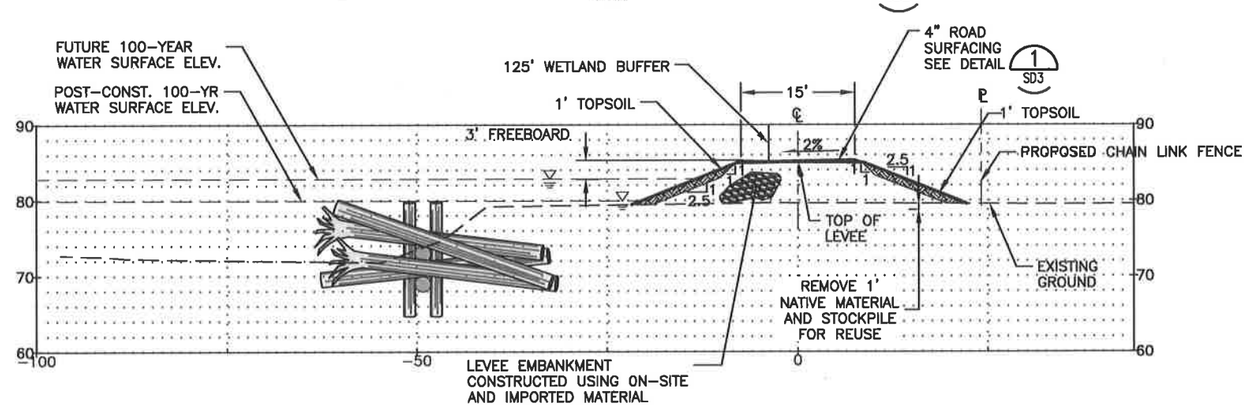
SD1



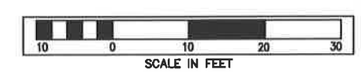

SECTION D-D
STA. 15+66
1"=10'
D SB2




SECTION E-E
STA. 19+20
1"=10'
E SB2




SECTION F-F
STA. 41+65
1"=10'
F SB4

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|---|---|---|---|---|---|---|---|
| FIELD BOOK: | | | | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C | |
| SURVEYED: | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) | |
| SURVEY BASE MAP: | | | | DESIGNED: CHRIS BRUMMER, PE | 4-2013 | | |
| CHECKED: | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | | |
| | | NUM. | REVISION / BY / DATE | DESIGN ENTERED: LICA DULAN | 4-2013 | | |

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CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40095 REGISTERED PROFESSIONAL ENGINEER

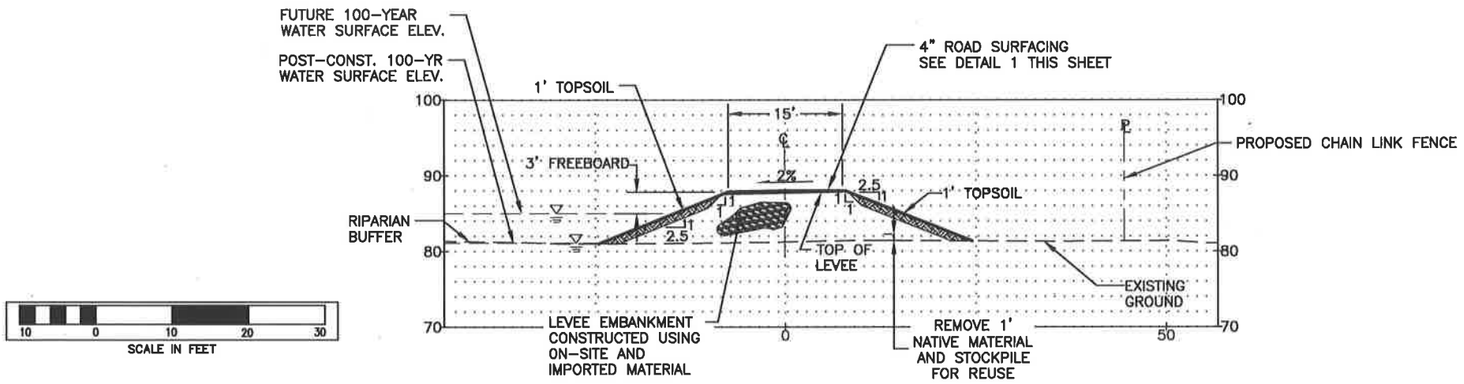
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

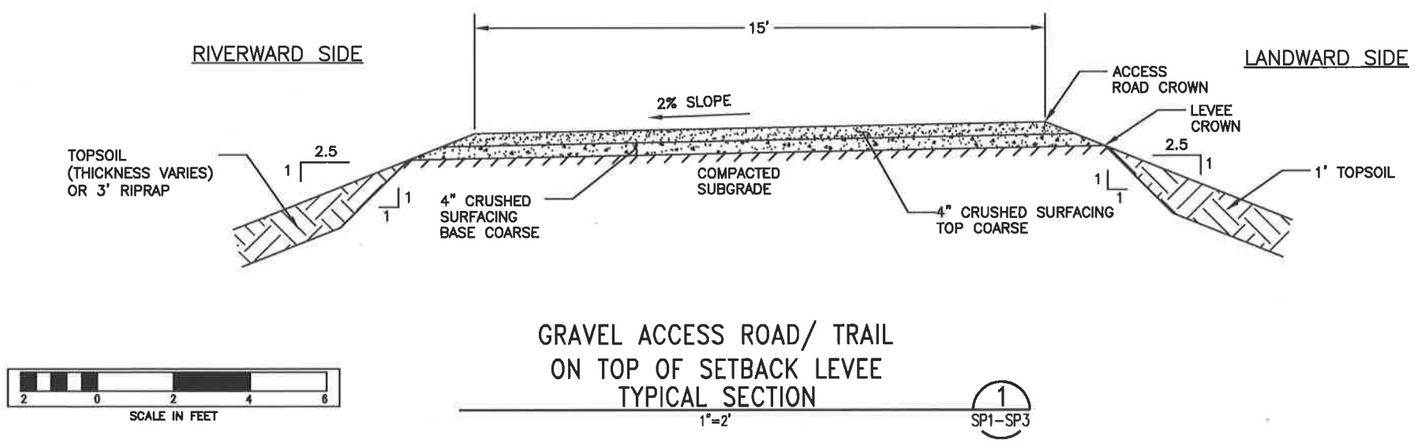
SETBACK LEVEE CROSS SECTIONS AND DETAILS

SHEET 29 OF 69 SHEETS

SD2




SECTION G-G
STA. 57+00
1"=10'
G
SB5




GRAVEL ACCESS ROAD/ TRAIL
ON TOP OF SETBACK LEVEE
TYPICAL SECTION
1"=2'
1
SP1-SP3

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

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5-2013

| NUM. | REVISION | BY | DATE |
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| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
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| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C
PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER, STATE OF WASHINGTON, 40995, REGISTERED PROFESSIONAL ENGINEER

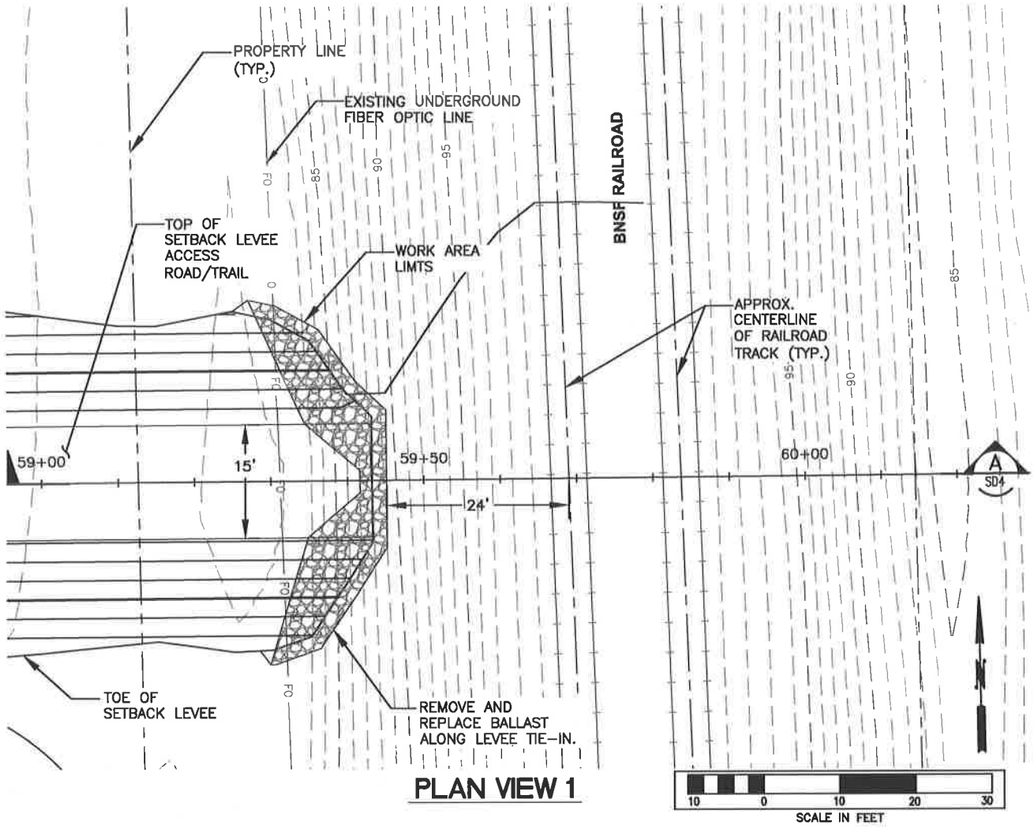
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

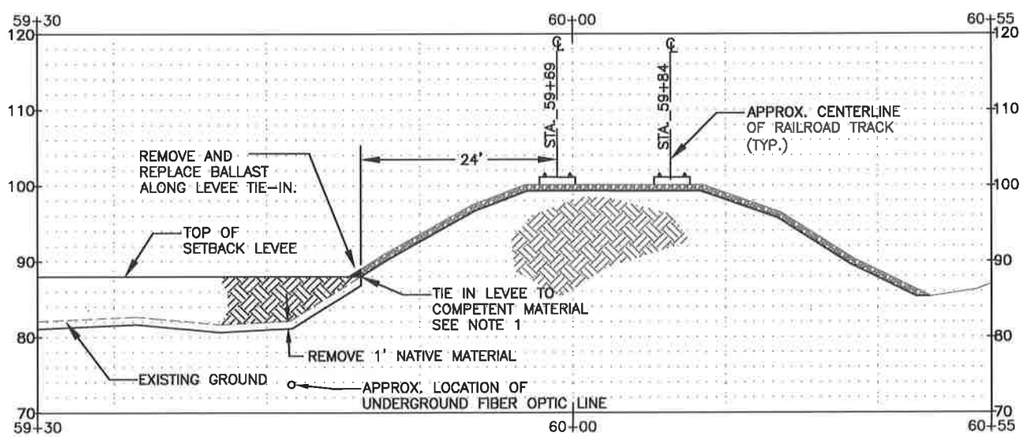
SETBACK LEVEE CROSS SECTIONS AND DETAILS

SHEET 30 OF 69 SHEETS

SD3



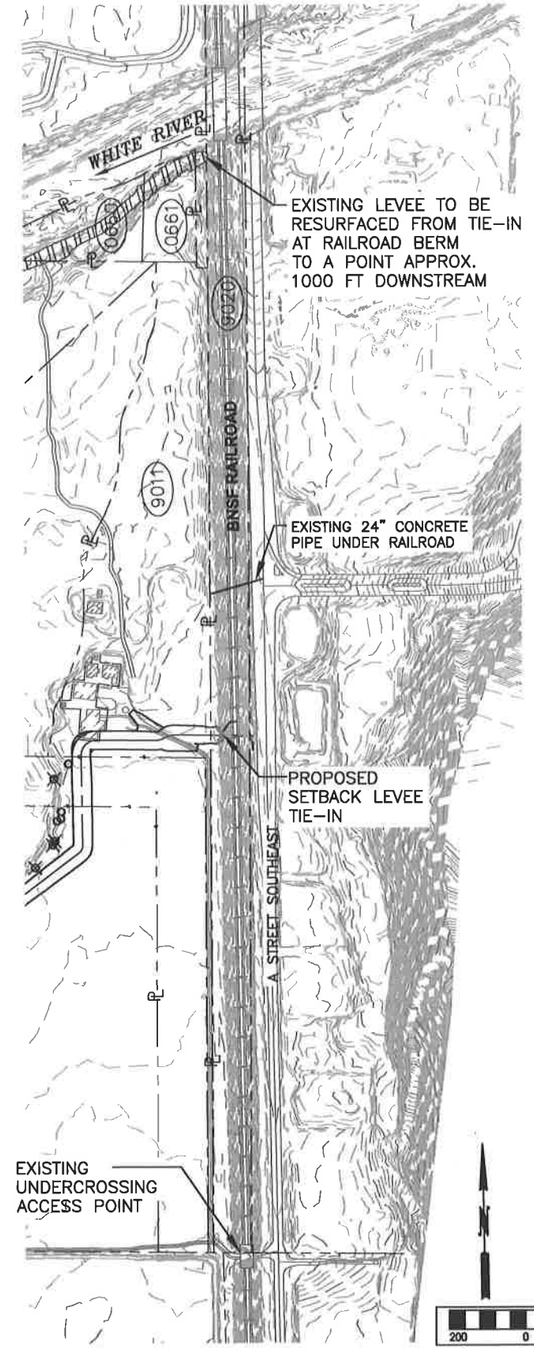

## PLAN VIEW 1




## SECTION

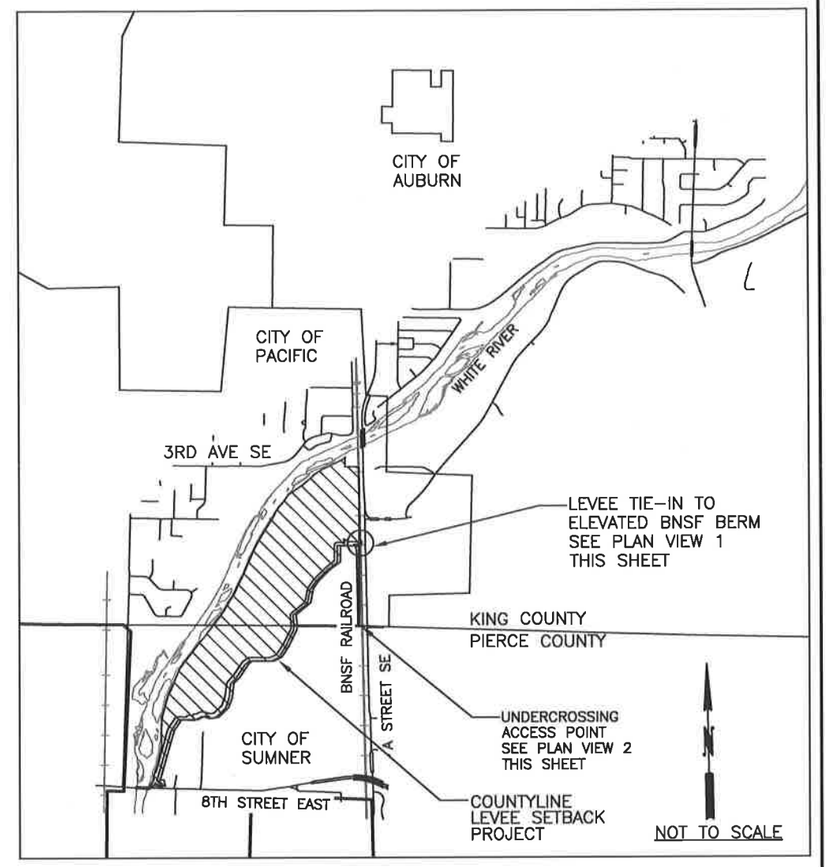
SCALE: 1"=10' HORIZ., 1"=10' VERT.

A
SD4




## PLAN VIEW 2

## VICINITY MAP




**NOTES:**

1. DRILL EXPLORATORY BORING TO CONFIRM DEPTH TO COMPETENT MATERIAL.
2. REMOVE EXISTING ROCK BALLAST FROM RAILROAD BERM WITHIN WORK AREA LIMITS AND EXPOSE COMPETENT MATERIAL.
3. SCARIFY EXPOSED SURFACE OF RAILROAD BERM AND PLACE SOIL LIFTS FOR SETBACK LEVEE TO FINISHED GRADES AS SHOWN ON THE PLANS.
4. REPLACE ROCK BALLAST ON RAILROAD BERM AND PLACE ADDITIONAL BALLAST OVER SETBACK LEVEE SLOPE AS SHOWN ON THE PLANS.

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
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| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER, STATE OF WASHINGTON, 40695, REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

SETBACK LEVEE TIE-IN PLAN AND DETAILS

SHEET 31 OF 69 SHEETS

SD4

WHITE RIVER

WORK AREA LIMITS

WORK AREA LIMITS

APPROX. EDGE OF OPEN WATER

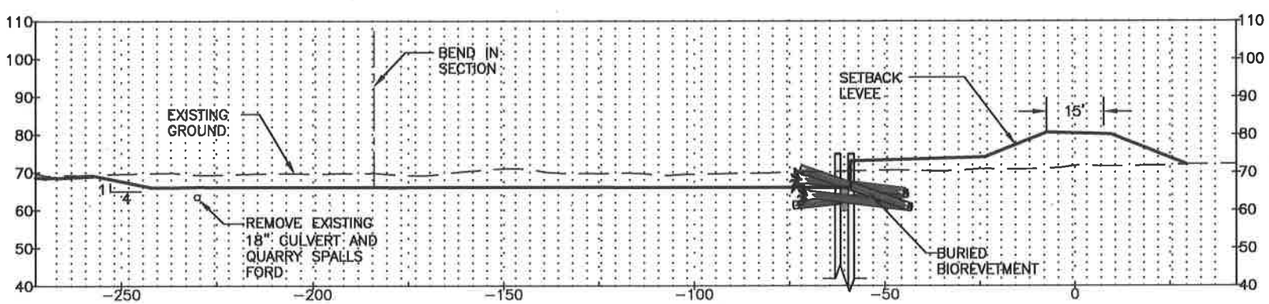
BIOREVETMENT

SETBACK LEVEE

PROPOSED PROPERTY LINE

7+00 8+00 9+00 10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 20+00

SCALE IN FEET




SCALE IN FEET

TYPICAL SECTION A DR1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FIELD BOOK: | | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 |
| SURVEYED: | | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 |
| SURVEY BASE MAP: | | | | | | DESIGNED: CHRIS BRUMMER, PE | 4-2013 |
| CHECKED: | | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 |
| | | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 |

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SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40695 REGISTERED PROFESSIONAL ENGINEER

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

SOUTH OUTLET CHANNEL PLAN AND SECTION

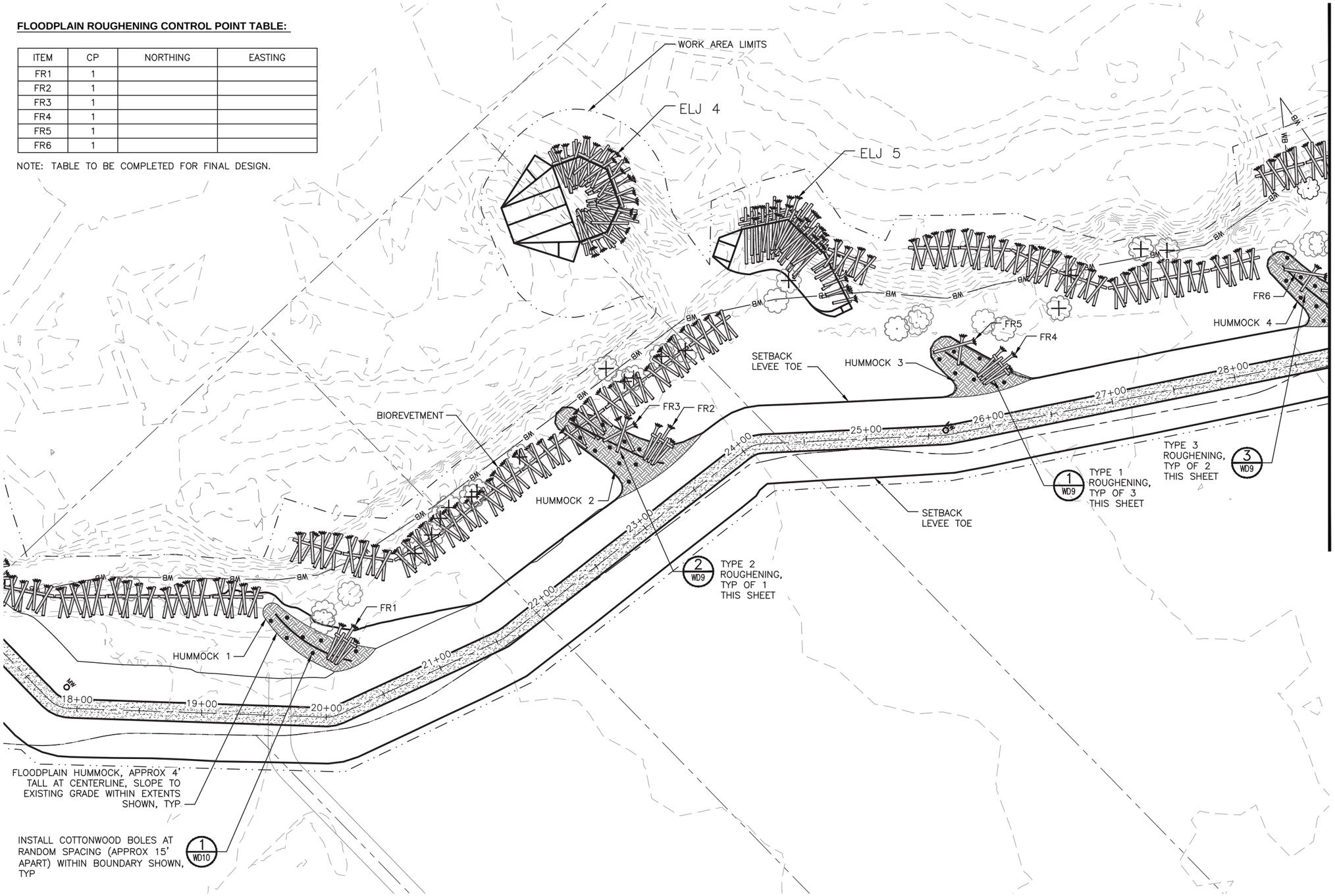
SHEET 32 OF 69 SHEETS

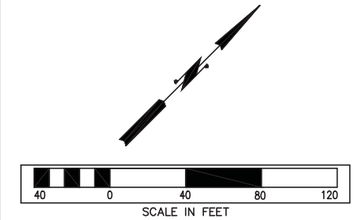
DR1

**FLOODPLAIN ROUGHENING CONTROL POINT TABLE:**

| ITEM | CP | NORTHING | EASTING |
|---|---|---|---|
| FR1 | 1 | | |
| FR2 | 1 | | |
| FR3 | 1 | | |
| FR4 | 1 | | |
| FR5 | 1 | | |
| FR6 | 1 | | |

NOTE: TABLE TO BE COMPLETED FOR FINAL DESIGN.



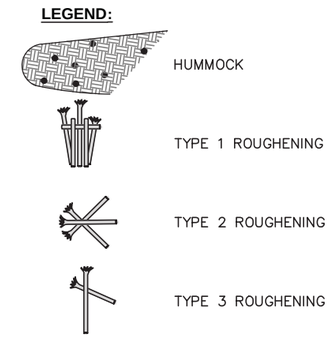




MATCHLINE - SEE SHEET FR2

**NOTES:**

1. CONSTRUCT FLOODPLAIN HUMMOCKS AFTER TYPES 1, 2, AND 3 ROUGHENING ELEMENTS HAVE BEEN INSTALLED.
2. EXTENTS AND ALIGNMENT OF FLOODPLAIN HUMMOCKS ARE APPROXIMATE AND WILL BE VERIFIED BY THE PROJECT REPRESENTATIVE PRIOR TO THEIR CONSTRUCTION.
3. SEE DWG WD9 FOR EXTENTS OF WOOD BURIAL FOR TYPES 1, 2, AND 3 ROUGHENING ELEMENTS.
4. EXTEND FLOODPLAIN HUMMOCKS TO SETBACK LEVEE AS SHOWN. CORE OF HUMMOCKS SHALL BE EITHER LEVEE REMOVAL SPOILS OR SURPLUS BIOREVETMENT EXCAVATION SPOILS PLACED IN 12" DEEP LAYERS. PLACE A 12" DEEP LAYER OF NATIVE TOPSOIL OVER CORE. COMPACT CORE LAYERS WITH BACKSIDE OF EXCAVATOR BUCKET. DO NOT COMPACT TOPSOIL.
5. SEE PLANTING PLAN FOR FLOODPLAIN HUMMOCK PLANTING DETAILS AND FOR PLANTING DETAILS OVER TYPES 1, 2, AND 3 ROUGHENING ELEMENTS.

**LEGEND:**




FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

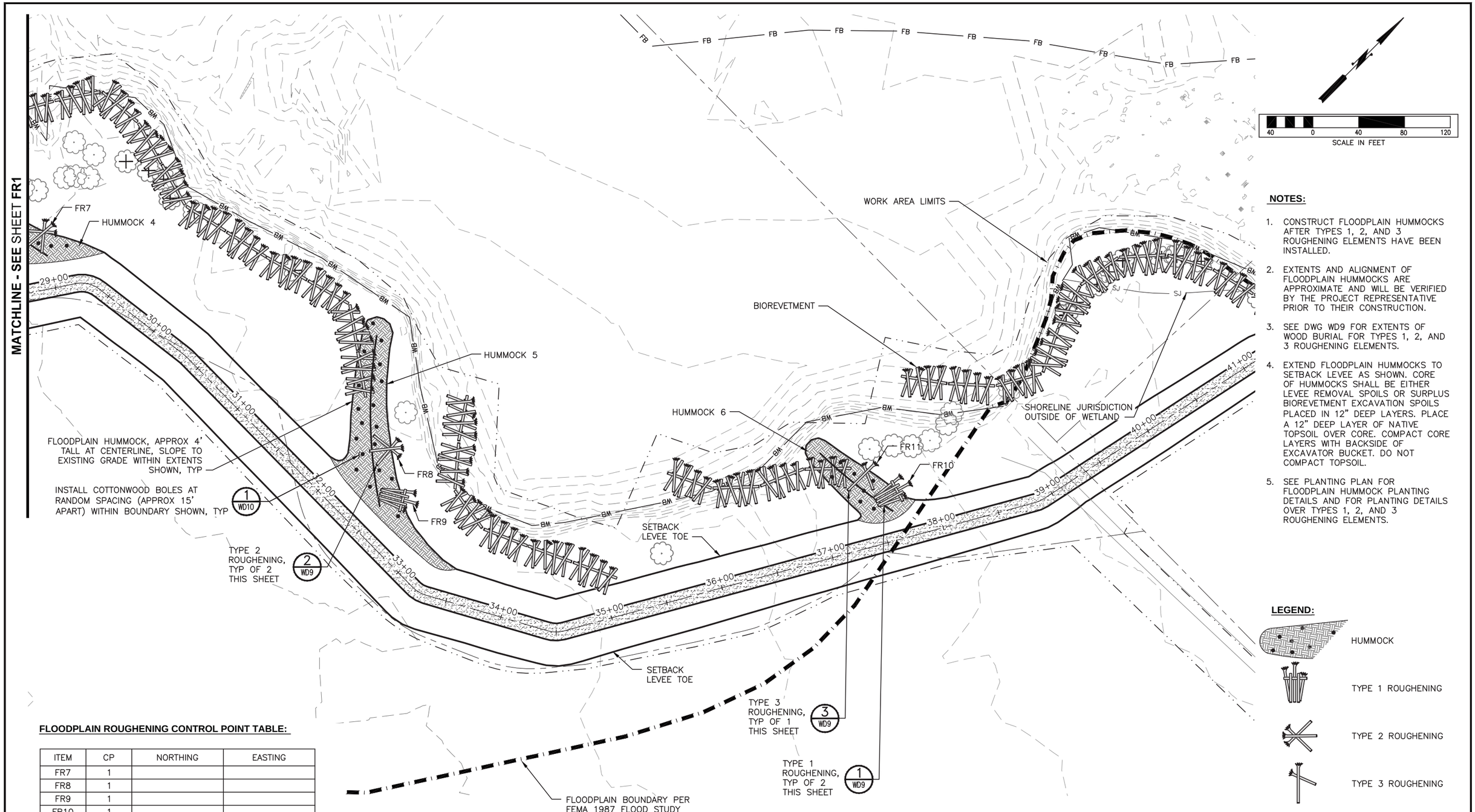
King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

FLOODPLAIN ROUGHENING PLAN
(SHEET 1 OF 2)

SHEET 33 OF 69 SHEETS

FR1




**NOTES:**

1. CONSTRUCT FLOODPLAIN HUMMOCKS AFTER TYPES 1, 2, AND 3 ROUGHENING ELEMENTS HAVE BEEN INSTALLED.
2. EXTENTS AND ALIGNMENT OF FLOODPLAIN HUMMOCKS ARE APPROXIMATE AND WILL BE VERIFIED BY THE PROJECT REPRESENTATIVE PRIOR TO THEIR CONSTRUCTION.
3. SEE DWG WD9 FOR EXTENTS OF WOOD BURIAL FOR TYPES 1, 2, AND 3 ROUGHENING ELEMENTS.
4. EXTEND FLOODPLAIN HUMMOCKS TO SETBACK LEVEE AS SHOWN. CORE OF HUMMOCKS SHALL BE EITHER LEVEE REMOVAL SPOILS OR SURPLUS BIOREVETMENT EXCAVATION SPOILS PLACED IN 12" DEEP LAYERS. PLACE A 12" DEEP LAYER OF NATIVE TOPSOIL OVER CORE. COMPACT CORE LAYERS WITH BACKSIDE OF EXCAVATOR BUCKET. DO NOT COMPACT TOPSOIL.
5. SEE PLANTING PLAN FOR FLOODPLAIN HUMMOCK PLANTING DETAILS AND FOR PLANTING DETAILS OVER TYPES 1, 2, AND 3 ROUGHENING ELEMENTS.

**FLOODPLAIN ROUGHENING CONTROL POINT TABLE:**

| ITEM | CP | NORTHING | EASTING |
|---|---|---|---|
| FR7 | 1 | | |
| FR8 | 1 | | |
| FR9 | 1 | | |
| FR10 | 1 | | |
| FR11 | 1 | | |

NOTE: TABLE TO BE COMPLETED FOR FINAL DESIGN.

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

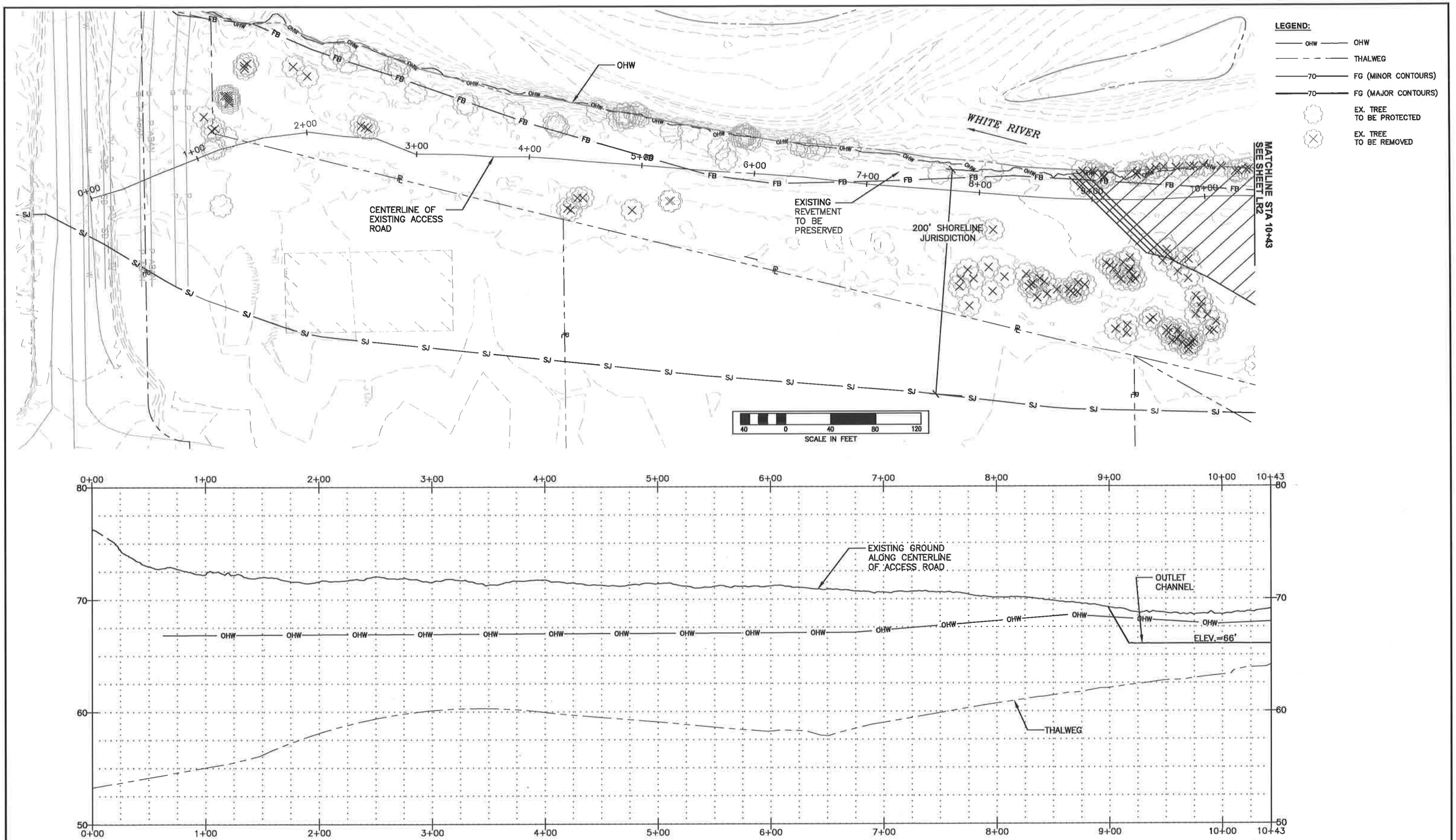
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

FLOODPLAIN ROUGHENING PLAN
(SHEET 2 OF 2)

SHEET 34 OF 69 SHEETS

FR2




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FIELD BOOK: | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C |
| SURVEYED: | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) |
| SURVEY BASE MAP: | | | | | DESIGNED: CHRIS BRUMMER, PE | 4-2013 | |
| CHECKED: | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | |
| | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | |

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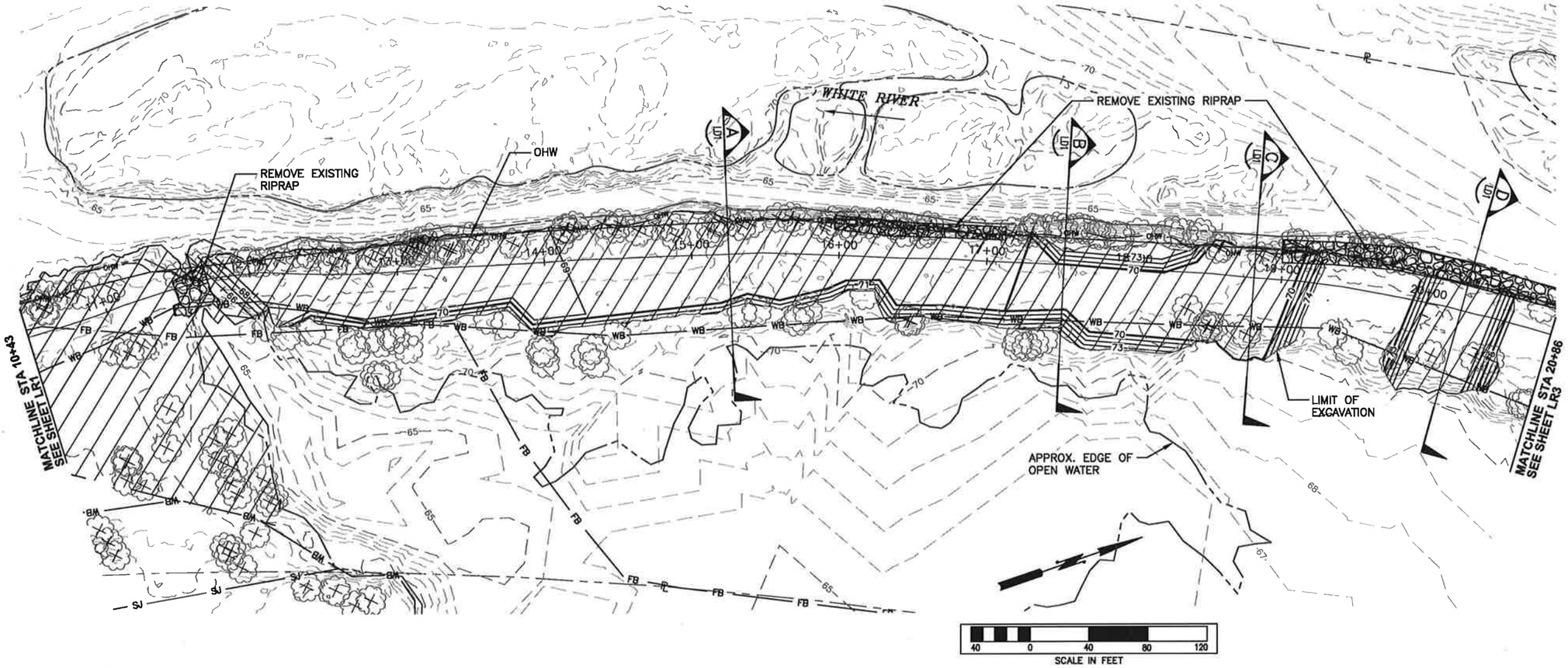
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

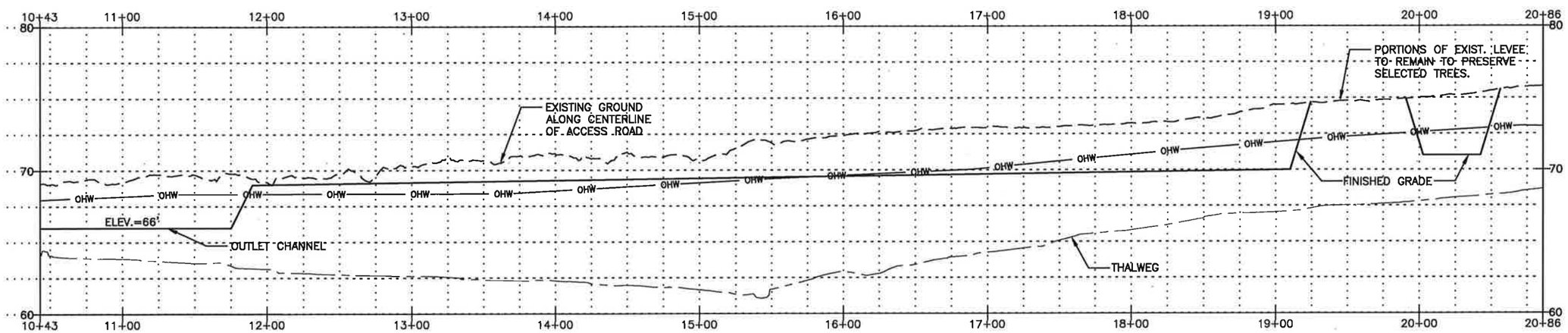
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

LEVEE EXCAVATION PLAN AND PROFILE

SHEET 35 OF 69 SHEETS

LR1

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|---|---|---|---|---|---|---|---|
| FIELD BOOK: | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C |
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| SURVEY BASE MAP: | | | | | DESIGNED: CHRIS BRUMMER, PE | 4-2013 | |
| CHECKED: | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | |
| | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | |

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CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40093 REGISTERED PROFESSIONAL ENGINEER

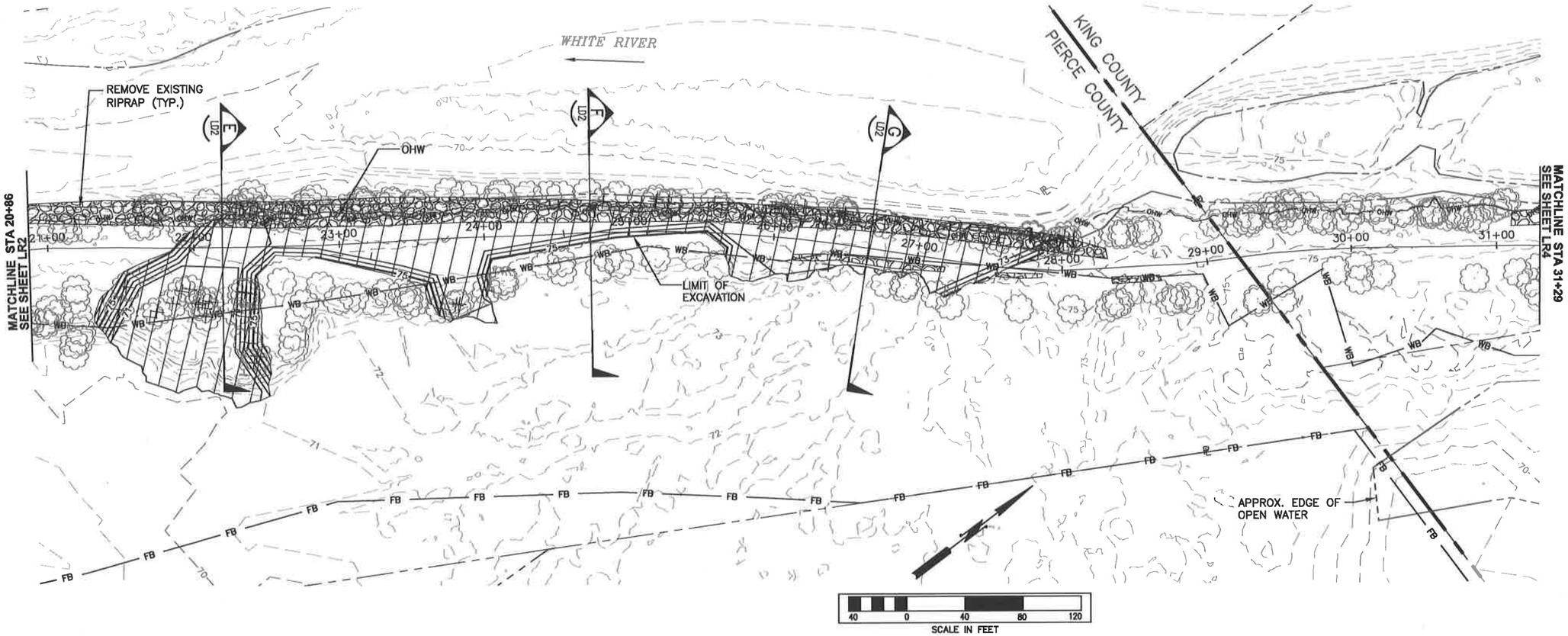
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

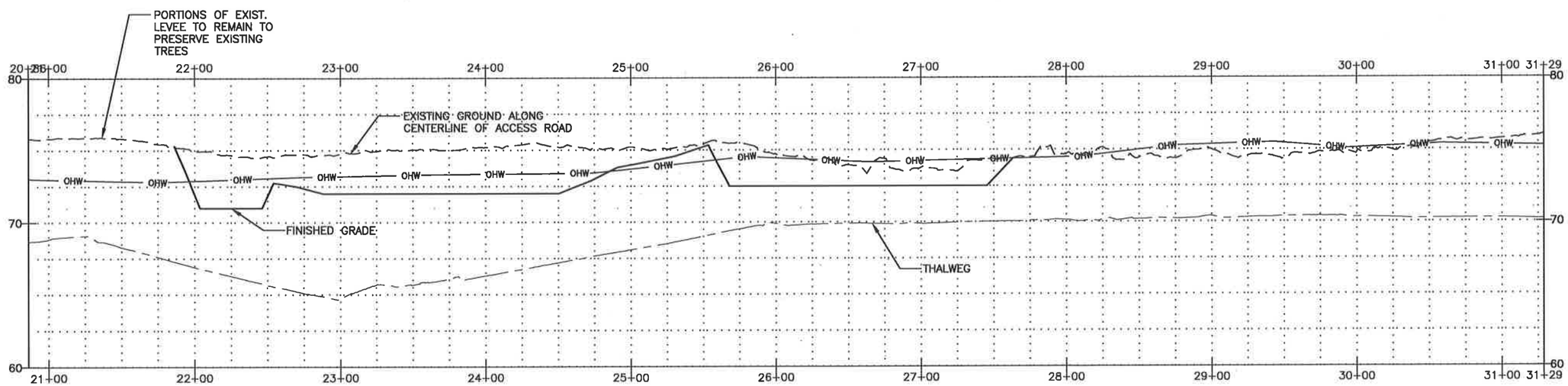
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

LEVEE EXCAVATION PLAN AND PROFILE

SHEET 36 OF 69 SHEETS

LR2




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FIELD BOOK: | | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4–2013 |
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| | | | | | | DESIGN ENTERED: LICA DULAN | 4–2013 |

CADD / 60% 5-2013

SRFB # RCO 087–1910C

PROJECT No. 1112049 (FL9001)

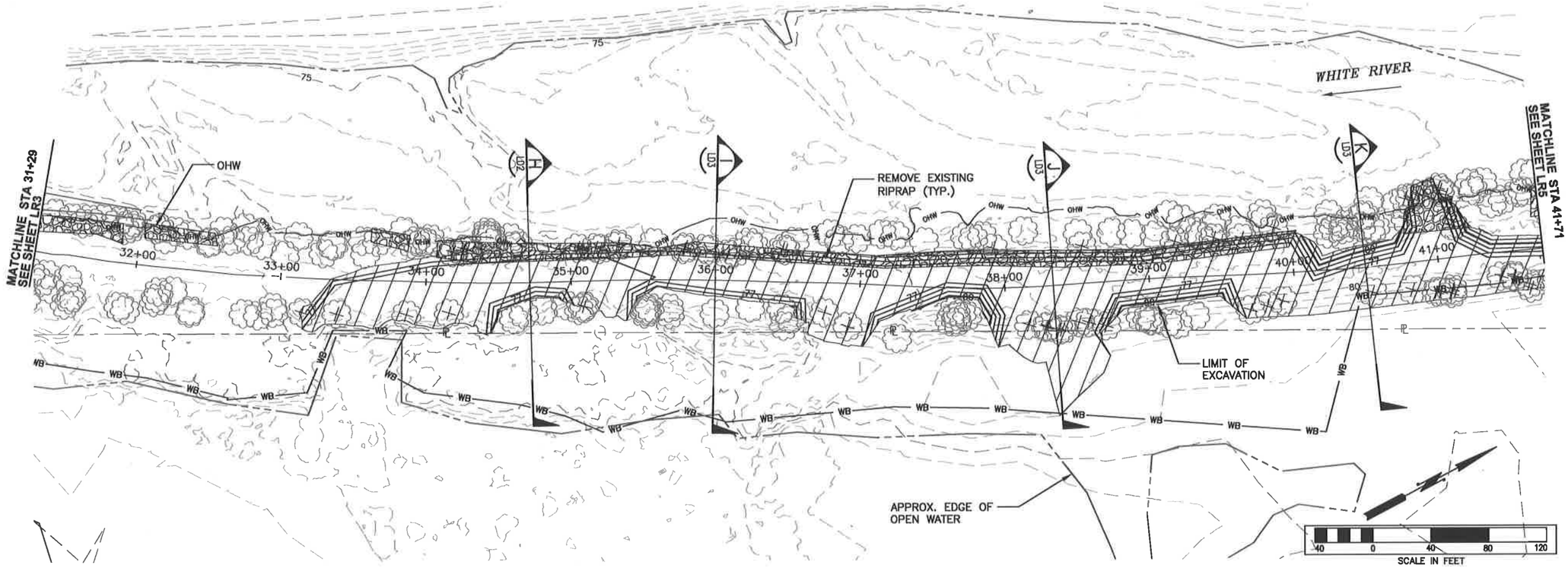
CHRISTOPHER JON BRUMMER STATE OF WASHINGTON 40995 REGISTERED PROFESSIONAL ENGINEER

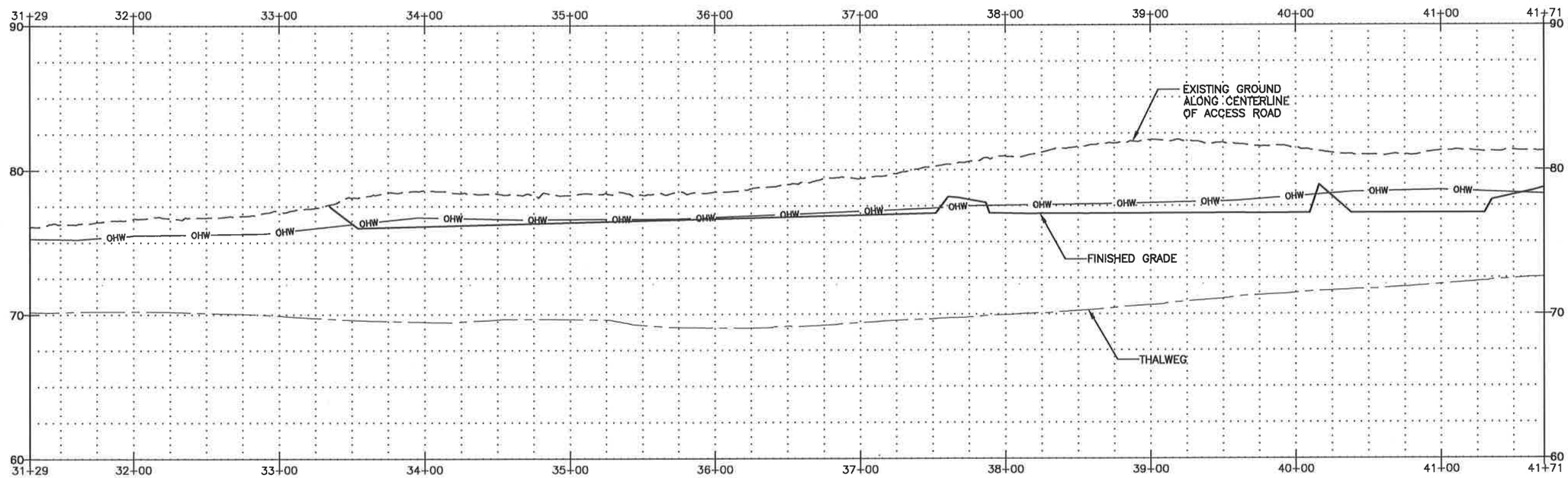
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION
LEVEE EXCAVATION PLAN AND PROFILE

SHEET 37 OF 69 SHEETS

LR3




FIELD BOOK:
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SURVEY BASE MAP:
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| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER
STATE OF WASHINGTON
40695
REGISTERED
PROFESSIONAL ENGINEER

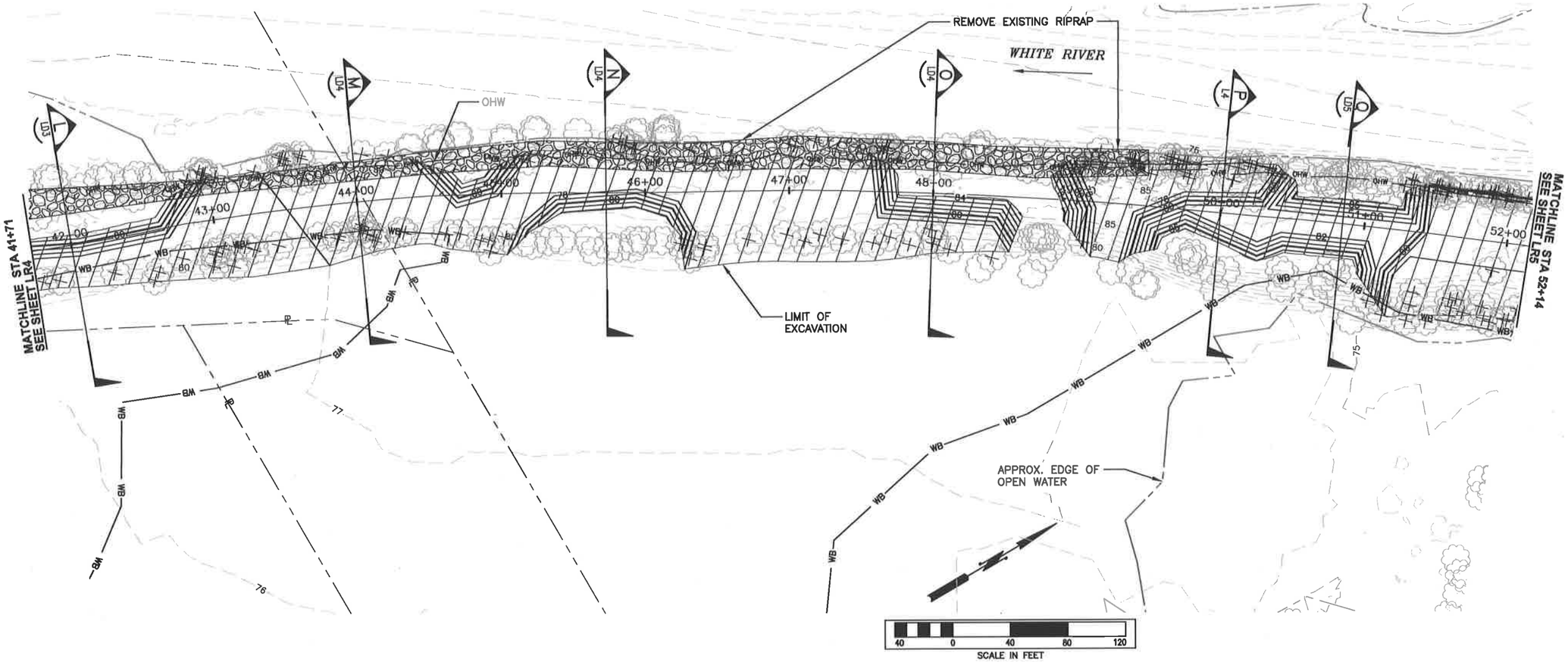
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

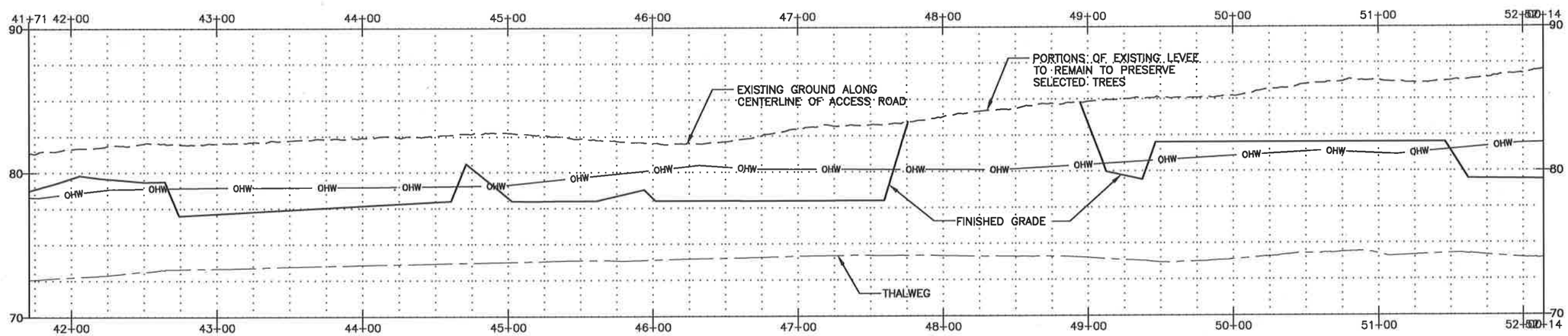
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

LEVEE EXCAVATION PLAN AND PROFILE

SHEET 38 OF 69 SHEETS

LR4




FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER
STATE OF WASHINGTON
40695
REGISTERED
PROFESSIONAL ENGINEER

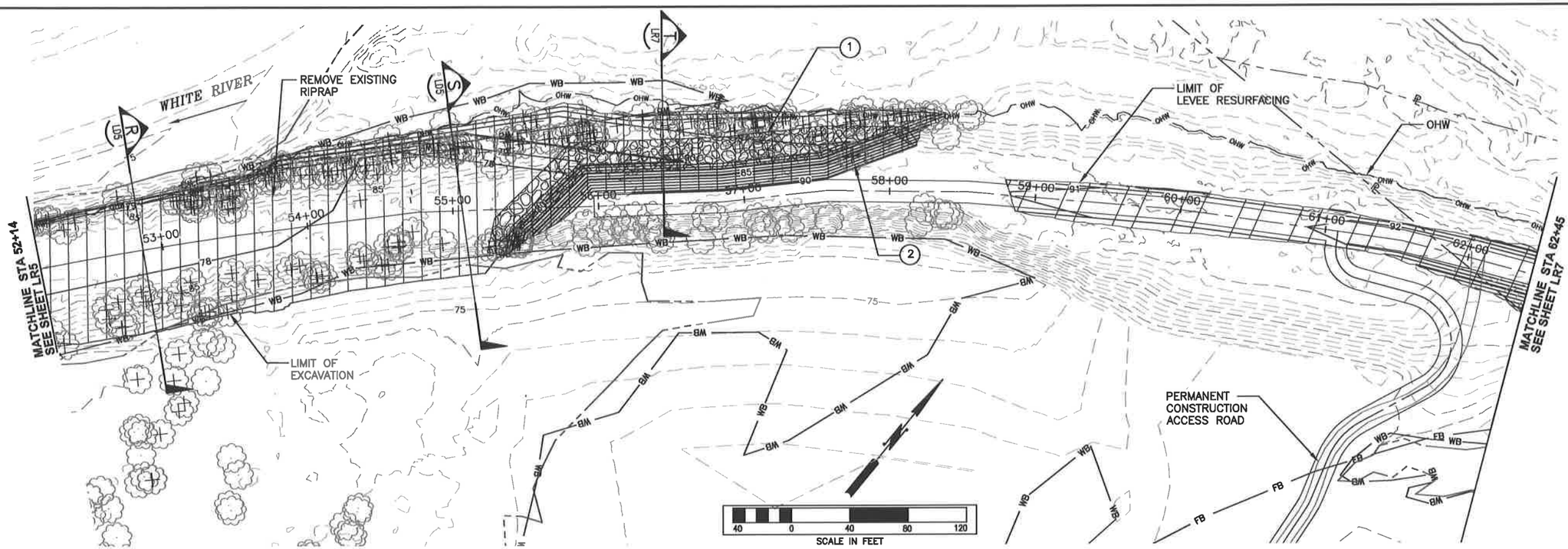
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

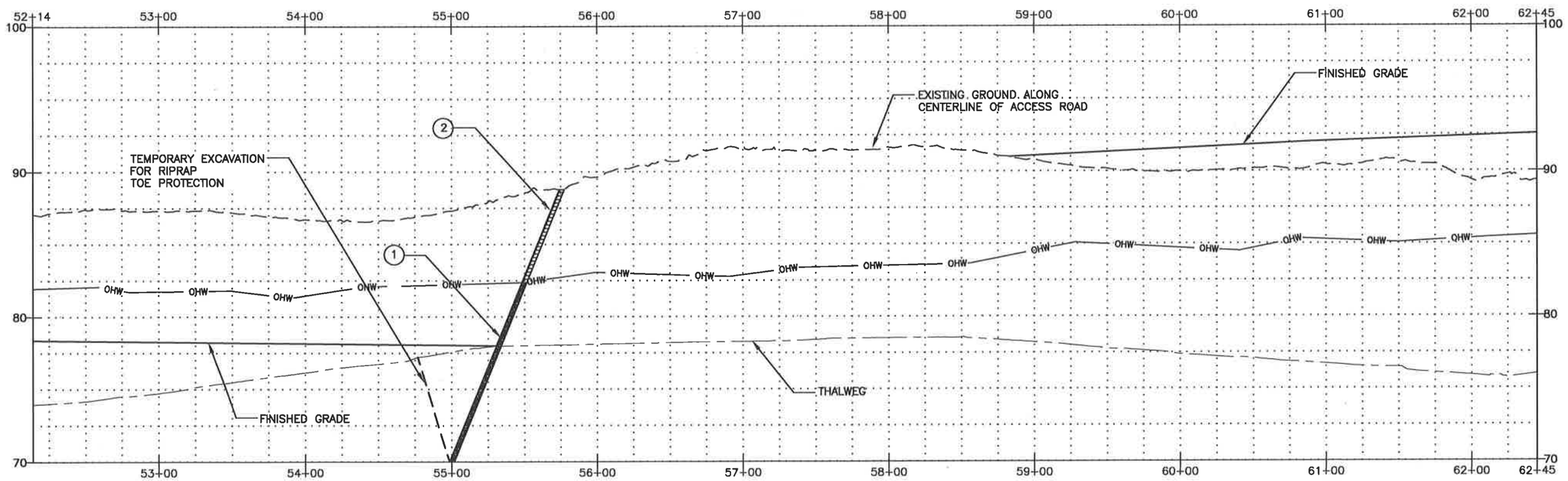
LEVEE EXCAVATION PLAN AND PROFILE

SHEET 39 OF 69 SHEETS

LR5




1. PLACE RIPRAP TOE PROTECTION BETWEEN ELEV 70' AND 83' (OHW)
2. INSTALL BIO-ENGINEERED BANK STABILIZATION FROM ELEV 83' (OHW) TO TOP OF BANK

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|---|---|---|---|---|---|
| FIELD BOOK: | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C | | |
| SURVEYED: | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) | | |
| SURVEY BASE MAP: | DESIGNED: CHRIS BRUMMER, PE | 4-2013 | | | |
| CHECKED: | ECOLOGIST: SARAH McCARTHY | 4-2013 | | | |
| | DESIGN ENTERED: LICA DULAN | 4-2013 | | | |

CADD / 60% 5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

CHRISTOPHER JON BRUMMER — STATE OF WASHINGTON — 40895 — REGISTERED PROFESSIONAL ENGINEER

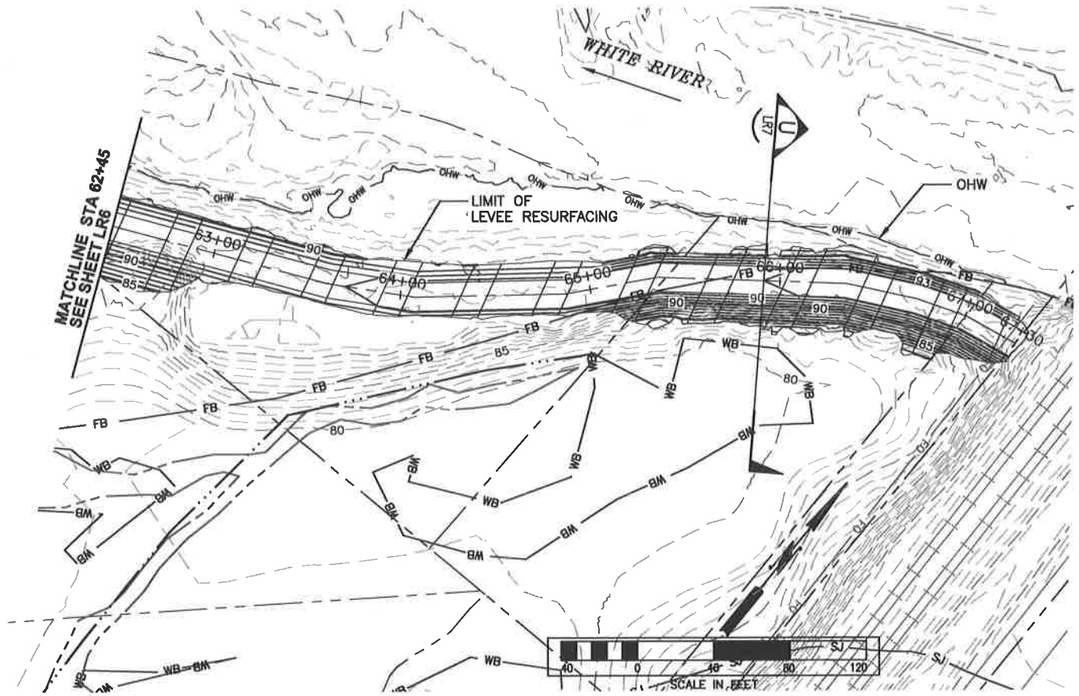
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

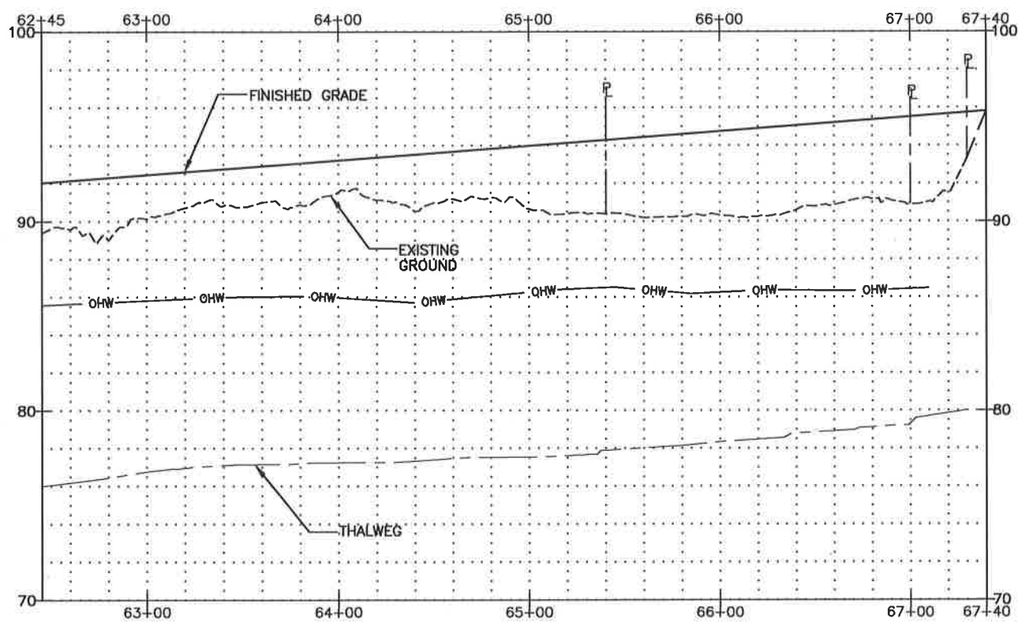
COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

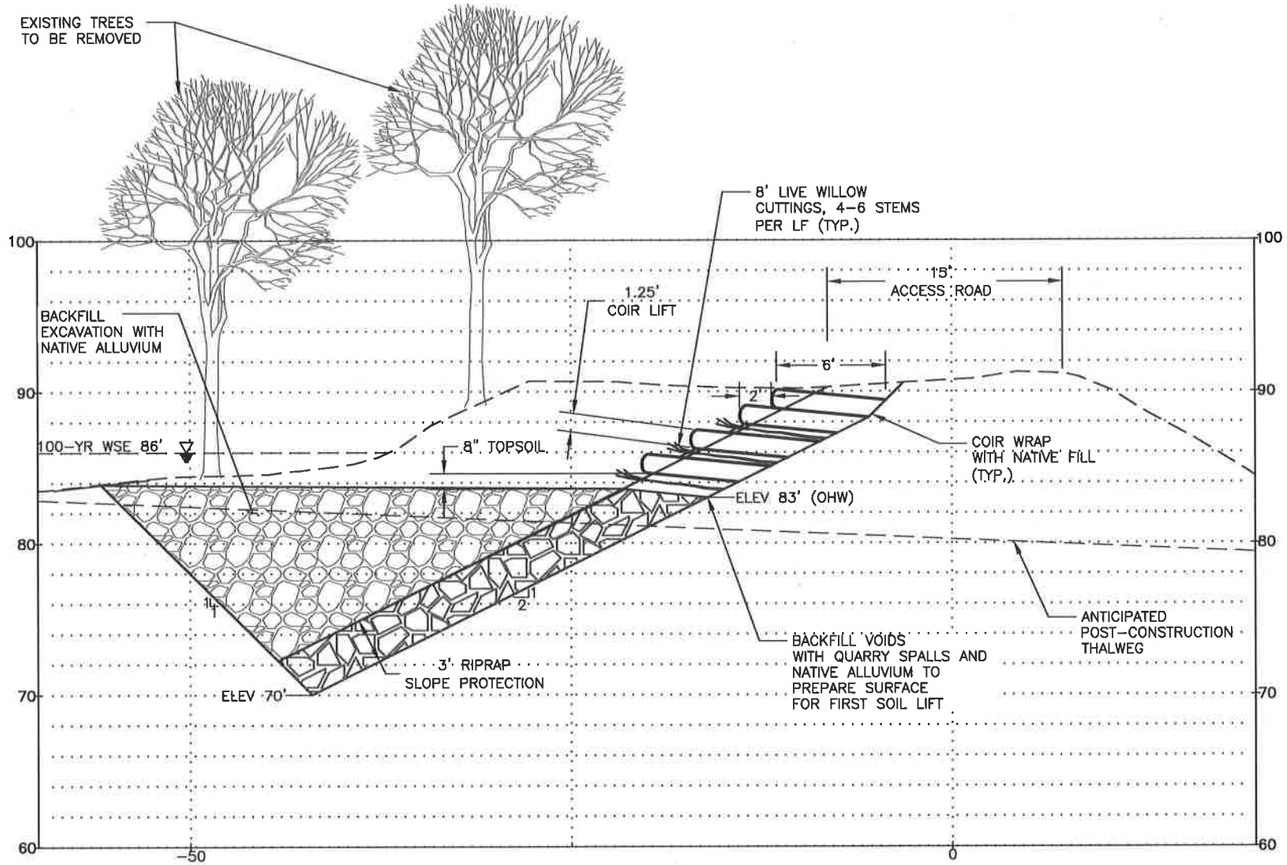
LEVEE EXCAVATION PLAN AND PROFILE

SHEET 40 OF 69 SHEETS

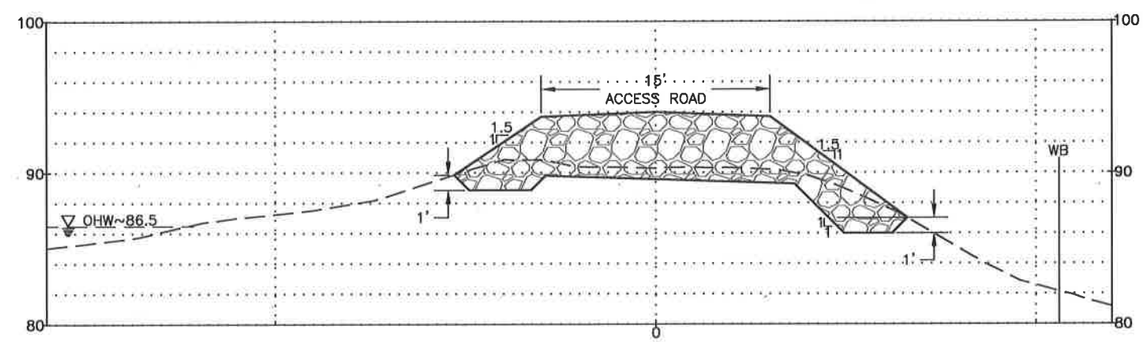
LR6




SECTION T–T
LEVEE TOE AND BANK PROTECTION
1"=5'
T
LR6




SECTION U–U
LEVEE RESURFACING
1"=5'
U
LR7

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FIELD BOOK: | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4–2013 | SRFB # RCO 087–1910C |
| SURVEYED: | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4–2013 | PROJECT No. 1112049 (FL9001) |
| SURVEY BASE MAP: | | | | | DESIGNED: CHRIS BRUMMER, PE | 4–2013 | |
| CHECKED: | | | | | ECOLOGIST: SARAH McCARTHY | 4–2013 | |
| | | | | | DESIGN ENTERED: LICA DULAN | 4–2013 | |

CADD / 60%
5–2013

CHRISTOPHER JON BRUMMER
STATE OF WASHINGTON
40665
REGISTERED
PROFESSIONAL ENGINEER

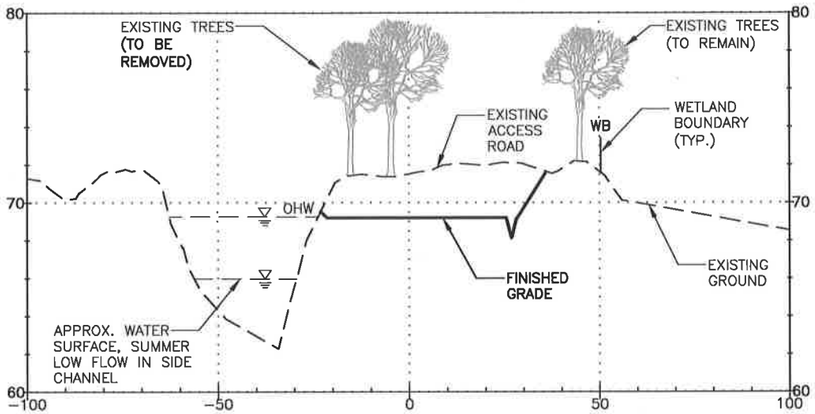
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION
LEVEE EXCAVATION PLAN AND PROFILE

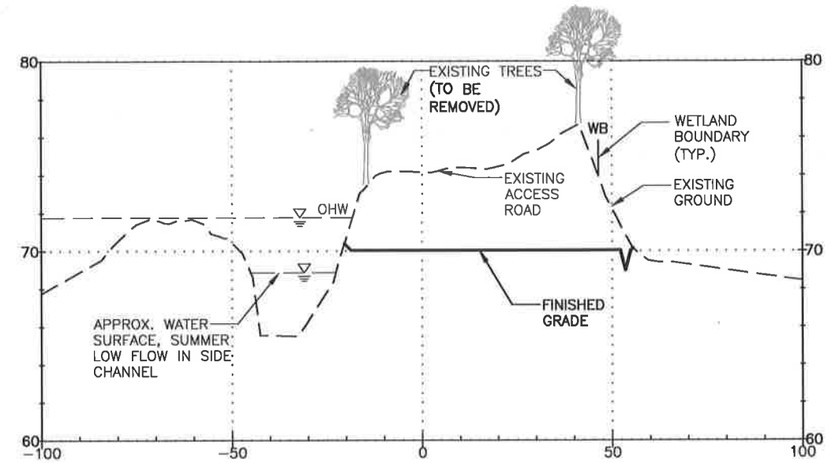
SHEET 41 OF 69 SHEETS
LR7

NOT USED

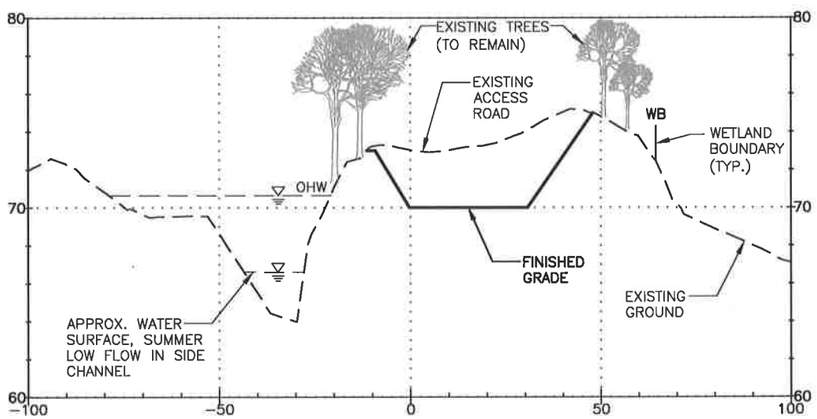
| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FIELD BOOK: | | | | | | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C | | King County<br>Department of Natural Resources and Parks<br>Water and Land Resources Division<br>**River and Floodplain Management Section**<br>*Christie True, Director* | COUNTYLINE LEVEE SETBACK<br>WHITE RIVER, RIVER MILE 5.00-6.33<br>LEVEE MODIFICATION<br>LEVEE EXCAVATION PLAN AND PROFILE | SHEET<br>42<br>OF<br>69<br>SHEETS |
| SURVEYED: | | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) | | | | |
| SURVEY BASE MAP: | | | CADD / 60%<br>5-2013 | | | DESIGNED: CHRIS BRUMMER, PE | 4-2013 | | | | | |
| CHECKED: | | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | | | | | |
| | | NUM. | REVISION | BY | DATE | DESIGN ENTERED: LICA DULAN | 4-2013 | | | | | LR7 |



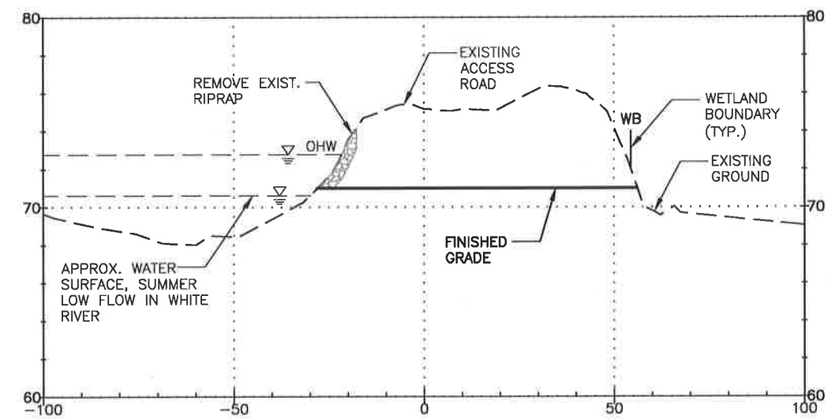

SECTION A–A
STA. 15+25
NTS
A
LR2



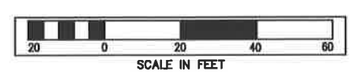

SECTION C–C
STA. 18+81
NTS
C
LR2




SECTION B–B
STA. 17+53
NTS
B
LR2




SECTION D–D
STA. 20+24
NTS
D
LR2

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SRFB # RCO 087–1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER, STATE OF WASHINGTON, 40995, REGISTERED PROFESSIONAL ENGINEER

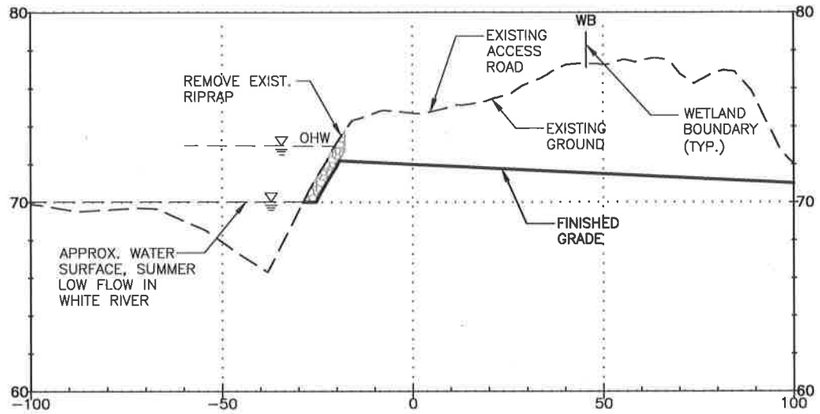
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

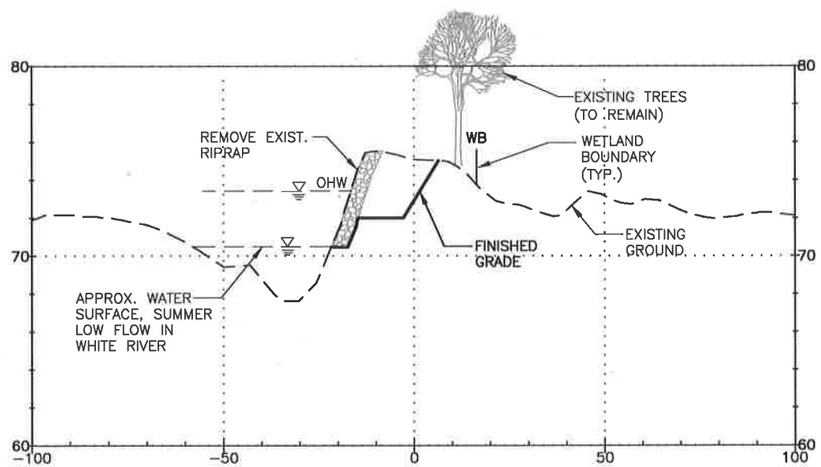
LEVEE EXCAVATION CROSS SECTIONS

SHEET 43 OF 69 SHEETS

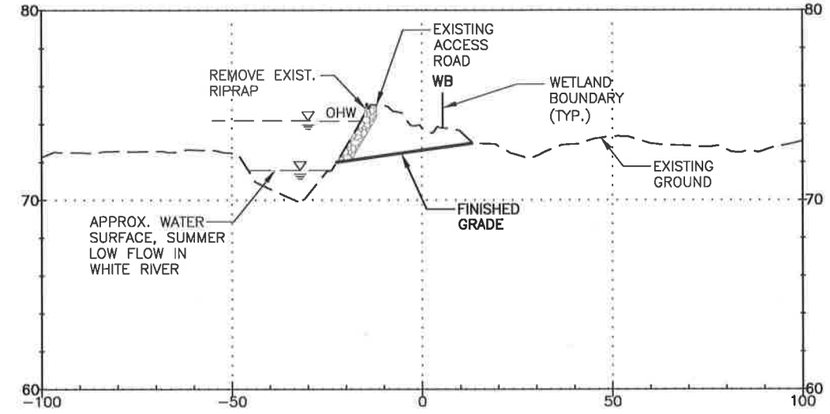
LD1



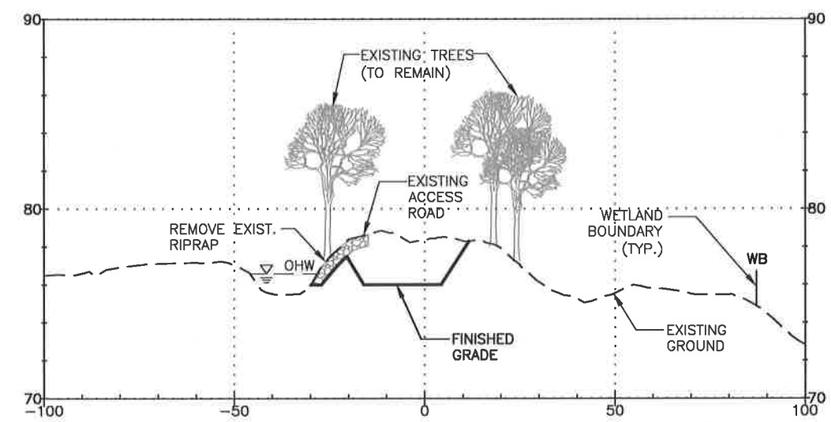

SECTION E-E
STA. 22+20
NTS
E
LR3



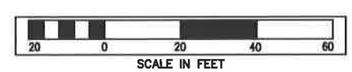

SECTION F-F
STA. 24+73
NTS
F
LR3




SECTION G-G
STA.26+66
NTS
G
LR3




SECTION H-H
STA. 34+72
NTS
H
LR4

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| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER
STATE OF WASHINGTON
40693
REGISTERED PROFESSIONAL ENGINEER

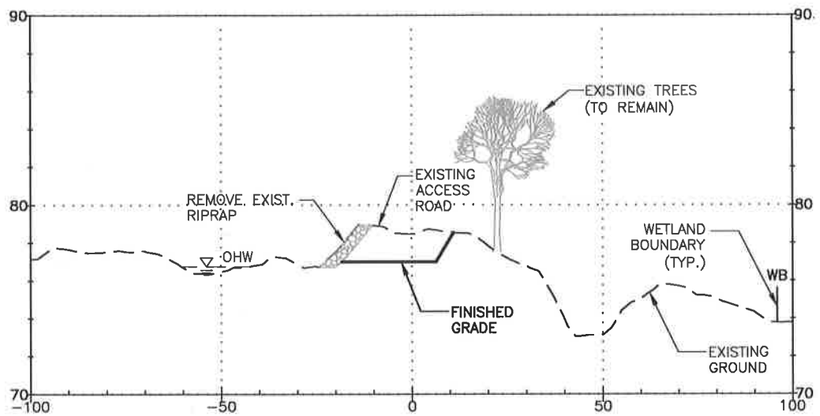
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

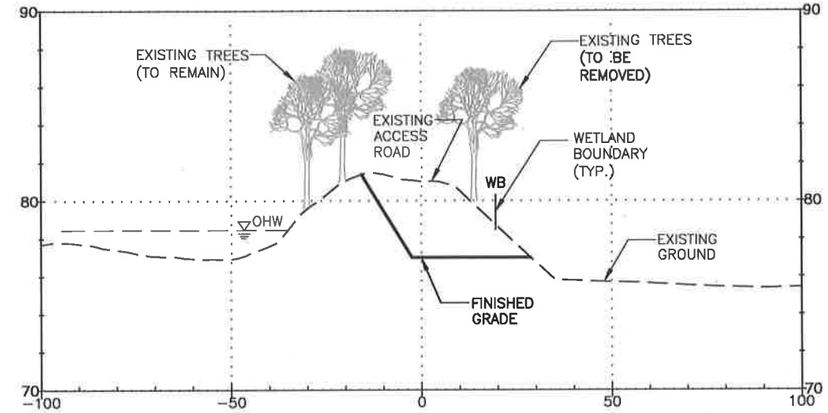
LEVEE EXCAVATION CROSS SECTIONS

SHEET 44 OF 69 SHEETS

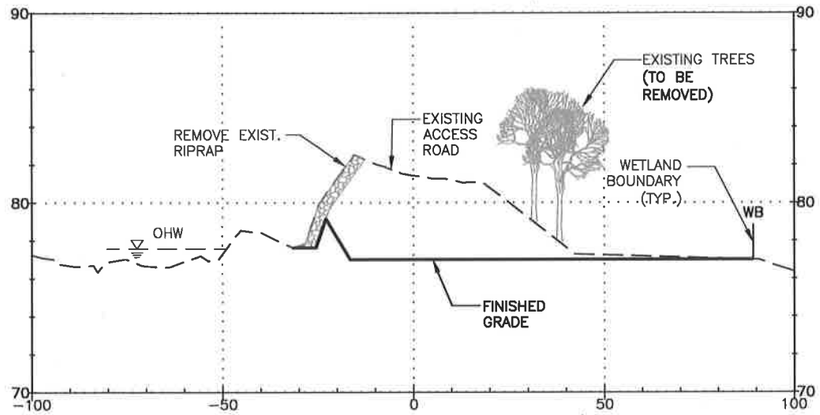
LD2



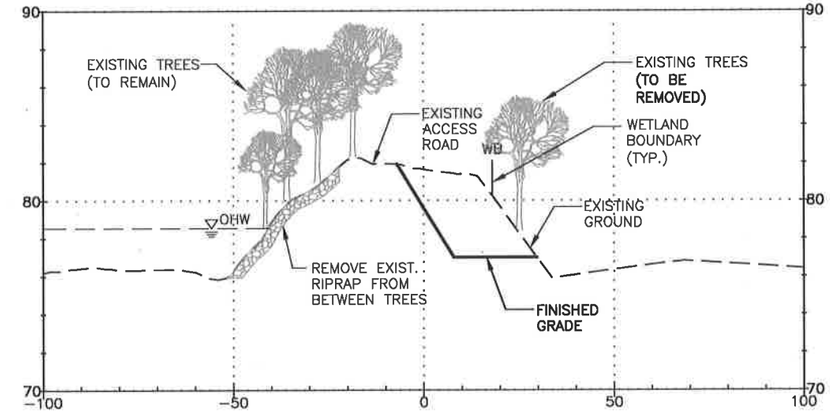

SECTION I-I
STA. 36+00
NTS
I
LR4



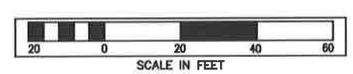

SECTION K-K
STA. 40+50
NTS
K
LR4




SECTION J-J
STA. 38+34
NTS
J
LR4




SECTION L-L
STA. 42+00
NTS
L
LR5

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| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER
STATE OF WASHINGTON
40693
REGISTERED
PROFESSIONAL ENGINEER

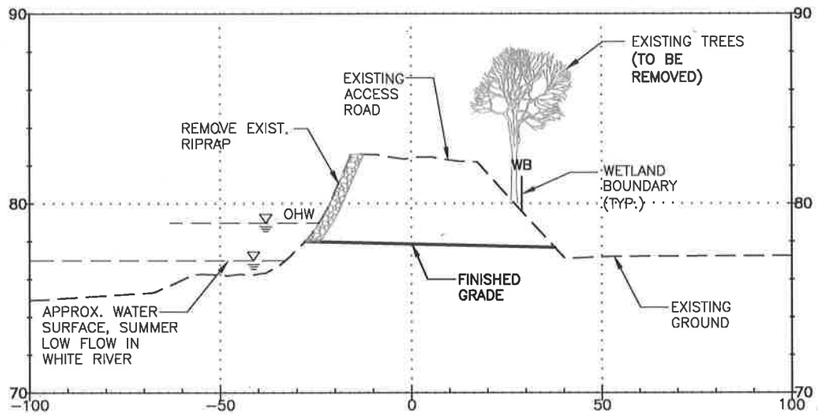
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

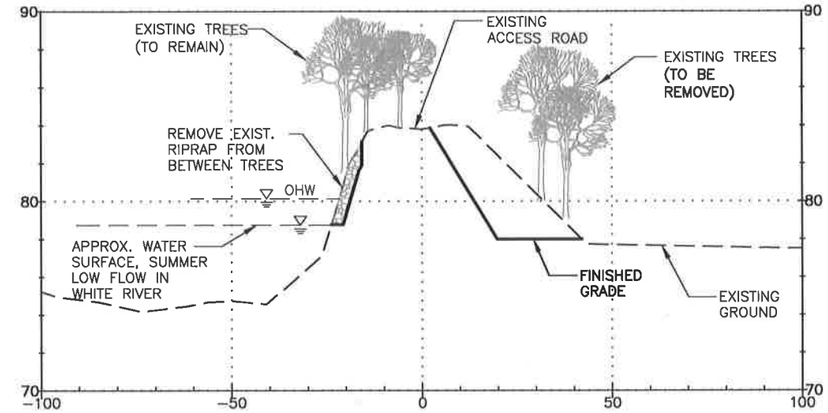
LEVEE EXCAVATION CROSS SECTIONS

SHEET 45 OF 69 SHEETS

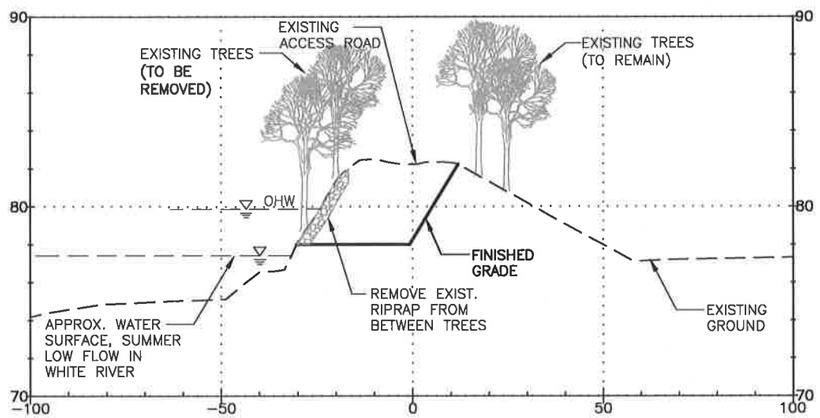
LD3



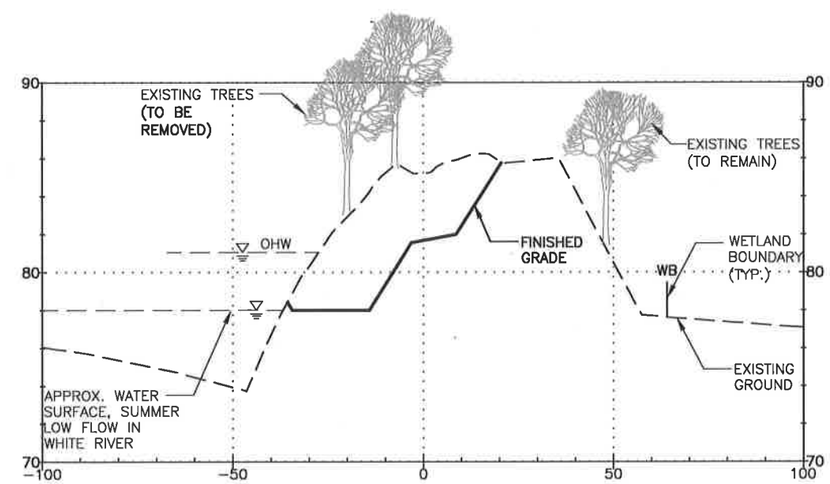

SECTION M-M
STA. 44+00
NTS
M
LR5



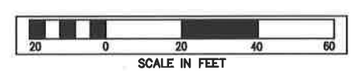

SECTION O-O
STA. 48+00
NTS
O
LR5




SECTION N-N
STA. 45+73
NTS
N
LR5




SECTION P-P
STA. 50+00
NTS
P
LR5




FIELD BOOK:
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| | CADD / 60% 5-2013 | | |

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| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | CHRIS BRUMMER, PE | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

CHRISTOPHER JON BRUMMER
STATE OF WASHINGTON
40695
REGISTERED
PROFESSIONAL ENGINEER

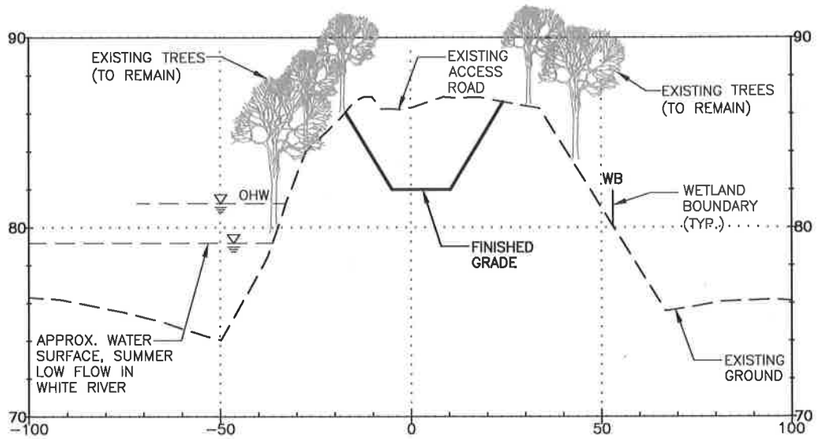
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

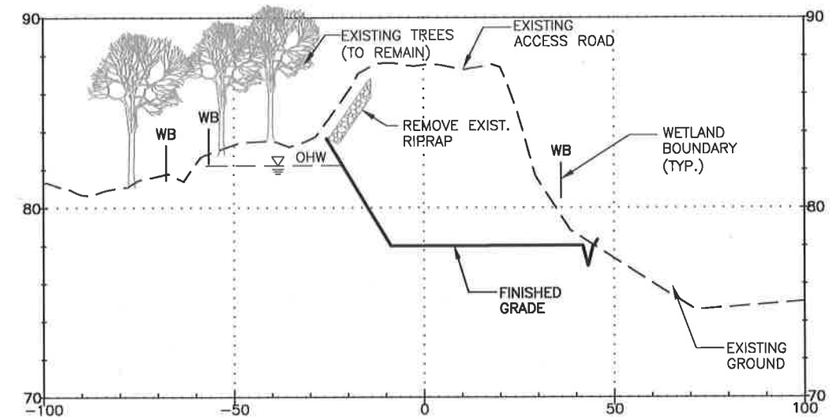
LEVEE EXCAVATION CROSS SECTIONS

SHEET 46 OF 69 SHEETS

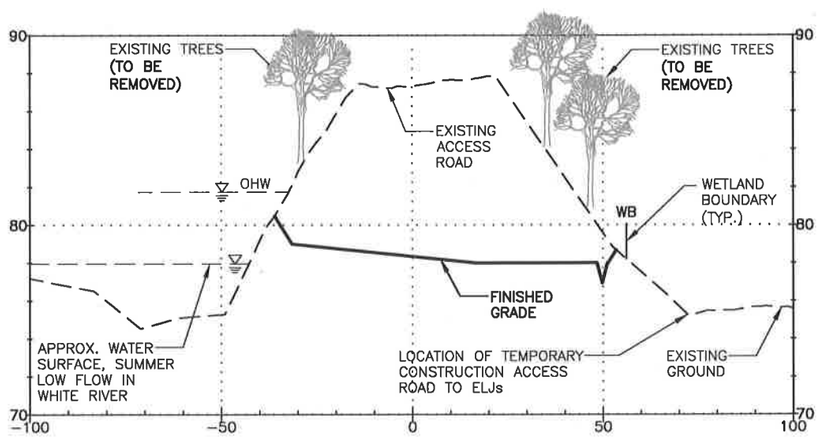
LD4



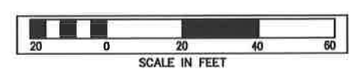

SECTION Q-Q
STA. 50+85
NTS
Q
LR5



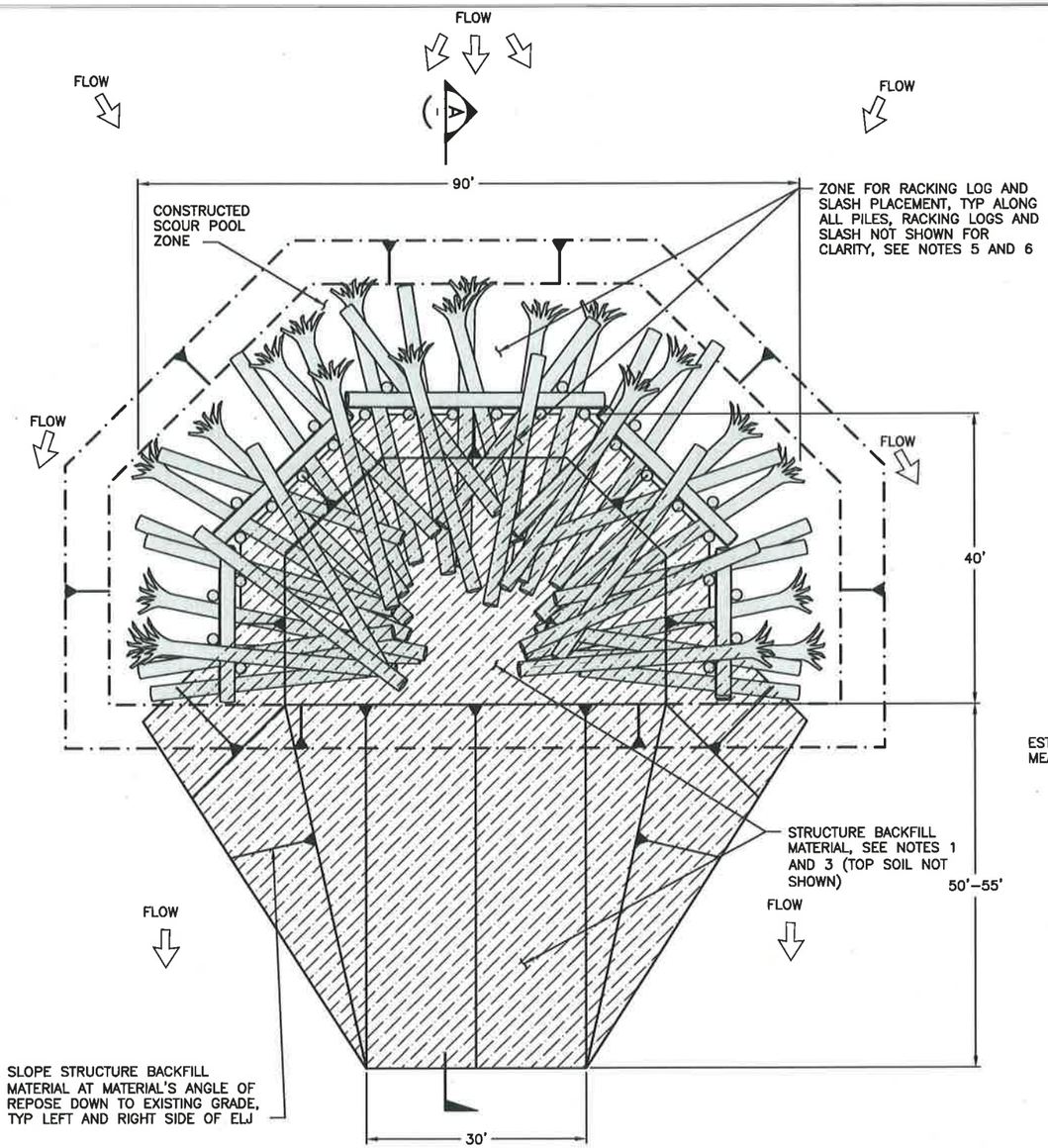

SECTION S-S
STA. 55+06
NTS
S
LR6




SECTION R-R
STA. 52+86
NTS
R
LR6




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FIELD BOOK: | | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C | | King County Department of Natural Resources and Parks Water and Land Resources Division River and Floodplain Management Section Christie True, Director | COUNTYLINE LEVEE SETBACK WHITE RIVER, RIVER MILE 5.00-6.33 LEVEE MODIFICATION |
| SURVEYED: | | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) | | | LEVEE EXCAVATION CROSS SECTIONS |
| SURVEY BASE MAP: | | | | | | DESIGNED: CHRIS BRUMMER, PE | 4-2013 | | | | SHEET 47 OF 69 SHEETS |
| CHECKED: | | | CADD / 60% 5-2013 | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | | | | |
| | | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | | | | LD5 |




PLAN – LARGE APEX ELJ (1 / WS2)

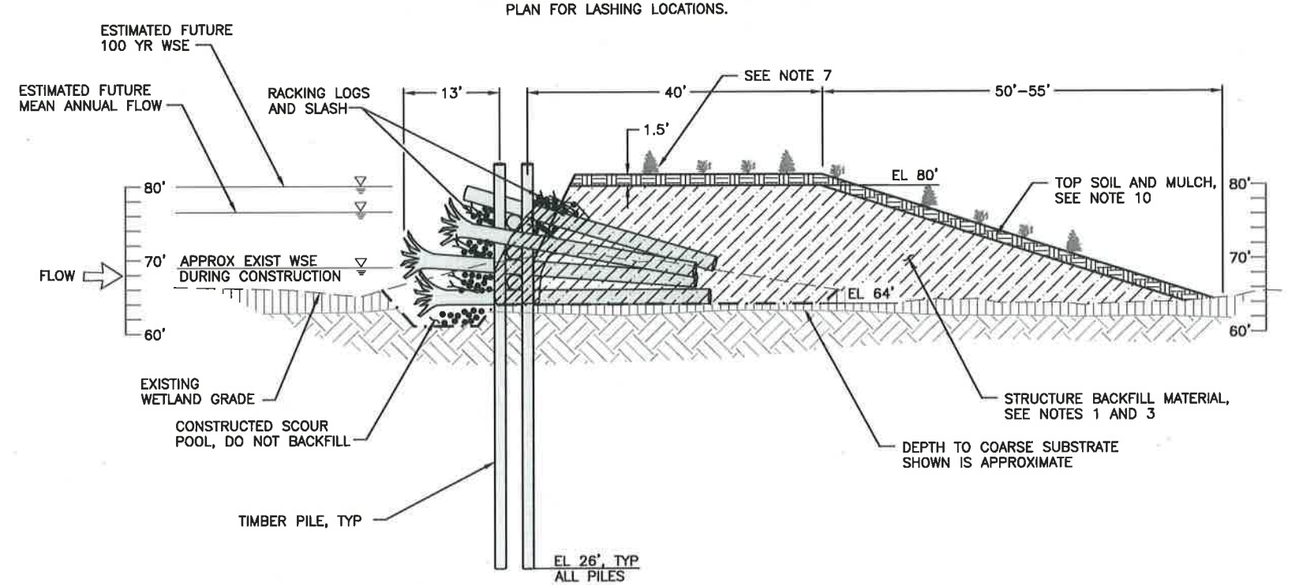
10 0 10 20 30
SCALE IN FEET

**LEGEND:**

- EXISTING GRADE
- PROPOSED GRADE
- EXCAVATION LIMITS
- SLASH PLACEMENT ZONE
- NATIVE TOP SOIL AND MULCH
- COARSE ALLUVIUM FROM EXISTING LEVEE
- EXISTING COARSE SUBSTRATE
- EXISTING FINE SUBSTRATE

**NOTES:**

1. EXTENTS OF BACKFILL ARE APPROXIMATE AND MAY VARY FROM THAT SHOWN.
2. EXCAVATION LIMITS SHOWN ARE APPROXIMATE AND WILL VARY BASED ON CONSTRUCTION MEANS AND METHODS, SUBSURFACE CONDITIONS, DEPTH OF SURFACE WATER (IF ANY), AND LOCATION OF STRUCTURE. CONTRACTOR SHALL ADJUST EXCAVATION LIMITS AS NECESSARY TO COMPLETE CONSTRUCTION.
3. PLACE ONLY DRY LEVEE REMOVAL SPOILS WITHIN INTERIOR CORE OF STRUCTURE AND OVER FINAL LAYER OF LOGS IN 2' LAYERS AND COMPACT WITH BACKSIDE OF EXCAVATOR BUCKET. SATURATED BACKFILL MATERIAL THAT CANNOT BE PROPERLY COMPACTED WILL NOT BE ALLOWED.
4. SEE LOG SCHEDULE ON STRUCTURE LAYERING PLAN FOR DIMENSIONS AND NUMBERS OF EACH LOG TYPE IN STRUCTURE.
5. PLACEMENT OF RACKING LOGS SHOWN IS APPROXIMATE. PLACE RACKING LOGS ALONG UPSTREAM FACE OF STRUCTURE. APPROXIMATELY 1/2 OF RACKING LOGS SHALL BE PLACED ACROSS PILE ROWS (PERPENDICULAR TO FLOW) AND 1/2 OF THE RACKING LOGS PARALLEL TO FLOW AND EXTENDING INTO THE CORE OF THE STRUCTURE BETWEEN HORIZONTAL KEY LOGS. RACKING SHALL BE PLACED WITH EACH LAYER OF KEY LOGS, SHALL BE ANGLED UP AND DOWN FROM THE HORIZONTAL, AND SHALL BE PLACED TO CREATE AN INTERLOCKING MATRIX OF LOGS SECURED BETWEEN VERTICAL PILE LOGS AND HORIZONTAL KEY LOGS. COORDINATE WITH THE PROJECT REPRESENTATIVE PRIOR TO PLACING RACKING LOGS, SLASH AND BACKFILLING.
6. SEE STRUCTURE LAYERING PLAN FOR SLASH PLACEMENT. PLACE SLASH AS SHOWN ON LAYERING PLAN TO FILL VOIDS BETWEEN RACKING LOGS.
7. SEE PLANTING PLAN FOR RECOMMENDED STRUCTURE PLANTING INFORMATION AND DETAILS.
8. CONSTRUCT TEMPORARY ACCESS PATH TO ELJ AND WORK PLATFORM AS NECESSARY USING ALLUVIUM EXCAVATED FROM THE EXISTING LEVEE AS SHOWN ON DWG ED2. ADJUST EXTENTS AND ELEVATION OF ACCESS PATH AND WORK PLATFORM AS NEEDED TO COMPLETE CONSTRUCTION. ACCESS PATH AND WORK PLATFORM NOT SHOWN HERE FOR CLARITY. SEE DWG ED2 FOR ADDITIONAL TESC AND WORK AREA ISOLATION MEASURES NEEDED TO COMPLETE STRUCTURE CONSTRUCTION.
9. INSTALL SILT CURTAIN, OR EQUIVALENT AS APPROVED BY THE PROJECT REPRESENTATIVE, AROUND PERIPHERY OF STRUCTURE AND WITHIN CONSTRUCTION LIMITS TO CONTAIN TURBID WATER DURING CONSTRUCTION. SILT CURTAIN NOT SHOWN HERE FOR CLARITY.
10. PLACE 18" OF NATIVE TOP SOIL OVER STRUCTURE BACKFILL MATERIAL, THEN CAP WITH 3"–6" OF MULCH, TO EXTENTS SHOWN OR AS DIRECTED BY THE PROJECT REPRESENTATIVE.
11. CABLE LASHING FOR KEY LOGS TO PILES NOT SHOWN FOR CLARITY. SEE STRUCTURE LAYERING PLAN FOR LASHING LOCATIONS.




SECTION – LARGE APEX ELJ (A)

10 0 10 20 30
SCALE IN FEET

| | | | | | |
|---|---|---|---|---|---|
| FIELD BOOK: | NUM. | REVISION | BY | DATE | APPROVED: IAN MOSTRENKO, PE 5-2013 |
| SURVEYED: | | CADD / 60% 5-2013 | | | PROJECT MANAGER: MARK EWBANK, PE 5-2013 |
| SURVEY BASE MAP: | | | | | DESIGNED: BRIAN SCOTT 5-2013 |
| CHECKED: | | | | | ECOLOGIST: |
| | | | | | DESIGN ENTERED: TODD PRESCOTT 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO — STATE OF WASHINGTON — 36069 — REGISTERED PROFESSIONAL ENGINEER

HERRERA

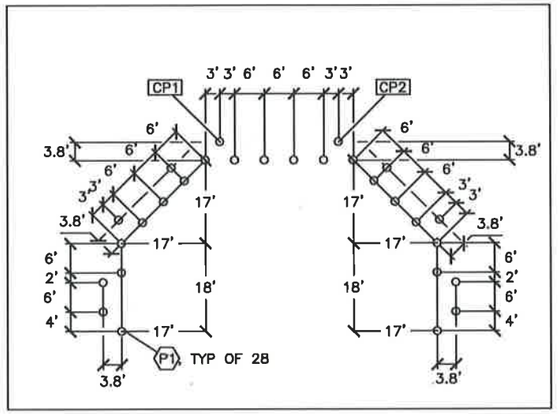
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

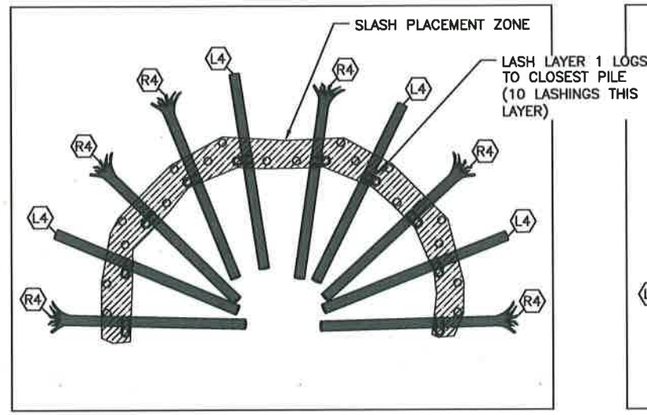
LARGE APEX ELJ PLAN AND SECTIONS

SHEET 48 OF 69 SHEETS

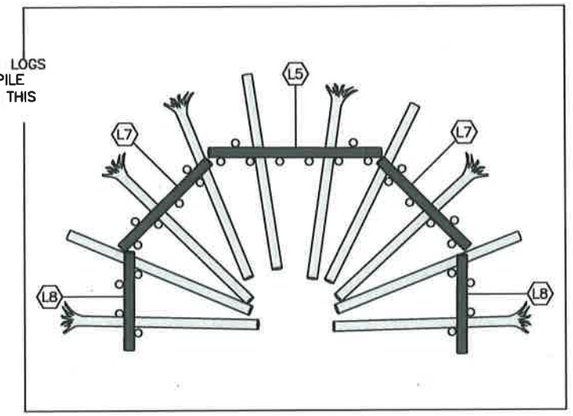
WD1




PILES




LAYER 1

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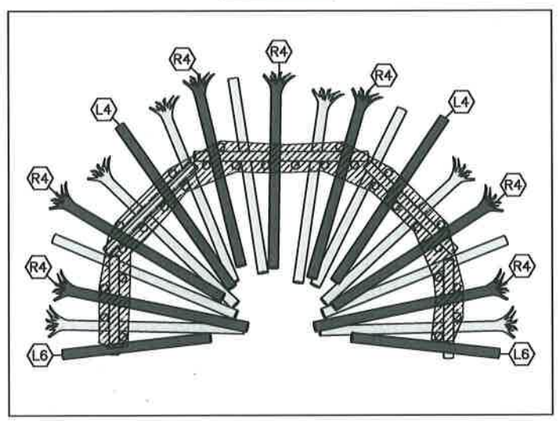
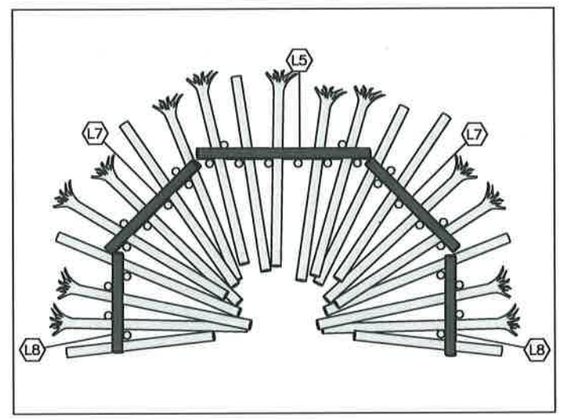
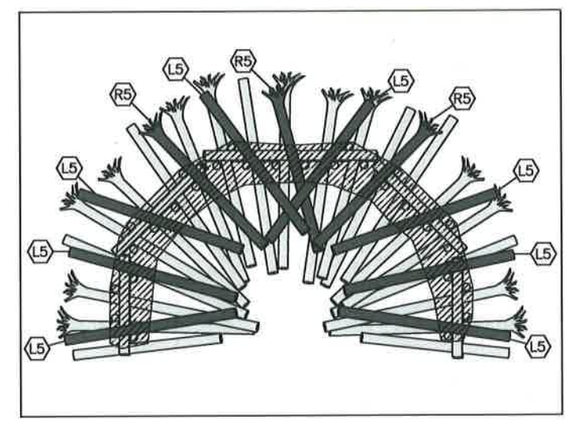



LAYER 3




LAYER 4

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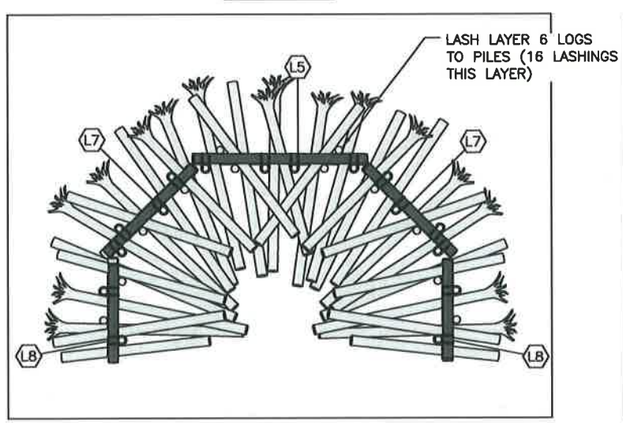
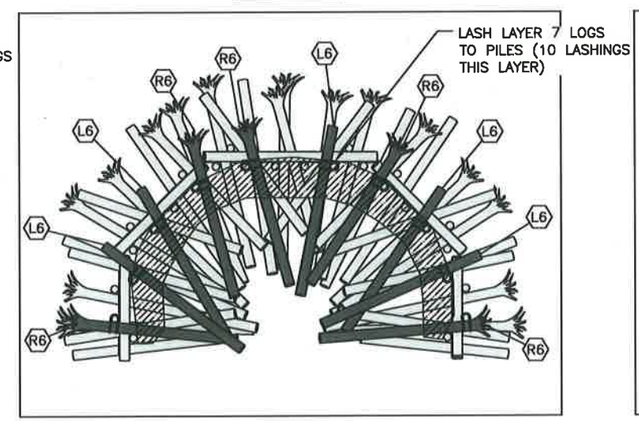
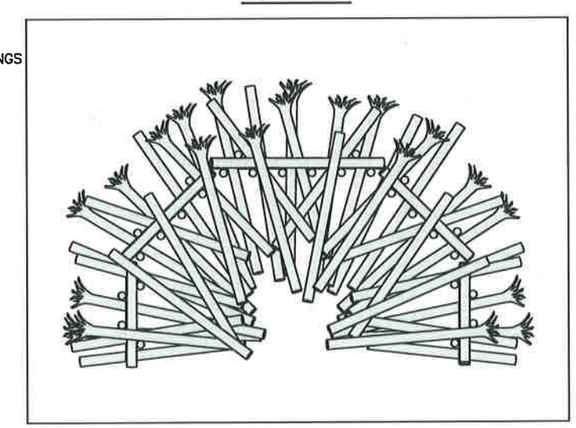



LAYER 6




LAYER 7



COMPLETE

**LOG SCHEDULE:**

| LOG TYPE | MIN DIA (IN) | LENGTH (FT) | ROOTWAD | TOTAL QTY PER ELJ |
|---|---|---|---|---|
| P1 | 18 (BUTT) | 55 | NO | 28 |
| R4 | 24 | 40 | YES | 13 |
| R5 | 24 | 35 | YES | 8 |
| L4 | 24 | 40 | NO | 6 |
| L5 | 24 | 35 | NO | 16 |
| L6 | 24 | 30 | NO | 2 |
| L7 | 24 | 25 | NO | 6 |
| L8 | 24 | 20 | NO | 6 |
| RACKING | 6–16 | 15–30 | OPTIONAL | 200 |
| SLASH | – | – | – | 200 CY |

**LEGEND:**

- CURRENT LAYER KEY LOG
- PREVIOUS LAYER KEY LOG (AFTER BACKFILLING)
- VERTICAL PILE LOG
- SLASH PLACEMENT ZONE
- L1 KEY LOG TYPE ID (LOG TYPE L1)
- CP1 STRUCTURE CONTROL POINT (1)

**NOTES:**

1. STRUCTURE GENERAL LOCATION AND ORIENTATION SHALL BE STAKED BY THE CONTRACTOR. FINAL STRUCTURE LOCATION AND ORIENTATION TO BE FIELD VERIFIED BY THE PROJECT REPRESENTATIVE FOLLOWING CONTRACTOR STAKING.
2. ALL PILE LOCATIONS SHALL BE STAKED BY THE CONTRACTOR AND APPROVED BY THE PROJECT REPRESENTATIVE PRIOR TO PILE INSTALLATION.
3. ALL PILE LOCATIONS SHALL BE BASED ON THE LOCATION OF THE STRUCTURE CONTROL POINTS AND SHALL BE WITHIN 6" OF THE LOCATION SHOWN ON THE DRAWINGS.
4. PILE DIAMETERS SHALL BE MEASURED AT THE BUTT (LARGER) ENDS. PILES SHALL BE UNTREATED DOUGLAS FIR MEETING ASTM D25 REQUIREMENTS.
5. LOG MATERIALS SHALL BE PLACED AT THE LOCATIONS AND ORIENTATIONS SPECIFIED ON THE DRAWINGS OR AS DIRECTED BY THE PROJECT REPRESENTATIVE. TRIM CUT ENDS OF HORIZONTAL KEY LOGS TO FIT AS REQUIRED.
6. PLACE SLASH OVER AND BETWEEN KEY LOGS AND PILES AS SHOWN FOR EACH LAYER SPECIFIED FOLLOWING PLACEMENT OF KEY LOGS AND RACKING LOGS. PLACE APPROXIMATELY 2' TO 3' OF NATIVE ALLUVIUM OVER 1/2 THE WIDTH OF SLASH TO SECURE IN PLACE SUCH THAT SLASH IS VISIBLE FOLLOWING CONSTRUCTION. COORDINATE WITH THE PROJECT REPRESENTATIVE PRIOR TO PLACING RACKING AND SLASH.
7. BACKFILL EACH LAYER WITH DRY COARSE ALLUVIUM AND RIPRAP EXCAVATED FROM THE EXISTING LEVEE FLUSH TO TOP OF CURRENT LAYER PRIOR TO CONSTRUCTING SUBSEQUENT LAYER. COMPACT ALLUVIUM BACKFILL WITH EXCAVATOR BUCKET. FILL ALL VOIDS BETWEEN BOULDERS (ROCKS GREATER THAN 12" DIAMETER) WITH FINER ALLUVIUM TO ACHIEVE A WELL GRADED AND COMPACTED MASS.
8. SEE DWG WS2 FOR COORDINATES OF STRUCTURE CONTROL POINTS.
9. SEE DWG WD10 FOR CABLE LASHING DETAIL.

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

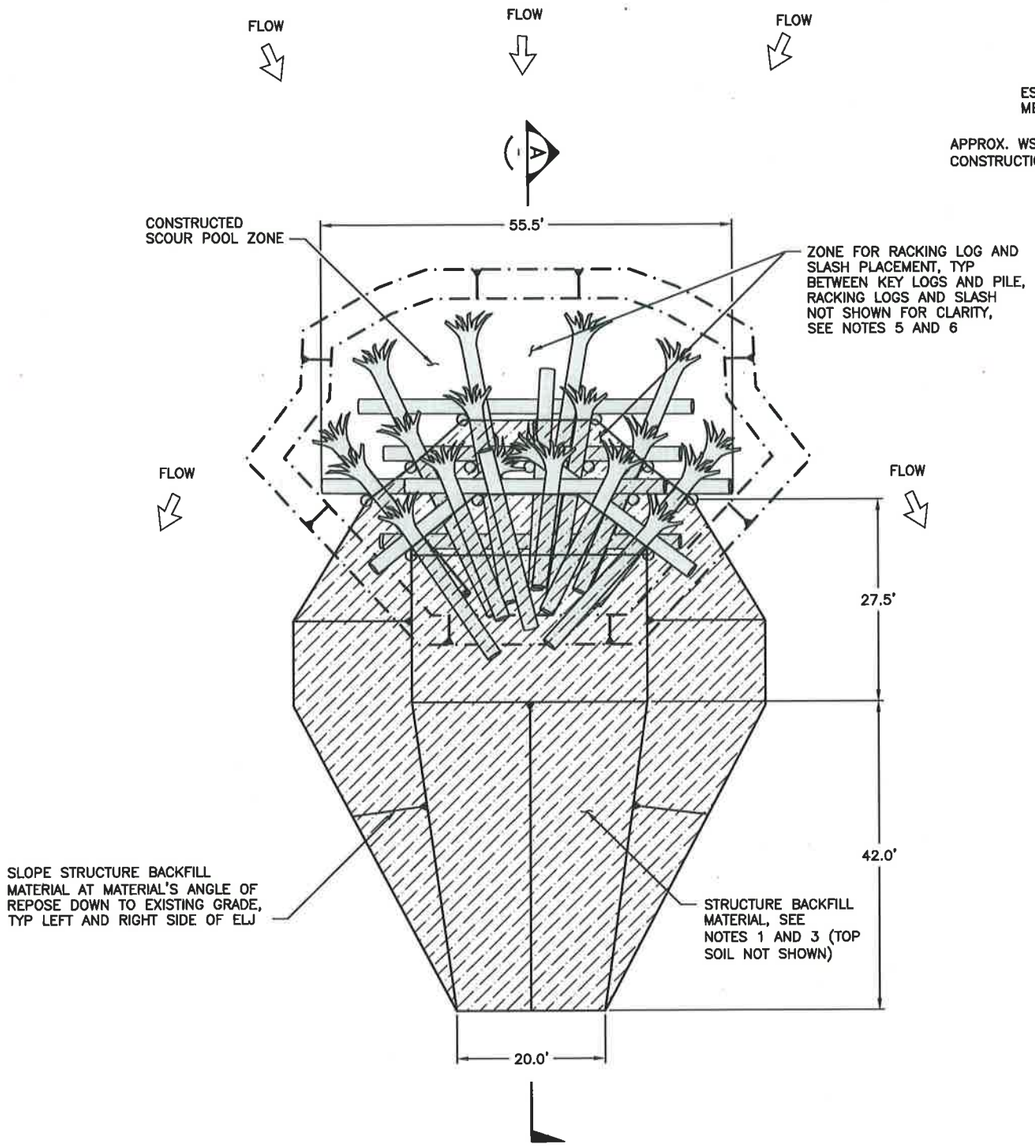
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

LARGE APEX ELJ LAYERING PLAN

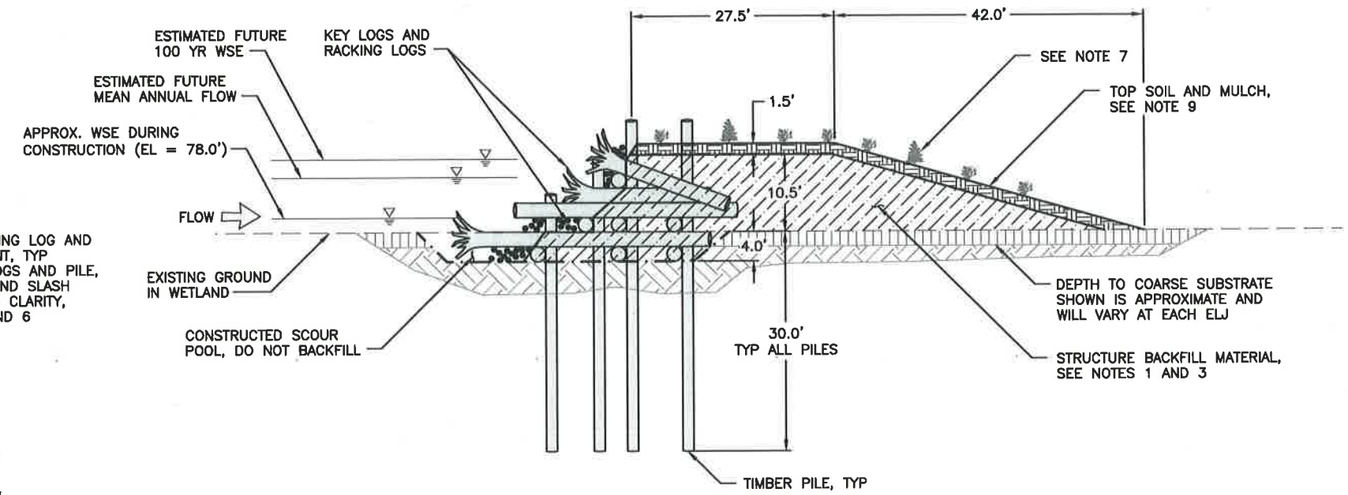
SHEET 49 OF 69 SHEETS

WD2




PLAN – SMALL APEX ELJ (1 / WS1)

10 0 10 20 30
SCALE IN FEET




SECTION – SMALL APEX ELJ (A / –)

10 0 10 20 30
SCALE IN FEET

**NOTES:**

1. EXTENTS OF BACKFILL SHOWN ARE APPROXIMATE AND WILL VARY FOR EACH ELJ.
2. EXCAVATION LIMITS SHOWN ARE APPROXIMATE AND WILL VARY BASED ON CONSTRUCTION MEANS AND METHODS, SUBSURFACE CONDITIONS AND LOCATION OF STRUCTURE. CONTRACTOR SHALL ADJUST EXCAVATION LIMITS AS NECESSARY TO COMPLETE CONSTRUCTION.
3. PLACE ONLY DRY LEVEE REMOVAL SPOILS WITHIN INTERIOR CORE OF STRUCTURE AND OVER FINAL LAYER OF LOGS IN 2 FOOT LAYERS AND COMPACT WITH BACKSIDE OF EXCAVATOR BUCKET. SATURATED BACKFILL MATERIAL THAT CANNOT BE PROPERLY COMPACTED WILL NOT BE ALLOWED.
4. SEE LOG SCHEDULE ON STRUCTURE LAYERING PLAN FOR DIMENSIONS AND NUMBERS OF EACH LOG TYPE IN STRUCTURE.
5. PLACEMENT OF RACKING LOGS SHOWN IS APPROXIMATE. PLACE RACKING LOGS ALONG UPSTREAM FACE OF STRUCTURE. APPROXIMATELY 1/2 OF RACKING LOGS SHALL BE PLACED ACROSS PILE ROWS (PERPENDICULAR TO FLOW) AND 1/2 OF THE RACKING LOGS PARALLEL TO FLOW AND EXTENDING INTO THE CORE OF THE STRUCTURE BETWEEN HORIZONTAL KEY LOGS. RACKING SHALL BE PLACED WITH EACH LAYER OF KEY LOGS, SHALL BE ANGLED UP AND DOWN FROM THE HORIZONTAL, AND SHALL BE PLACED TO CREATE AN INTERLOCKING MATRIX OF LOGS SECURED BETWEEN VERTICAL PILE LOGS AND HORIZONTAL KEY LOGS. COORDINATE WITH THE PROJECT REPRESENTATIVE PRIOR TO PLACING RACKING LOGS, SLASH AND BACKFILLING.
6. SEE STRUCTURE LAYERING PLAN FOR SLASH PLACEMENT. SLASH NOT SHOWN HERE FOR CLARITY. PLACE SLASH AS SHOWN ON LAYERING PLAN TO FILL VOIDS BETWEEN RACKING LOGS.
7. SEE PLANTING PLAN FOR RECOMMENDED STRUCTURE PLANTING INFORMATION AND DETAILS.
8. CONSTRUCT TEMPORARY ACCESS PATH TO ELJ AND WORK PLATFORM AS NECESSARY USING ALLUVIUM EXCAVATED FROM THE EXISTING LEVEE AS SHOWN ON DWG ED2. ADJUST EXTENTS AND ELEVATION OF ACCESS PATH AND WORK PLATFORM AS NEEDED TO COMPLETE CONSTRUCTION. ACCESS PATH AND WORK PLATFORM NOT SHOWN HERE FOR CLARITY. SEE DWG ED2 FOR ADDITIONAL TESC AND WORK AREA ISOLATION MEASURES NEEDED TO COMPLETE STRUCTURE CONSTRUCTION.
9. PLACE 18" OF NATIVE TOP SOIL OVER STRUCTURE BACKFILL MATERIAL, THEN CAP WITH 3"–6" OF MULCH, TO EXTENTS SHOWN OR AS DIRECTED BY THE PROJECT REPRESENTATIVE.

**LEGEND:**

- EXISTING GRADE
- PROPOSED GRADE
- EXCAVATION LIMITS
- NATIVE TOP SOIL AND MULCH
- COARSE ALLUVIUM FROM EXISTING LEVEE
- EXISTING COARSE SUBSTRATE
- EXISTING FINE SUBSTRATE

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

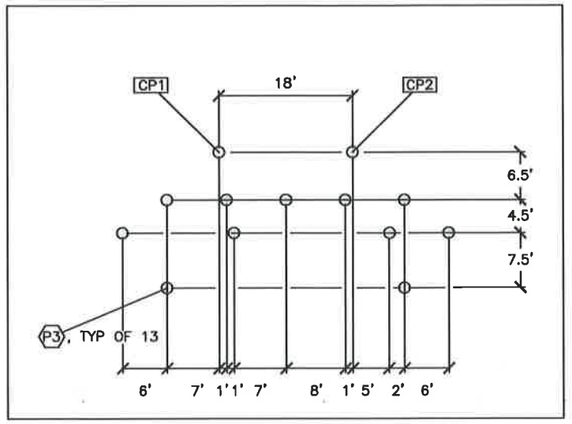
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

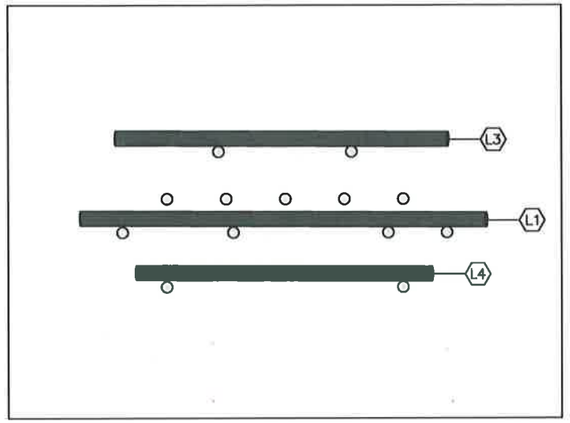
SMALL APEX ELJ PLAN AND SECTIONS

SHEET 50 OF 69 SHEETS

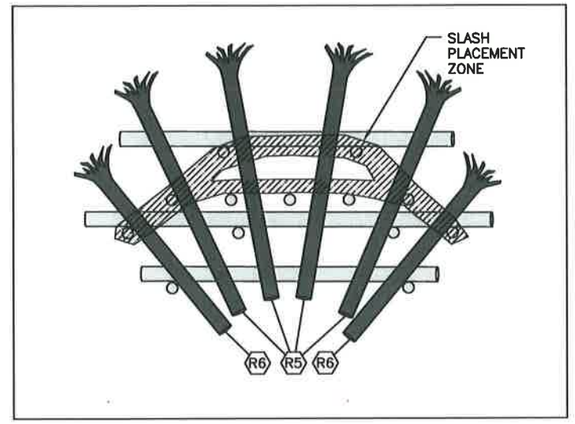
WD3




PILES




LAYER 1

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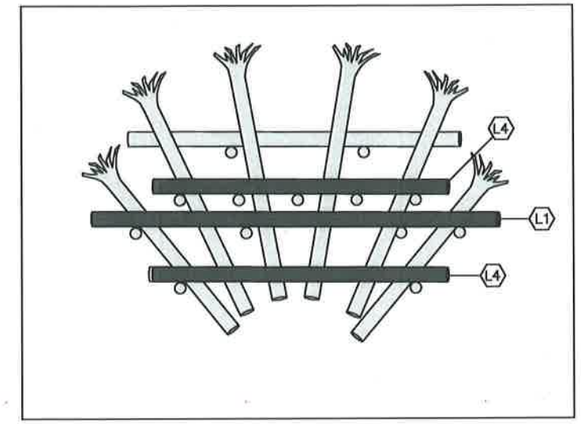
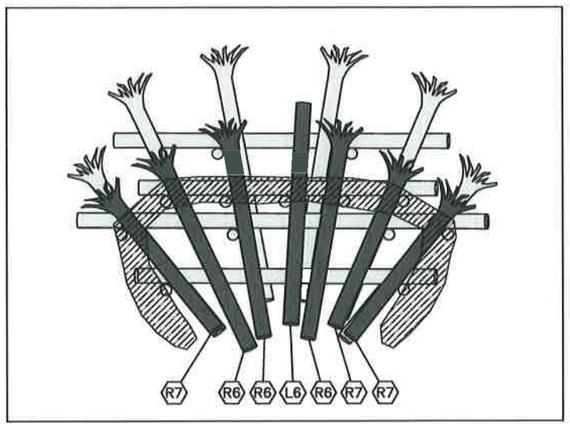



LAYER 3

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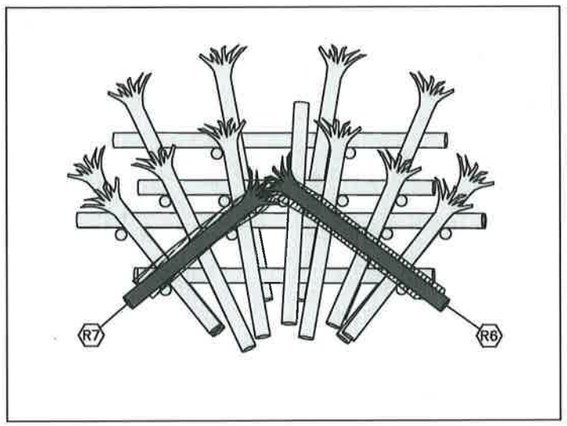


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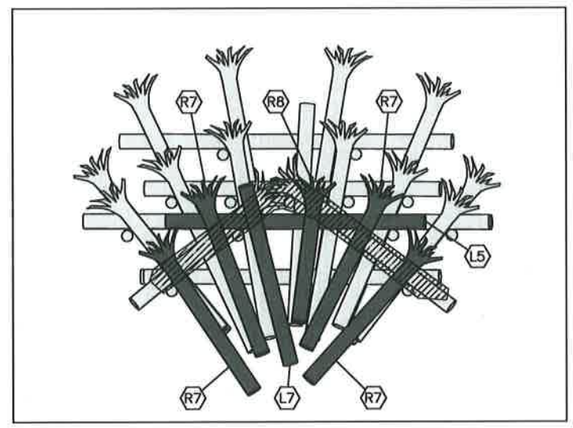


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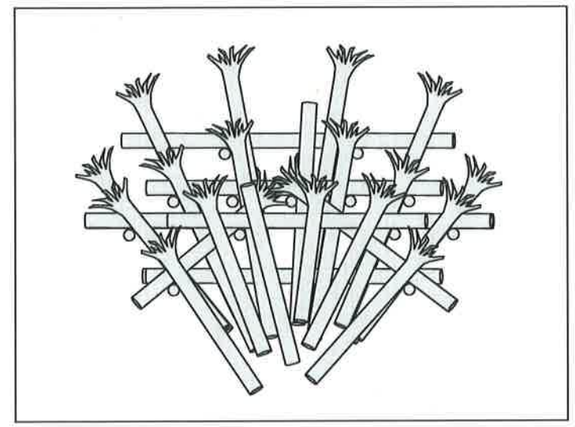


COMPLETE

**LOG SCHEDULE:**

| LOG TYPE | MIN DIA (IN) | LENGTH (FT) | ROOTWAD | TOTAL QTY PER ELJ |
|---|---|---|---|---|
| P3 | 18 (BUTT) | 45 | NO | 13 |
| 5 | 24 | 35 | YES | 4 |
| 6 | 24 | 30 | YES | 6 |
| 7 | 24 | 25 | YES | 8 |
| 8 | 24 | 20 | YES | 1 |
| L1 | 24 | 55 | NO | 2 |
| L3 | 24 | 45 | NO | 1 |
| L4 | 24 | 40 | NO | 3 |
| L5 | 24 | 35 | NO | 1 |
| L6 | 24 | 30 | NO | 1 |
| L7 | 24 | 25 | NO | 1 |
| RACKING | 6–16 | 15–30 | OPTIONAL | 100 |
| SLASH | | | | 80 CY |

**NOTES:**

1. STRUCTURE GENERAL LOCATION AND ORIENTATION SHALL BE STAKED BY THE CONTRACTOR. FINAL STRUCTURE LOCATION AND ORIENTATION TO BE FIELD VERIFIED BY THE PROJECT REPRESENTATIVE FOLLOWING CONTRACTOR STAKING.
2. ALL PILE LOCATIONS SHALL BE STAKED BY THE CONTRACTOR AND APPROVED BY THE PROJECT REPRESENTATIVE PRIOR TO PILE INSTALLATION.
3. ALL PILE LOCATIONS SHALL BE BASED ON THE LOCATION OF THE STRUCTURE CONTROL POINTS AND SHALL BE WITHIN 6" OF THE LOCATION SHOWN ON THE DRAWINGS.
4. PILE DIAMETERS SHALL BE MEASURED AT THE BUTT (LARGER) ENDS. PILES SHALL BE UNTREATED DOUGLAS FIR MEETING ASTM D25 REQUIREMENTS.
5. LOG MATERIALS SHALL BE PLACED AT THE LOCATIONS AND ORIENTATIONS SPECIFIED ON THE DRAWINGS OR AS DIRECTED BY THE PROJECT REPRESENTATIVE. TRIM CUT ENDS OF HORIZONTAL KEY LOGS TO FIT AS REQUIRED.
6. PLACE SLASH OVER AND BETWEEN KEY LOGS AND PILES AS SHOWN FOR EACH LAYER SPECIFIED FOLLOWING PLACEMENT OF KEY LOGS AND RACKING LOGS. PLACE APPROXIMATELY 2' TO 3' OF NATIVE ALLUVIUM OVER 1/2 THE WIDTH OF SLASH TO SECURE IN PLACE SUCH THAT SLASH IS VISIBLE FOLLOWING CONSTRUCTION. COORDINATE WITH THE PROJECT REPRESENTATIVE PRIOR TO PLACING RACKING AND SLASH.
7. BACKFILL EACH LAYER WITH DRY COARSE ALLUVIUM EXCAVATED FROM THE EXISTING LEVEE FLUSH TO TOP OF CURRENT LAYER PRIOR TO CONSTRUCTING SUBSEQUENT LAYER. COMPACT ALLUVIUM BACKFILL WITH EXCAVATOR BUCKET. FILL ALL VOIDS BETWEEN BOULDERS (ROCKS GREATER THAN 12" DIAMETER) WITH FINER ALLUVIUM TO ACHIEVE A WELL GRADED AND COMPACTED MASS.
8. SEE DWG WS1 FOR COORDINATES OF STRUCTURE CONTROL POINTS.

10 0 10 20 30
SCALE IN FEET

**LEGEND:**

- CURRENT LAYER KEY LOG
- PREVIOUS LAYER KEY LOG (AFTER BACKFILLING)
- VERTICAL PILE LOG
- SLASH PLACEMENT ZONE
- L1 — KEY LOG TYPE ID (LOG TYPE L1)
- CP1 — STRUCTURE CONTROL POINT (1)

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

SAMLL APEX ELJ LAYERING PLAN

SHEET 51 OF 69 SHEETS

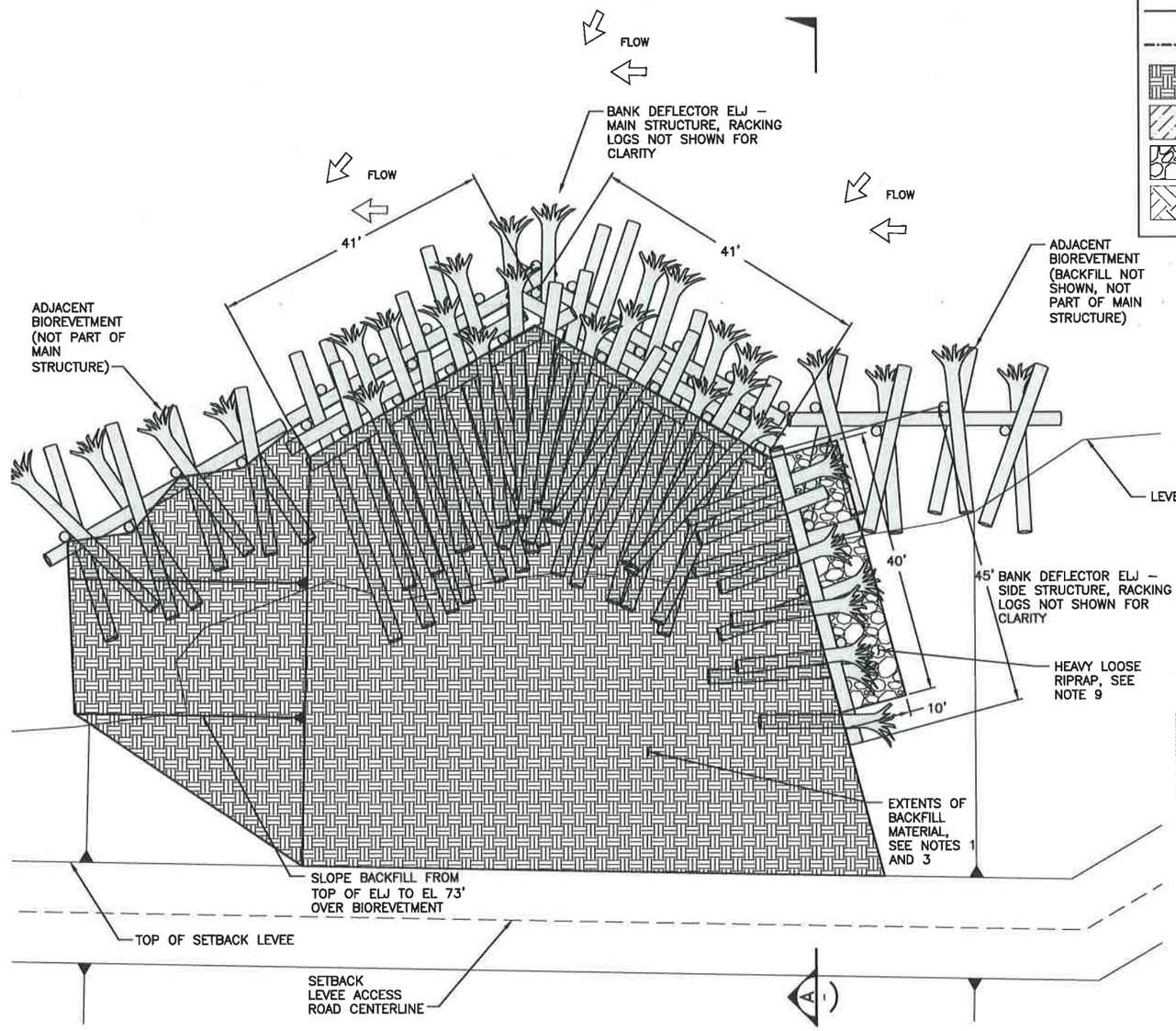
WD4

**LEGEND:**

- EXISTING GRADE
- PROPOSED GRADE
- EXCAVATION LIMITS
- TOP SOIL TYPE A AND MULCH
- COARSE ALLUVIUM FROM EXIST LEVEE
- HEAVY LOOSE RIPRAP
- EXISTING SUBSTRATE

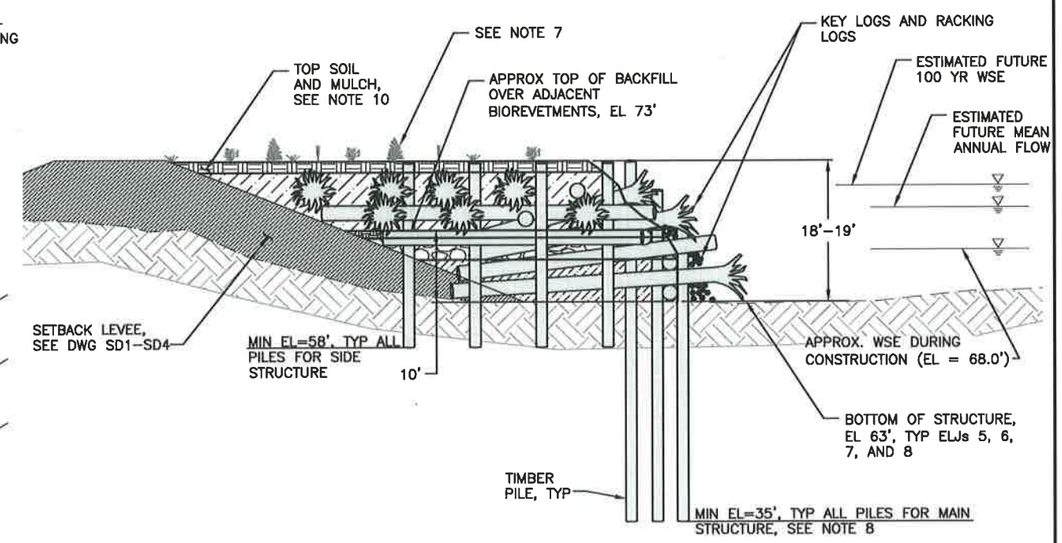
**NOTES:**

1. EXTENTS OF BACKFILL SHOWN ARE APPROXIMATE AND WILL VARY FOR EACH ELJ.
2. EXCAVATION LIMITS ARE APPROXIMATE AND WILL VARY BASED ON CONSTRUCTION MEANS AND METHODS, SUBSURFACE CONDITIONS AND LOCATION OF STRUCTURE. CONTRACTOR SHALL ADJUST EXCAVATION LIMITS AS NECESSARY TO COMPLETE CONSTRUCTION. SEE DWG ED4 FOR EXCAVATION LIMITS FOR ELJs 6, 7, AND 8.
3. PLACE ONLY DRY LEVEE REMOVAL SPOILS WITHIN INTERIOR CORE OF STRUCTURE AND OVER FINAL LAYER OF LOGS IN 2' LAYERS AND COMPACT WITH BACKSIDE OF EXCAVATOR BUCKET. SATURATED BACKFILL MATERIAL THAT CANNOT BE PROPERLY COMPACTED WILL NOT BE ALLOWED.
4. SEE LOG SCHEDULE ON STRUCTURE LAYERING PLAN FOR DIMENSIONS AND NUMBERS OF EACH LOG TYPE IN STRUCTURE.
5. PLACEMENT OF RACKING LOGS SHOWN IS APPROXIMATE. PLACE RACKING LOGS ALONG UPSTREAM FACE OF STRUCTURE. APPROXIMATELY 1/2 OF RACKING LOGS SHALL BE PLACED ACROSS PILE ROWS (PERPENDICULAR TO FLOW) AND 1/2 OF THE RACKING LOGS PARALLEL TO FLOW AND EXTENDING INTO THE CORE OF THE STRUCTURE BETWEEN HORIZONTAL KEY LOGS. RACKING SHALL BE PLACED WITH EACH LAYER OF KEY LOGS, SHALL BE ANGLED UP AND DOWN FROM THE HORIZONTAL, AND SHALL BE PLACED TO CREATE AN INTERLOCKING MATRIX OF LOGS SECURED BETWEEN VERTICAL PILE LOGS AND HORIZONTAL KEY LOGS. COORDINATE WITH THE PROJECT REPRESENTATIVE PRIOR TO PLACING RACKING LOGS, SLASH AND BACKFILLING.
6. SEE STRUCTURE LAYERING PLAN FOR SLASH PLACEMENT. SLASH NOT SHOWN HERE FOR CLARITY. PLACE SLASH AT SAME TIME AS RACKING LOGS TO FILL VOIDS BETWEEN RACKING LOGS.
7. SEE PLANTING PLAN FOR RECOMMENDED STRUCTURE PLANTING INFORMATION AND DETAILS.
8. PILE TIPS FOR MAIN STRUCTURE SHALL BE EMBEDDED A MINIMUM OF 10' BELOW THE TOP OF DENSE SOIL.
9. PLACE A 3' DEEP LAYER OF HEAVY LOOSE RIPRAP TO THE DIMENSIONS SHOWN. TOP OF RIPRAP SHALL BE 1' BELOW THE ELEVATION OF BACKFILL OVER THE ADJACENT BIOREVETMENT. PLACE 1' OF TOPSOIL THEN 3" OF MULCH OVER THE RIPRAP.
10. PLACE 18" OF NATIVE TOP SOIL OVER STRUCTURE BACKFILL MATERIAL, THEN CAP WITH 3"–6" OF MULCH, TO EXTENTS SHOWN OR AS DIRECTED BY THE PROJECT REPRESENTATIVE.




PLAN – BANK DEFLECTOR ELJ 1 WS2

10 0 10 20 30
SCALE IN FEET




SECTION – BANK DEFLECTOR ELJ A –

10 0 10 20 30
SCALE IN FEET

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

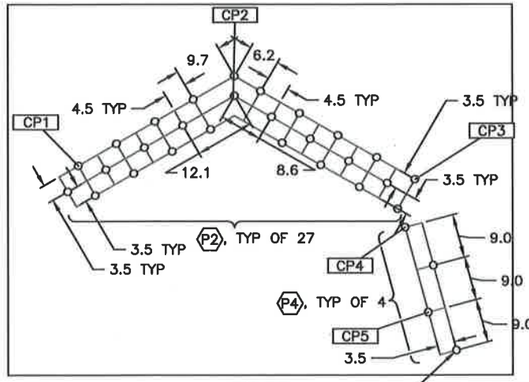
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

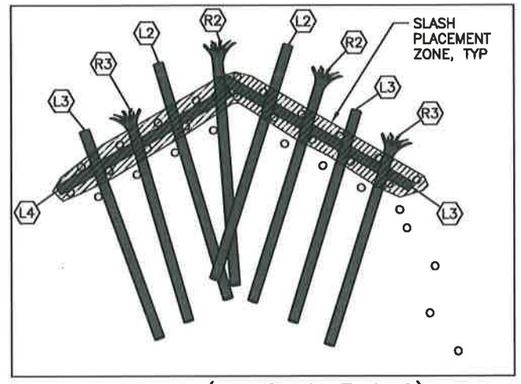
BANK DEFLECTOR ELJ PLAN AND SECTIONS

SHEET 52 OF 69 SHEETS

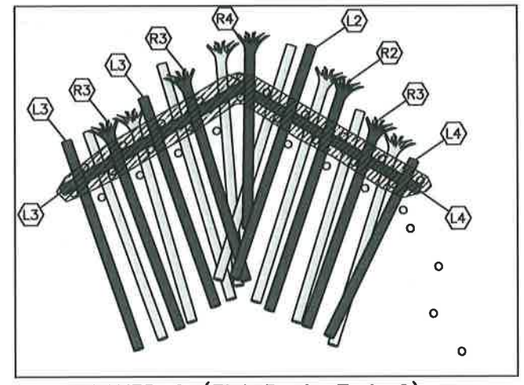
WD5



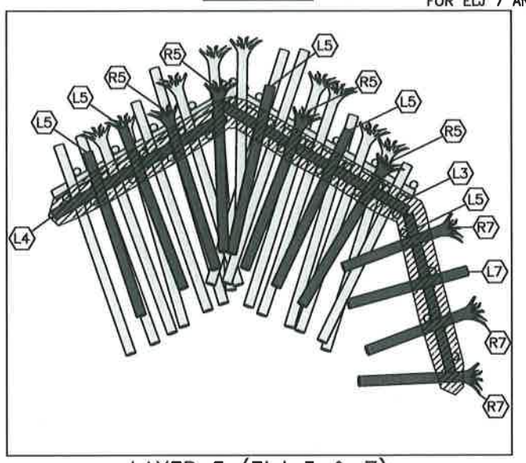

PILES



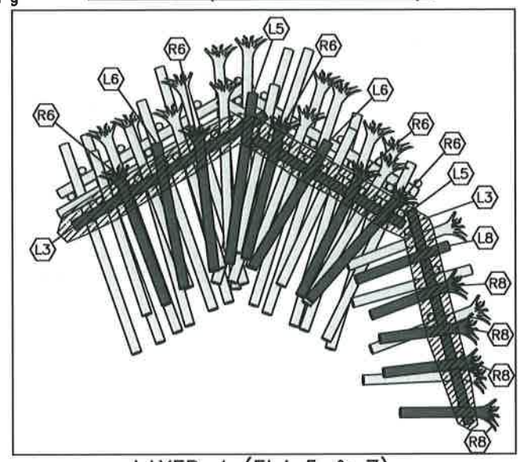

LAYER 1 (ELJ 5, 6, 7 & 8)




LAYER 2 (ELJ 5, 6, 7 & 8)




LAYER 3 (ELJ 5 & 7)

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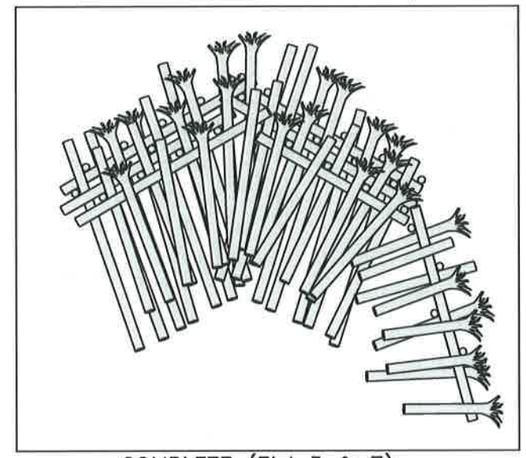
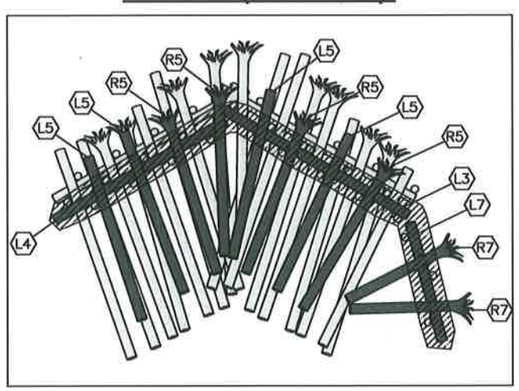
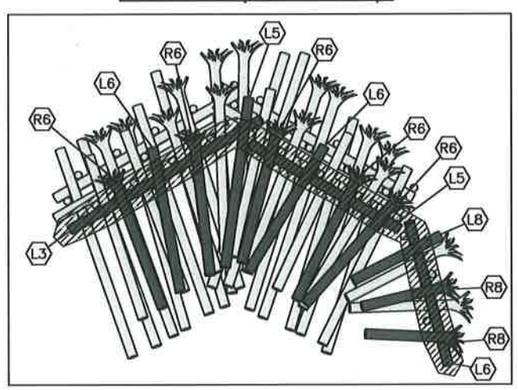


COMPLETE (ELJ 5 & 7)




LAYER 3 (ELJ 6 & 8)

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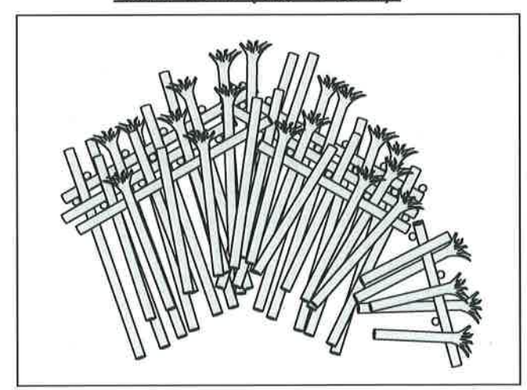

COMPLETE (ELJ 6 & 8)

**NOTES:**

1. STRUCTURE GENERAL LOCATION AND ORIENTATION SHALL BE STAKED BY THE CONTRACTOR. FINAL STRUCTURE LOCATION AND ORIENTATION TO BE FIELD VERIFIED BY THE PROJECT REPRESENTATIVE FOLLOWING CONTRACTOR STAKING.
2. ALL PILE LOCATIONS SHALL BE STAKED BY THE CONTRACTOR AND APPROVED BY THE PROJECT REPRESENTATIVE PRIOR TO PILE INSTALLATION.
3. ALL PILE LOCATIONS SHALL BE BASED ON THE LOCATION OF THE STRUCTURE CONTROL POINTS AND SHALL BE WITHIN 6" OF THE LOCATION SHOWN ON THE DRAWINGS.
4. PILE DIAMETERS SHALL BE MEASURED AT THE BUTT (LARGER) ENDS. PILES SHALL BE UNTREATED DOUGLAS FIR MEETING ASTM D25 REQUIREMENTS.
5. LOG MATERIALS SHALL BE PLACED AT THE LOCATIONS AND ORIENTATIONS SPECIFIED ON THE DRAWINGS OR AS DIRECTED BY THE PROJECT REPRESENTATIVE. TRIM CUT ENDS OF HORIZONTAL KEY LOGS TO FIT AS REQUIRED.
6. PLACE SLASH OVER AND BETWEEN KEY LOGS AND PILES AS SHOWN FOR EACH LAYER FOLLOWING PLACEMENT OF KEY LOGS AND RACKING LOGS. PLACE APPROXIMATELY 2' TO 3' OF NATIVE ALLUVIUM OVER 1/2 THE WIDTH OF SLASH TO SECURE IN PLACE SUCH THAT SLASH IS VISIBLE FOLLOWING CONSTRUCTION. COORDINATE WITH THE PROJECT REPRESENTATIVE PRIOR TO PLACING RACKING AND SLASH.
7. BACKFILL EACH LAYER WITH DRY COARSE ALLUVIUM AND RIPRAP EXCAVATED FROM THE EXISTING LEVEE TO TOP OF CURRENT LAYER PRIOR TO CONSTRUCTING SUBSEQUENT LAYER. COMPACT BACKFILL WITH EXCAVATOR BUCKET. FILL ALL VOIDS BETWEEN BOULDERS (ROCKS GREATER THAN 12" DIAMETER) WITH FINER ALLUVIUM TO ACHIEVE A WELL GRADED AND COMPACTED MASS.
8. SEE DWG WS2 FOR COORDINATES OF STRUCTURE CONTROL POINTS.

**LOG SCHEDULE:**

| LOG TYPE | MIN DIA (IN) | LENGTH (FT) | ROOTWAD | TOTAL QTY PER ELJ 5 & 7 | TOTAL QTY PER ELJ 6 & 8 |
|---|---|---|---|---|---|
| P2 | 18 (BUTT) | 50 | NO | 27 | 27 |
| P4 | 18 (BUTT) | 25 | NO | 4 | 3 |
| R2 | 24 | 50 | YES | 3 | 3 |
| R3 | 24 | 45 | YES | 5 | 5 |
| R4 | 24 | 40 | YES | 1 | 1 |
| R5 | 24 | 35 | YES | 4 | 4 |
| R6 | 24 | 30 | YES | 5 | 5 |
| R7 | 24 | 25 | YES | 3 | 2 |
| R8 | 24 | 20 | YES | 4 | 2 |
| L2 | 24 | 50 | NO | 3 | 3 |
| L3 | 24 | 45 | NO | 9 | 8 |
| L4 | 24 | 40 | NO | 4 | 4 |
| L5 | 24 | 35 | NO | 7 | 6 |
| L6 | 24 | 30 | NO | 2 | 3 |
| L7 | 24 | 25 | NO | 1 | 1 |
| L8 | 24 | 20 | NO | 1 | 1 |
| RACKING | 6–16 | 15–30 | OPTIONAL | 200 | 200 |
| SLASH | | | | 200 CY | 200 CY |

**LEGEND:**

- CURRENT LAYER KEY LOG
- PREVIOUS LAYER KEY LOG (AFTER BACKFILLING)
- VERTICAL PILE LOG
- SLASH PLACEMENT ZONE
- L1 — KEY LOG TYPE ID (LOG TYPE L1)
- CP1 — STRUCTURE CONTROL POINT (1)

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

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| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO — STATE OF WASHINGTON — 36069 — REGISTERED PROFESSIONAL ENGINEER

HERRERA

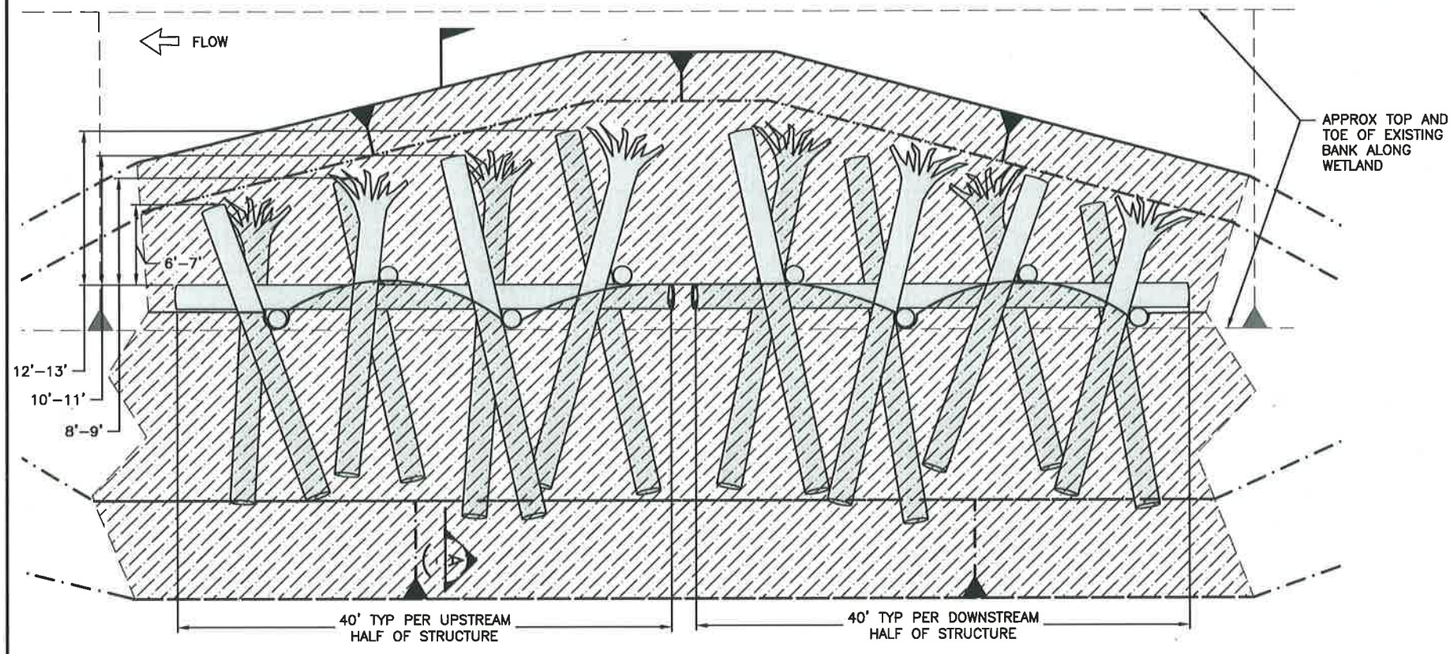
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

BANK DEFLECTOR ELJ LAYERING PLAN

SHEET 53 OF 69 SHEETS

WD6




PLAN – BIOREVETMENT (1 / WS2)

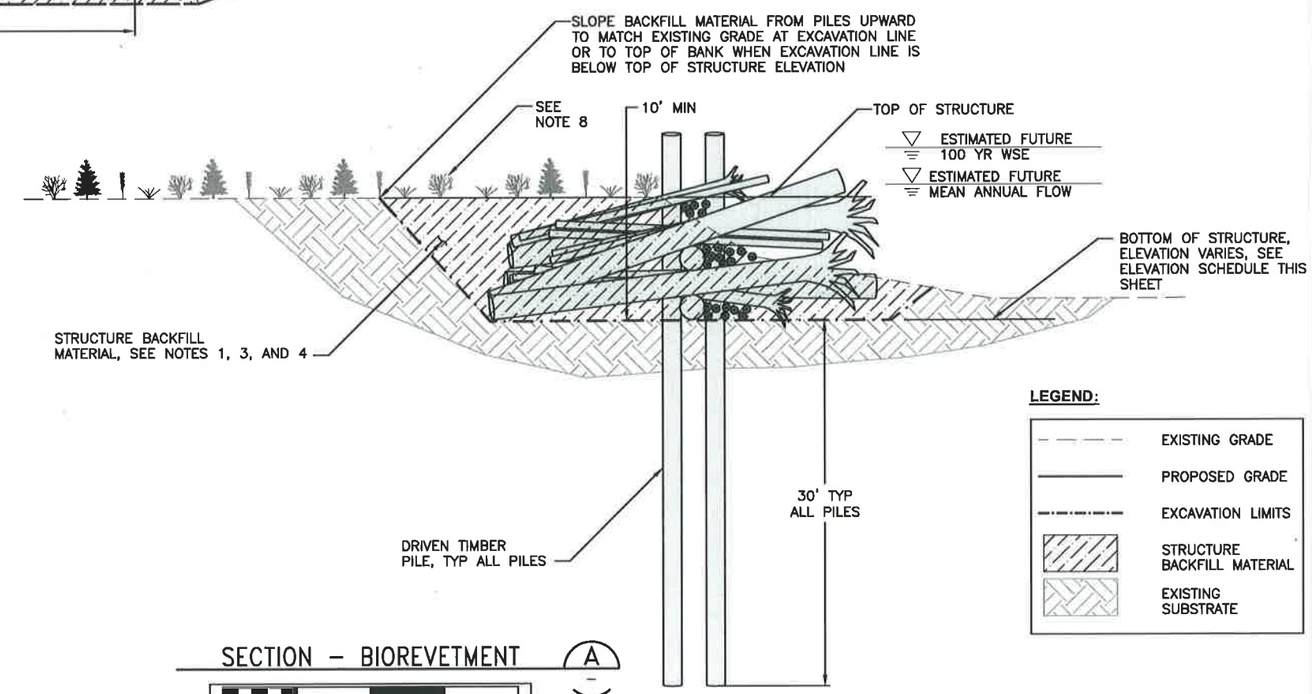
6 0 6 12 24
SCALE IN FEET

**NOTES:**

1. EXTENTS OF BACKFILL SHOWN ARE APPROXIMATE AND WILL VARY FOR EACH STRUCTURE.
2. EXCAVATION LIMITS SHOWN ARE APPROXIMATE AND WILL VARY BASED ON CONSTRUCTION MEANS AND METHODS, SUBSURFACE CONDITIONS AND LOCATION OF STRUCTURE. CONTRACTOR SHALL ADJUST EXCAVATION LIMITS AS NECESSARY TO COMPLETE CONSTRUCTION.
3. FOR "SHINGLED" BIOREVETMENT STRUCTURES, BACKFILL MATERIAL WILL CONSIST OF DRY LEVEE EXCAVATION SPOILS CAPPED WITH A 12" DEEP LAYER OF NATIVE TOPSOIL. PLACE SPOILS WITHIN INTERIOR CORE OF STRUCTURE AND OVER FINAL LAYER OF LOGS IN 2' LAYERS AND COMPACT WITH BACKSIDE OF EXCAVATOR BUCKET. SATURATED BACKFILL MATERIAL THAT CANNOT BE PROPERLY COMPACTED WILL NOT BE ALLOWED. SEE DWGS SB1–SB5 FOR LOCATION OF "SHINGLED" BIOREVETMENT STRUCTURES.
4. FOR NON–SHINGLED BIOREVETMENT STRUCTURES, PLACE ONLY DRY NATIVE EXCAVATION SPOILS WITHIN INTERIOR CORE OF STRUCTURE AND OVER FINAL LAYER OF LOGS IN 2' LAYERS AND COMPACT WITH BACKSIDE OF EXCAVATOR BUCKET. SATURATED BACKFILL MATERIAL THAT CANNOT BE COMPACTED PROPERLY WILL NOT BE ALLOWED.
5. SEE LOG SCHEDULE ON STRUCTURE LAYERING PLAN FOR DIMENSIONS AND NUMBERS OF EACH LOG TYPE IN STRUCTURE.
6. PLACEMENT OF RACKING LOGS SHOWN IS APPROXIMATE. PLACE RACKING LOGS ALONG UPSTREAM FACE OF STRUCTURE. APPROXIMATELY 1/2 OF RACKING LOGS SHALL BE PLACED ACROSS PILE ROWS (PERPENDICULAR TO FLOW) AND 1/2 OF THE RACKING LOGS PARALLEL TO FLOW AND EXTENDING INTO THE CORE OF THE STRUCTURE BETWEEN HORIZONTAL KEY LOGS. RACKING SHALL BE PLACED WITH EACH LAYER OF KEY LOGS, SHALL BE ANGLED UP AND DOWN FROM THE HORIZONTAL, AND SHALL BE PLACED TO CREATE AN INTERLOCKING MATRIX OF LOGS SECURED BETWEEN VERTICAL PILE LOGS AND HORIZONTAL KEY LOGS. COORDINATE WITH THE PROJECT REPRESENTATIVE PRIOR TO PLACING RACKING LOGS, SLASH AND BACKFILLING.
7. SEE STRUCTURE LAYERING PLAN FOR SLASH PLACEMENT. SLASH NOT SHOWN HERE FOR CLARITY. PLACE SLASH AS SHOWN ON LAYERING PLAN TO FILL VOIDS BETWEEN RACKING LOGS.
8. SEE PLANTING PLAN FOR RECOMMENDED STRUCTURE PLANTING INFORMATION AND DETAILS.
9. BIOREVETMENT CONTROL POINT TABLE TO BE PROVIDED FOR FINAL DESIGN.
10. SEE DWGS WD11 – WD14 FOR APPROX WSE DURING CONSTRUCTION.

**ELEVATION SCHEDULE FOR ALL BIOREVETMENT STRUCTURES**

| STRUCTURE # | NO. OF STRUCTURES | BOTTOM OF STRUCTURE EL (FT) | TOP OF STRUCTURE EL (FT) |
|---|---|---|---|
| 1–38 | 38 | 63 | 73 |
| 39–50 | 12 | 64 | 74 |
| 51–56 | 6 | 65 | 75 |
| 57–60 | 4 | 66 | 76 |
| 61–65 | 5 | 67 | 77 |
| 66–75 | 10 | 68 | 78 |
| 76–82 | 7 | 69 | 79 |
| 83–108 | 26 | 70 | 80 |




**LEGEND:**

- EXISTING GRADE
- PROPOSED GRADE
- EXCAVATION LIMITS
- STRUCTURE BACKFILL MATERIAL
- EXISTING SUBSTRATE

SECTION – BIOREVETMENT (A / –)

6 0 6 12 24
SCALE IN FEET

| | | | |
|---|---|---|---|
| FIELD BOOK: | | | |
| SURVEYED: | | | |
| SURVEY BASE MAP: | | | |
| CHECKED: | | | |

CADD / 60% 5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | | | |

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| APPROVED: | IAN MOSTRENKO, PE | 5–2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5–2013 |
| DESIGNED: | BRIAN SCOTT | 5–2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5–2013 |

SRFB # RCO 087–1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

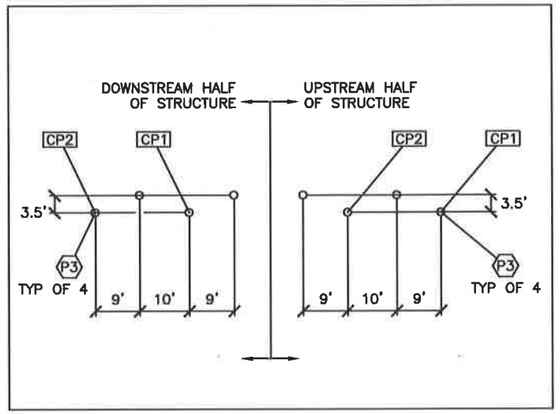
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

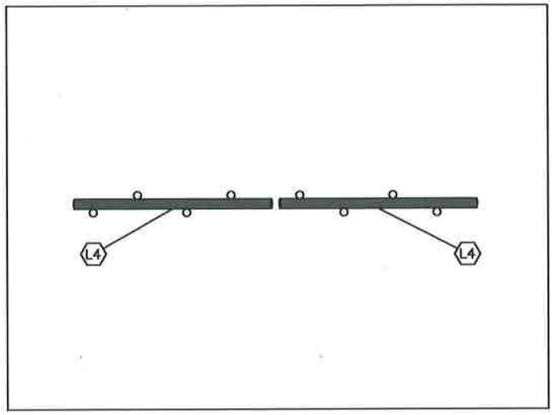
BIOREVETMENT PLAN AND SECTIONS

SHEET 54 OF 69 SHEETS

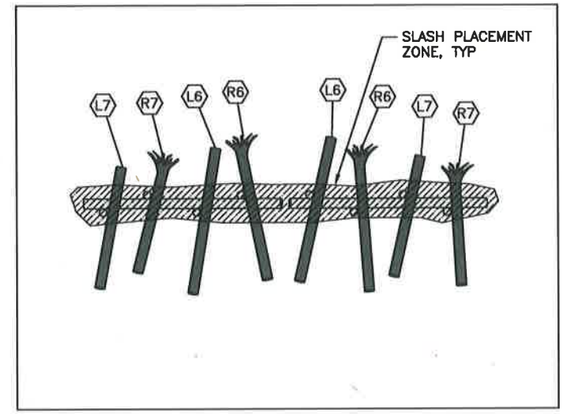
WD7



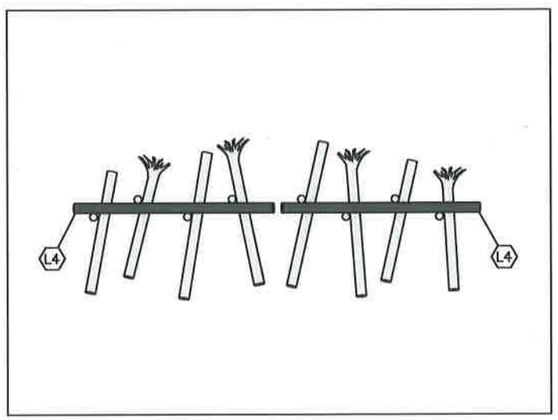

PILES



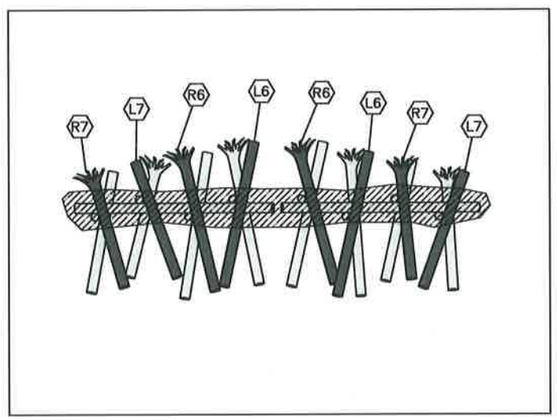

LAYER 1



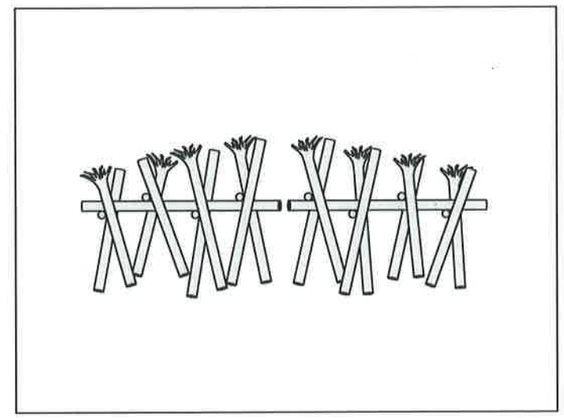

LAYER 2




LAYER 3




LAYER 4



COMPLETE

**LOG SCHEDULE - PER 80' STRUCTURE**

| LOG TYPE | MIN DIA (IN) | LENGTH (FT) | ROOTWAD | TOTAL QTY PER ELJ |
|---|---|---|---|---|
| P3 | 18 (BUTT) | 45 | NO | 8 |
| 6 | 24 | 30 | YES | 4 |
| 7 | 24 | 25 | YES | 4 |
| L4 | 24 | 40 | NO | 4 |
| L6 | 24 | 30 | NO | 4 |
| L7 | 24 | 25 | NO | 4 |
| RACKING | 8–16 | 15–30 | OPTIONAL | 80 |
| SLASH | – | – | – | 80 CY |

**NOTES:**

1. STRUCTURE GENERAL LOCATION AND ORIENTATION SHALL BE STAKED BY THE CONTRACTOR. FINAL STRUCTURE LOCATION AND ORIENTATION TO BE FIELD VERIFIED BY THE PROJECT REPRESENTATIVE FOLLOWING CONTRACTOR STAKING.
2. ALL PILE LOCATIONS SHALL BE STAKED BY THE CONTRACTOR AND APPROVED BY THE PROJECT REPRESENTATIVE PRIOR TO PILE INSTALLATION.
3. ALL PILE LOCATIONS SHALL BE BASED ON THE LOCATION OF THE STRUCTURE CONTROL POINTS AND SHALL BE WITHIN 6" OF THE LOCATION SHOWN ON THE DRAWINGS.
4. PILE DIAMETERS SHALL BE MEASURED AT THE BUTT (LARGER) ENDS. PILES SHALL BE UNTREATED DOUGLAS FIR MEETING ASTM D25 REQUIREMENTS.
5. LOG MATERIALS SHALL BE PLACED AT THE LOCATIONS AND ORIENTATIONS SPECIFIED ON THE DRAWINGS OR AS DIRECTED BY THE PROJECT REPRESENTATIVE. TRIM CUT ENDS OF HORIZONTAL KEY LOGS TO FIT AS REQUIRED.
6. PLACE SLASH OVER AND BETWEEN KEY LOGS AND PILES AS SHOWN FOR EACH LAYER SPECIFIED FOLLOWING PLACEMENT OF KEY LOGS AND RACKING LOGS. PLACE APPROXIMATELY 2' TO 3' OF NATIVE ALLUVIUM OVER 1/2 THE WIDTH OF SLASH TO SECURE IN PLACE SUCH THAT SLASH IS VISIBLE FOLLOWING CONSTRUCTION. COORDINATE WITH THE PROJECT REPRESENTATIVE PRIOR TO PLACING RACKING AND SLASH.
7. BACKFILL EACH LAYER WITH THE SPECIFIED MATERIAL FLUSH TO TOP OF CURRENT LAYER PRIOR TO CONSTRUCTING SUBSEQUENT LAYER. COMPACT ALLUVIUM BACKFILL WITH EXCAVATOR BUCKET. FILL ALL VOIDS BETWEEN BOULDERS (ROCKS GREATER THAN 12" DIAMETER) WITH FINER ALLUVIUM TO ACHIEVE A WELL GRADED AND COMPACTED MASS.

**LEGEND:**

- CURRENT LAYER KEY LOG
- PREVIOUS LAYER KEY LOG (AFTER BACKFILLING)
- O VERTICAL PILE LOG
- SLASH PLACEMENT ZONE
- L1 KEY LOG TYPE ID (LOG TYPE L1)
- CP1 STRUCTURE CONTROL POINT (1)

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

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| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

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HERRERA

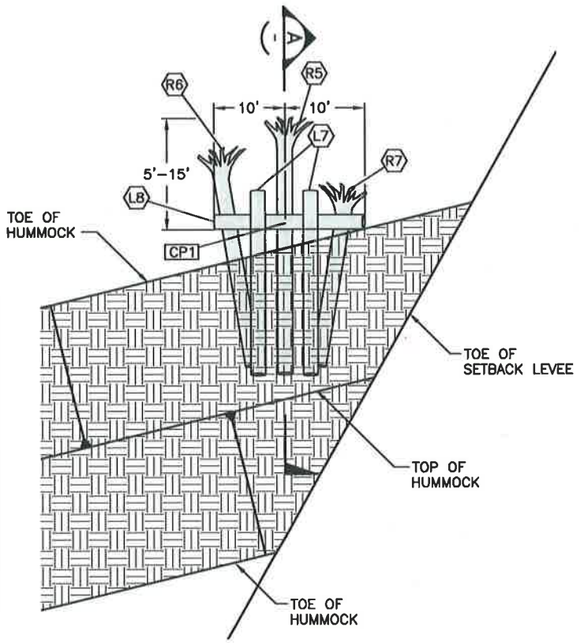
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

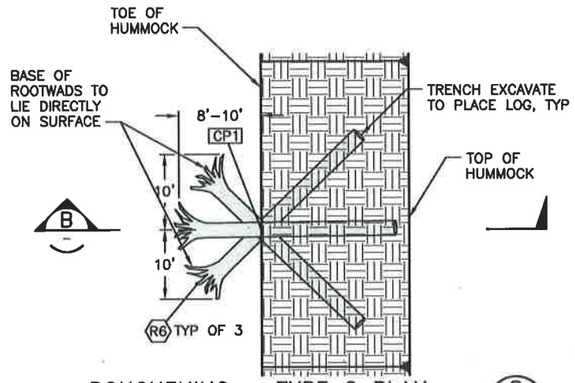
BIOREVETMENT LAYERING PLAN

SHEET 55 OF 69 SHEETS

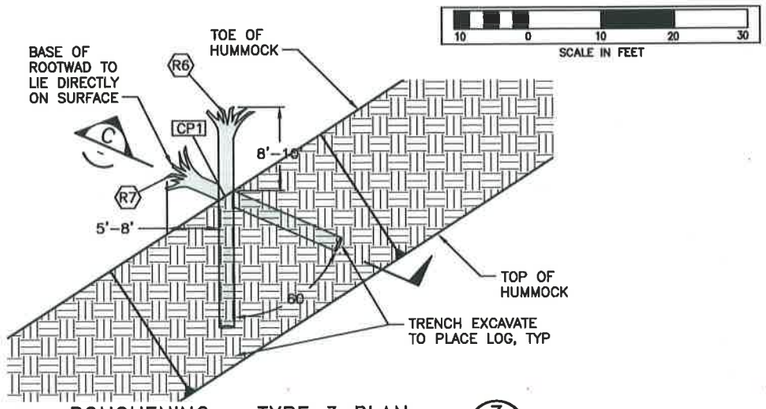
WD8



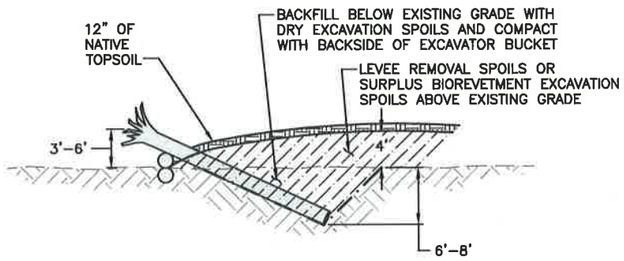

ROUGHENING – TYPE 1 PLAN (1) FR1, FR2



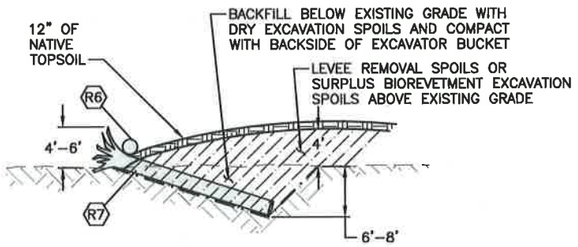

ROUGHENING – TYPE 2 PLAN (2) FR1, FR2



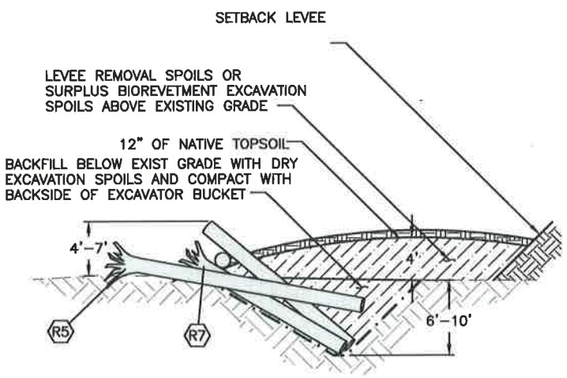

ROUGHENING – TYPE 3 PLAN (3) FR1, FR2




ROUGHENING – TYPE 2 SECTION (B)




ROUGHENING – TYPE 3 SECTION (C)




ROUGHENING – TYPE 1 SECTION (A)

**LEGEND:**

| | | | |
|---|---|---|---|
| – – – – | EXISTING GRADE | | TOPSOIL |
| ——— | PROPOSED GRADE | | STRUCTURE BACKFILL MATERIAL |
| —·—·— | EXCAVATION LIMITS | | EXISTING SUBSTRATE |
| —(L1) | KEY LOG TYPE ID (LOG TYPE L1) | | |
| —[CP1] | STRUCTURE CONTROL POINT (1) | | |

**NOTES:**

1. EXTENTS OF BACKFILL SHOWN ARE APPROXIMATE AND WILL VARY FOR EACH LOG STRUCTURE.
2. EXCAVATION LIMITS SHOWN ARE APPROXIMATE AND WILL VARY BASED ON CONSTRUCTION MEANS AND METHODS, SUBSURFACE CONDITIONS AND LOCATION OF STRUCTURE. CONTRACTOR SHALL ADJUST EXCAVATION LIMITS AS NECESSARY TO COMPLETE CONSTRUCTION.
3. SEE LOG SCHEDULE FOR DIMENSIONS AND NUMBERS OF EACH LOG TYPE IN STRUCTURE.

**ROUGHENING - TYPE 1 LOG SCHEDULE**

| LOG TYPE | MIN DIA (IN) | LENGTH (FT) | ROOTWAD | TOTAL QTY PER ELJ |
|---|---|---|---|---|
| R5 | 24 | 35 | Y | 1 |
| R6 | 24 | 30 | Y | 1 |
| R7 | 24 | 25 | Y | 1 |
| L7 | 24 | 25 | N | 2 |
| L8 | 24 | 20 | N | 1 |

**ROUGHENING - TYPE 2 LOG SCHEDULE**

| LOG TYPE | MIN DIA (IN) | LENGTH (FT) | ROOTWAD | TOTAL QTY PER ELJ |
|---|---|---|---|---|
| R6 | 24 | 30 | Y | 3 |

**ROUGHENING - TYPE 3 LOG SCHEDULE**

| LOG TYPE | MIN DIA (IN) | LENGTH (FT) | ROOTWAD | TOTAL QTY PER ELJ |
|---|---|---|---|---|
| R6 | 24 | 30 | Y | 1 |
| R7 | 24 | 25 | Y | 1 |

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

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5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN D. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

HERRERA

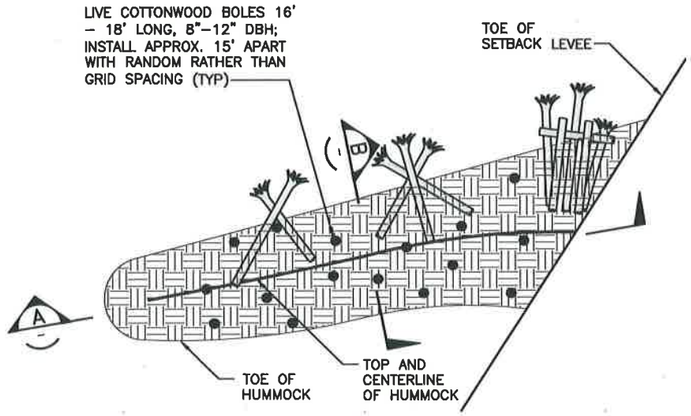
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

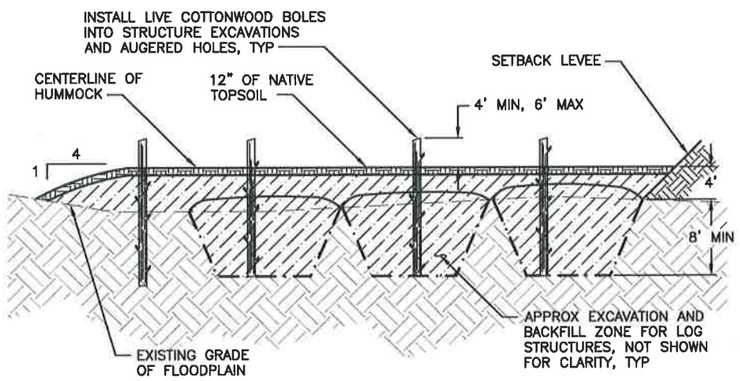
FLOODPAIN ROUGHENING DETAILS

SHEET 56 OF 69 SHEETS

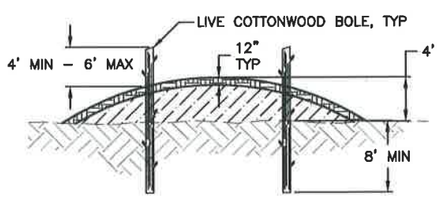
WD9



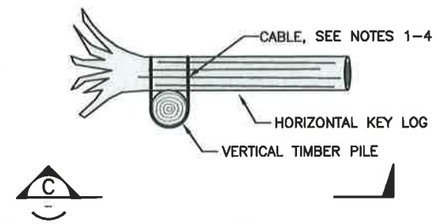

FLOODPLAIN HUMMOCK PLAN (1 / FR1, FR2)



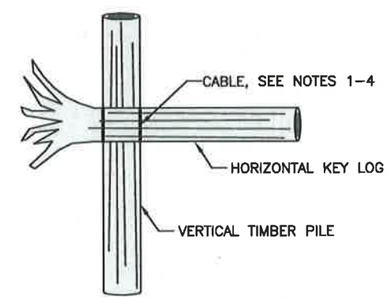

FLOODPLAIN HUMMOCK SECTION, TYP (A)




FLOODPLAIN HUMMOCK SECTION, TYP (B)




DETAIL – CABLE LASHING (1 / WD2)
SCALE: NTS




SECTION – CABLE LASHING (C)
SCALE: NTS

**LEGEND:**

- EXISTING GRADE
- PROPOSED GRADE
- EXCAVATION LIMITS
- TOPSOIL
- STRUCTURE BACKFILL MATERIAL
- EXISTING SUBSTRATE
- L1 — KEY LOG TYPE ID (LOG TYPE L1)
- CP1 — STRUCTURE CONTROL POINT (1)

**NOTES:**

1. LASH HORIZONTAL KEY LOGS TO VERTICAL TIMBER PILES WITH CABLE AS SHOWN ON STRUCTURE LAYERING PLAN OR AS DIRECTED BY THE PROJECT REPRESENTATIVE. CABLE LASHING SYSTEM SHALL BE PUT IN TENSION TO 1/4 OF THE CABLE WORKING LOAD LIMIT AND BE MAINTAINED DURING CABLE CLAMPING.
2. CABLE LENGTH NEEDED PER LASHING WILL VARY BASED ON DIAMETER OF LOGS BEING LASHED TOGETHER.
3. CABLE FOR LASHING SHALL BE 1/2 INCH DIAMETER GALVANIZED WIRE ROPE, CLASS 6X19, WITH A MINIMUM BREAKING STRENGTH OF 10 TONS. STEEL GRADE SHALL BE IMPROVED PLOWED STEEL (IPS). INTERNAL CORE SHALL BE INDEPENDENT WIRE ROPE CORE (IWRC).
4. ALL HARDWARE USED FOR LASHING SHALL BE GALVANIZED OR STAINLESS STEEL, AND CONNECTIONS SHALL BE OF THE TYPE SPECIFIED BY THE MANUFACTURER WITH AN EQUAL OR GREATER STRENGTH THAN THE CABLE BREAKING STRENGTH OR AS APPROVED BY THE PROJECT REPRESENTATIVE.

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C
PROJECT No. 1112049 (FL9001)

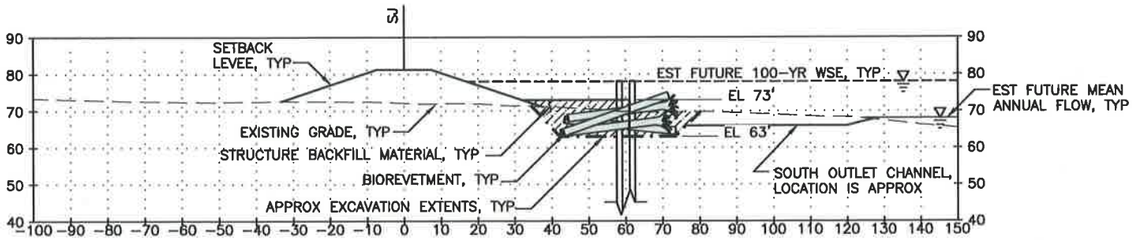
IAN B. MOSTRENKO — STATE OF WASHINGTON — 36069 — REGISTERED PROFESSIONAL ENGINEER

HERRERA

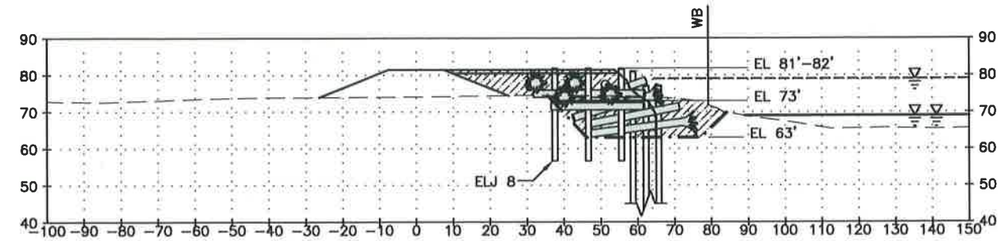
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION
FLOODPAIN ROUGHENING DETAILS

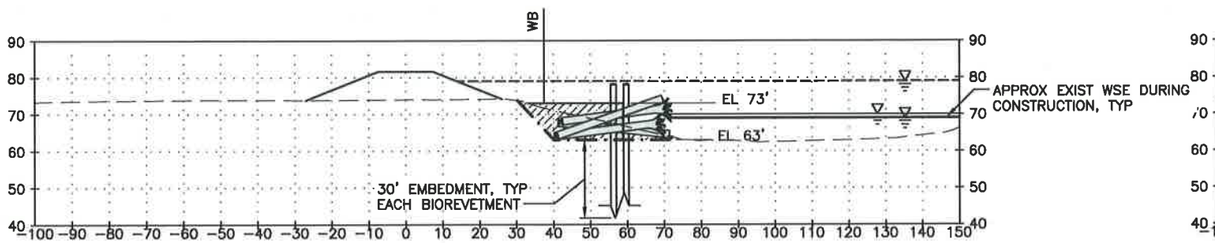
SHEET 57 OF 69 SHEETS
WD10



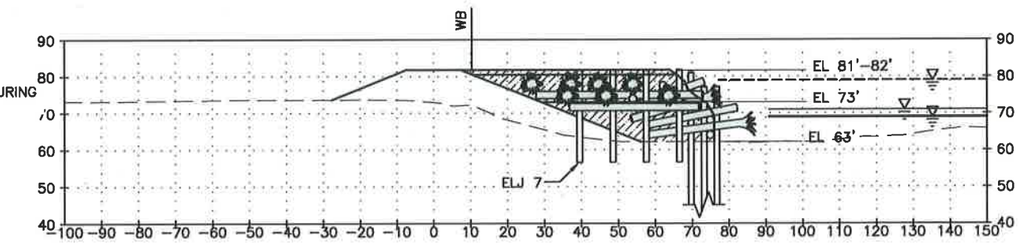

SECTION AA-AA (AA / SB1)
1"=20'



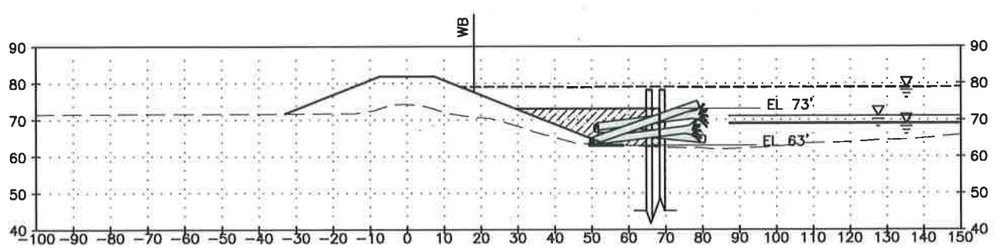

SECTION BB-BB (BB / SB2)
1"=20'



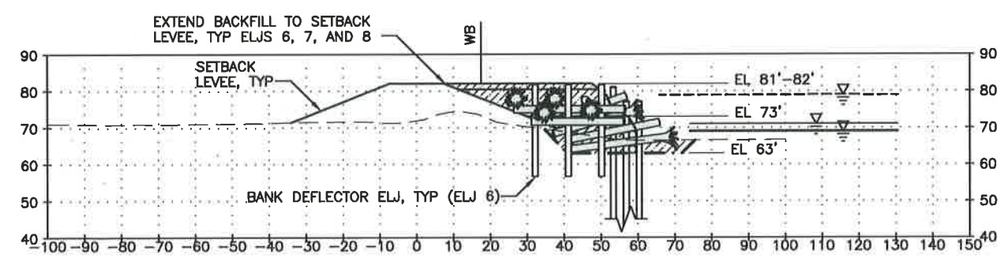

SECTION CC-CC (CC / SB2)
1"=20'




SECTION DD-DD (DD / SB2)
1"=20'




SECTION EE-EE (EE / SB2)
1"=20'




SECTION FF-FF (FF / SB2)
1"=20'

FIELD BOOK:
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|---|---|---|---|
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| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

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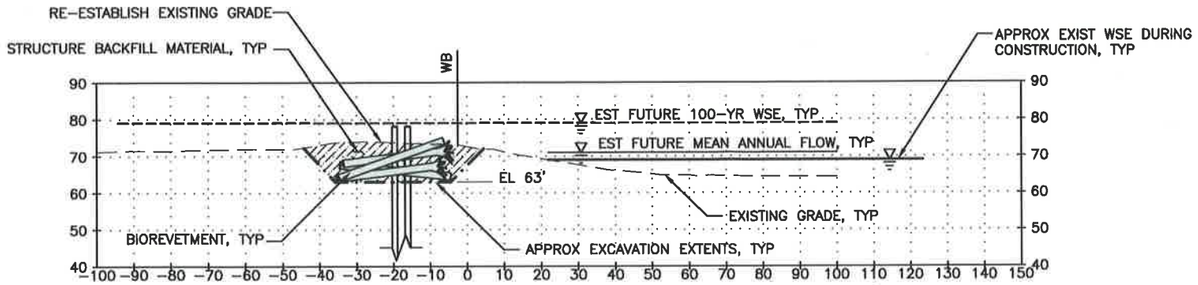
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

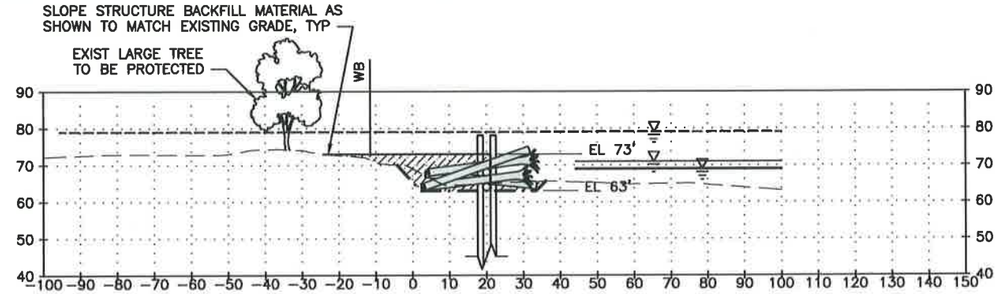
BIOREVETMENT SECTIONS

SHEET 58 OF 69 SHEETS

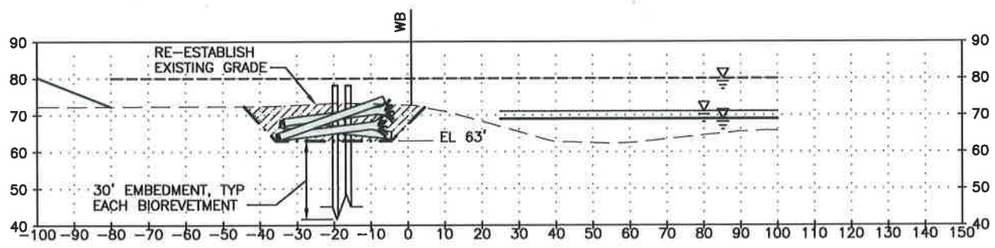
WD11



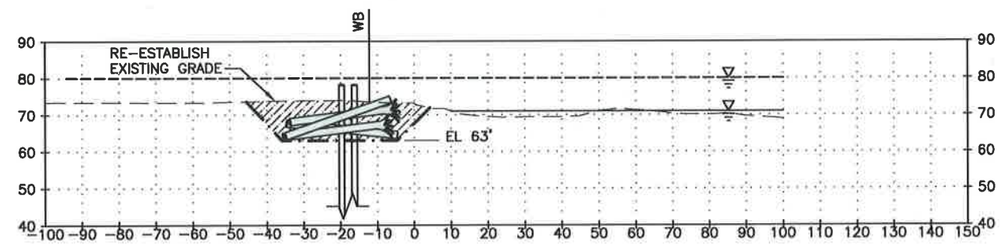

SECTION GG-GG
1"=20'
GG SB2



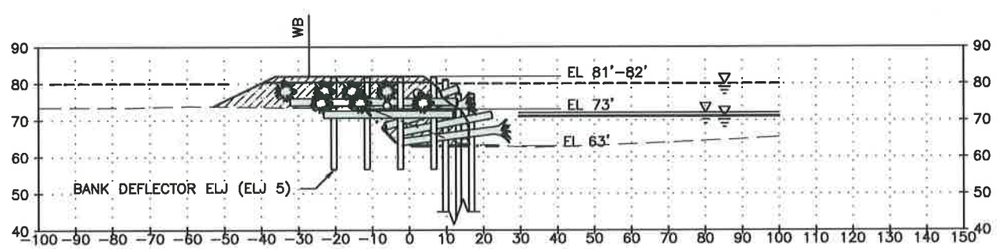

SECTION HH-HH
1"=20'
HH SB2



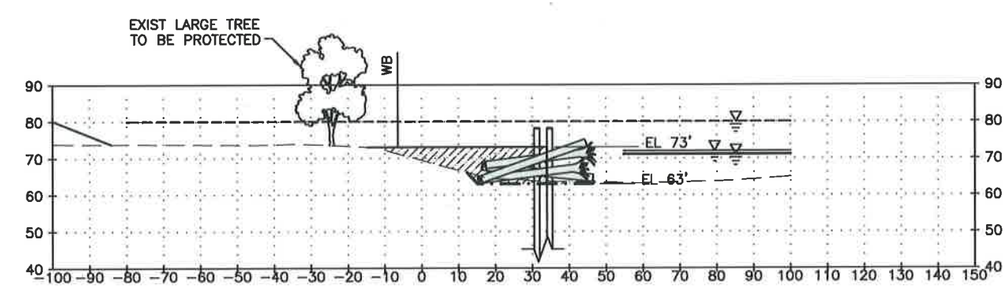

SECTION II-II
1"=20'
II SB2




SECTION JJ-JJ
1"=20'
JJ SB3




SECTION KK-KK
1"=20'
KK SB3




SECTION LL-LL
1"=20'
LL SB3

FIELD BOOK:
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| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

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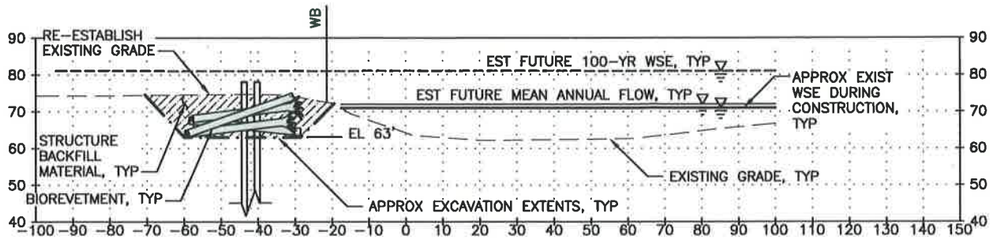
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

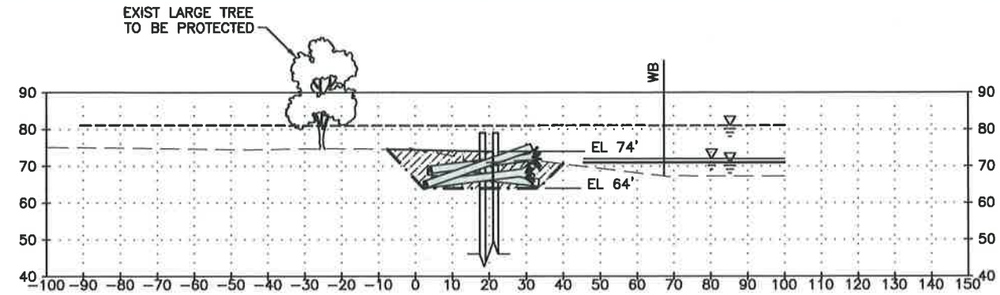
BIOREVETMENT SECTIONS

SHEET 59 OF 69 SHEETS

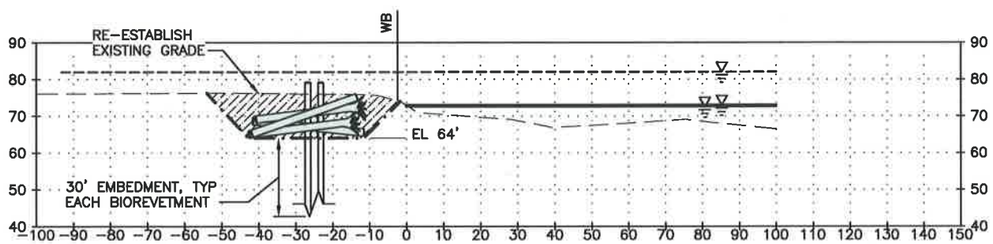
WD12



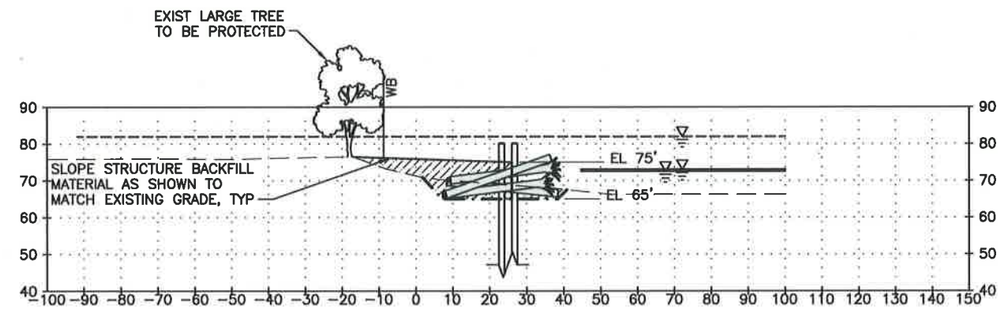

SECTION MM-MM (MM / SB3)
1"=20'



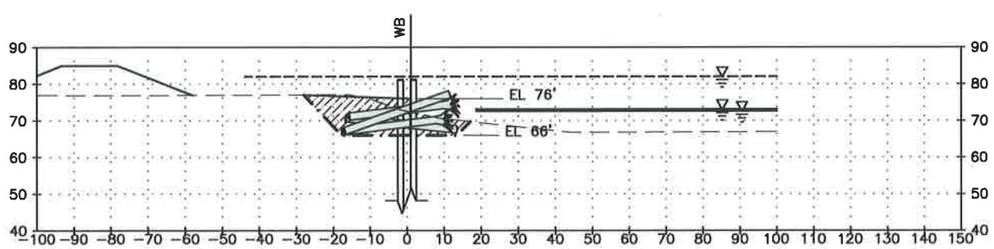

SECTION NN-NN (NN / SB3)
1"=20'



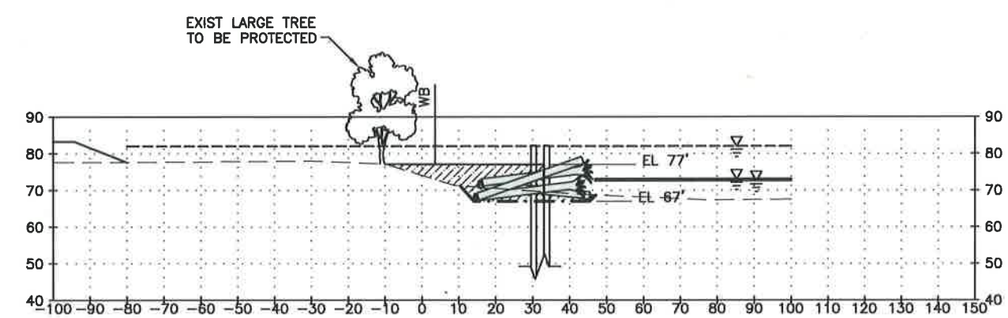

SECTION OO-OO (OO / SB3)
1"=20'




SECTION PP-PP (PP / SB3)
1"=20'




SECTION QQ-QQ (QQ / SB4)
1"=20'




SECTION RR-RR (RR / SB4)
1"=20'

FIELD BOOK:
SURVEYED:
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5-2013

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|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

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IAN P. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

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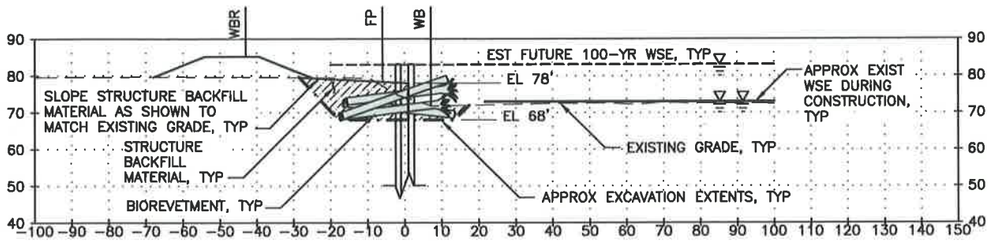
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

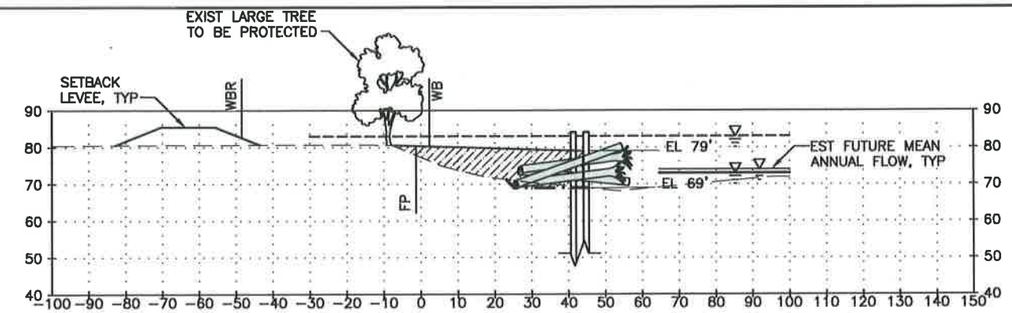
BIOREVETMENT SECTIONS

SHEET 60 OF 69 SHEETS

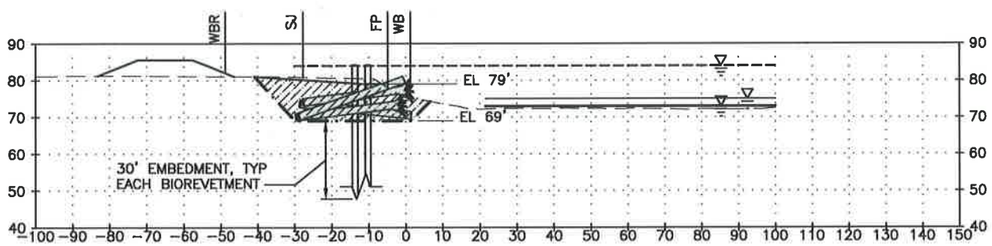
WD13



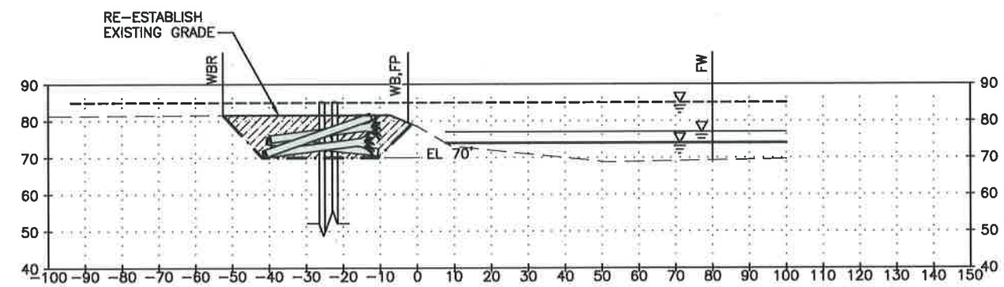

SECTION SS-SS (SS / SB4)
1"=20'



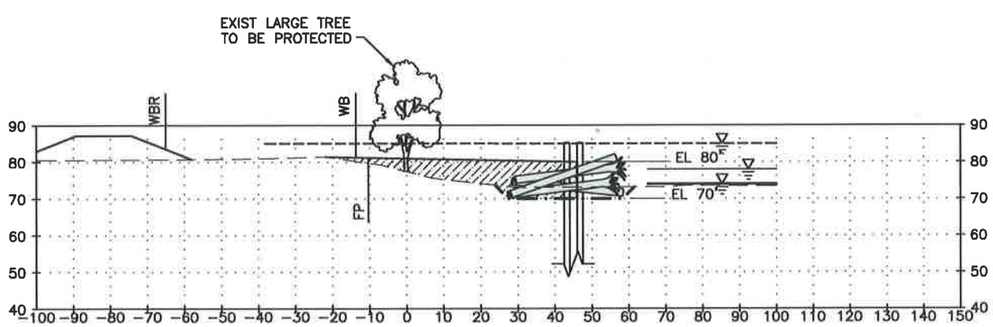

SECTION TT-TT (TT / SB4)
1"=20'



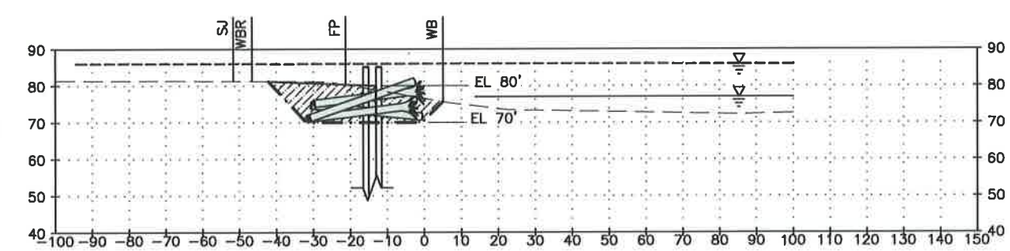

SECTION UU-UU (UU / SB4)
1"=20'




SECTION VV-VV (VV / SB5)
1"=20'




SECTION WW-WW (WW / SB5)
1"=20'




SECTION XX-XX (XX / SB5)
1"=20'

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | IAN MOSTRENKO, PE | 5-2013 |
| PROJECT MANAGER: | MARK EWBANK, PE | 5-2013 |
| DESIGNED: | BRIAN SCOTT | 5-2013 |
| ECOLOGIST: | | |
| DESIGN ENTERED: | TODD PRESCOTT | 5-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

IAN B. MOSTRENKO — STATE OF WASHINGTON — 36069 — REGISTERED PROFESSIONAL ENGINEER

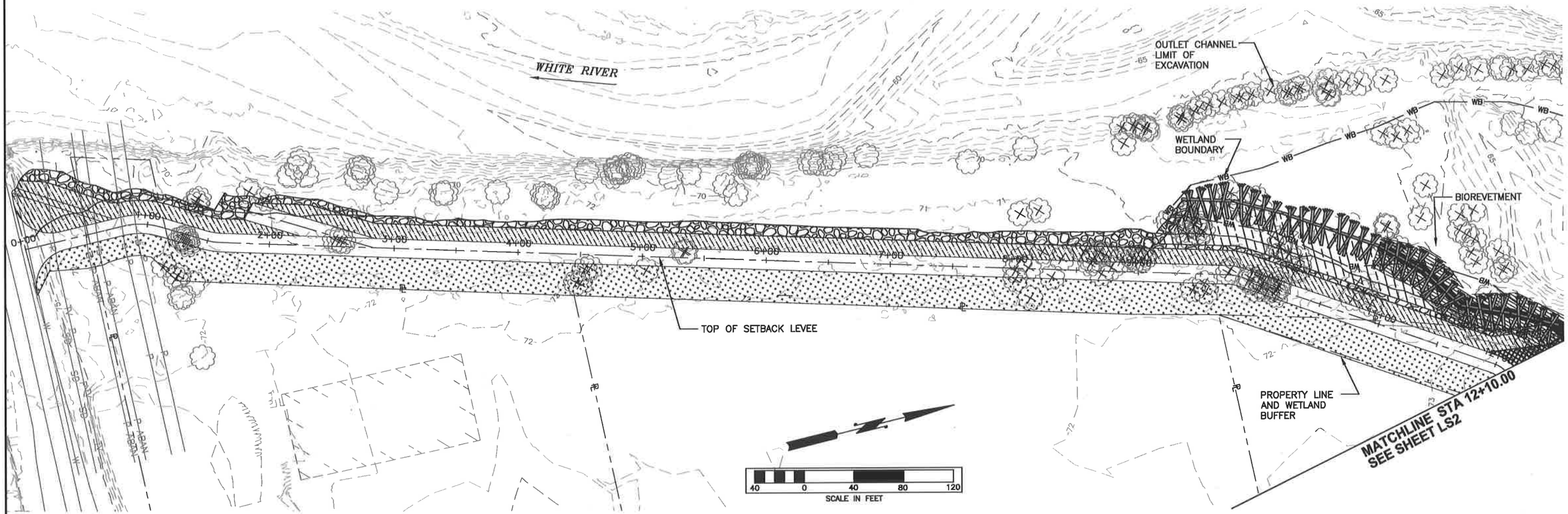
HERRERA

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION
BIOREVETMENT SECTIONS

SHEET 61 OF 69 SHEETS

WD14




**NOTES:**

1. SEE DWG LS7 FOR LEGEND OF PLANT TYPES.

**LEGEND:**

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FIELD BOOK: | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C |
| SURVEYED: | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) |
| SURVEY BASE MAP: | | | | | DESIGNED: KATE AKYUZ | 4-2013 | |
| CHECKED: | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | |
| | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | |

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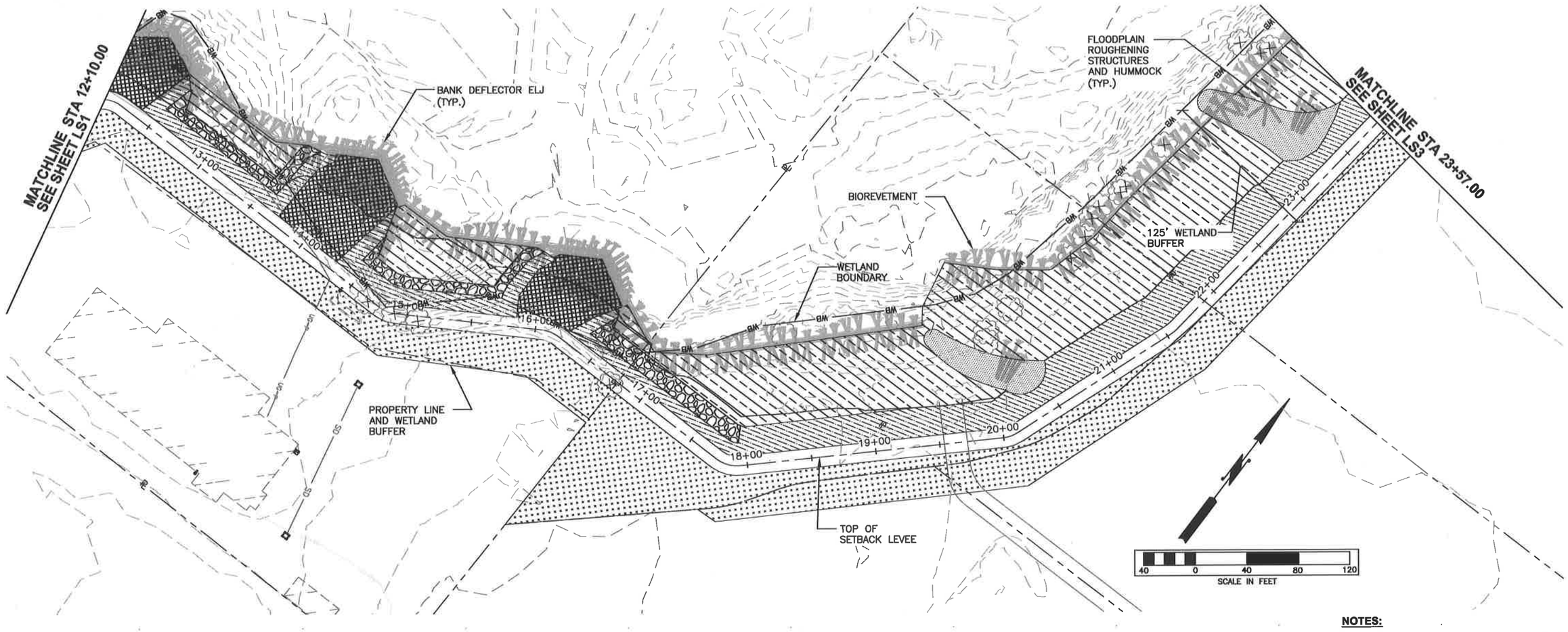
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION
PLANTING PLAN

SHEET 62 OF 69 SHEETS

LS1




**NOTES:**

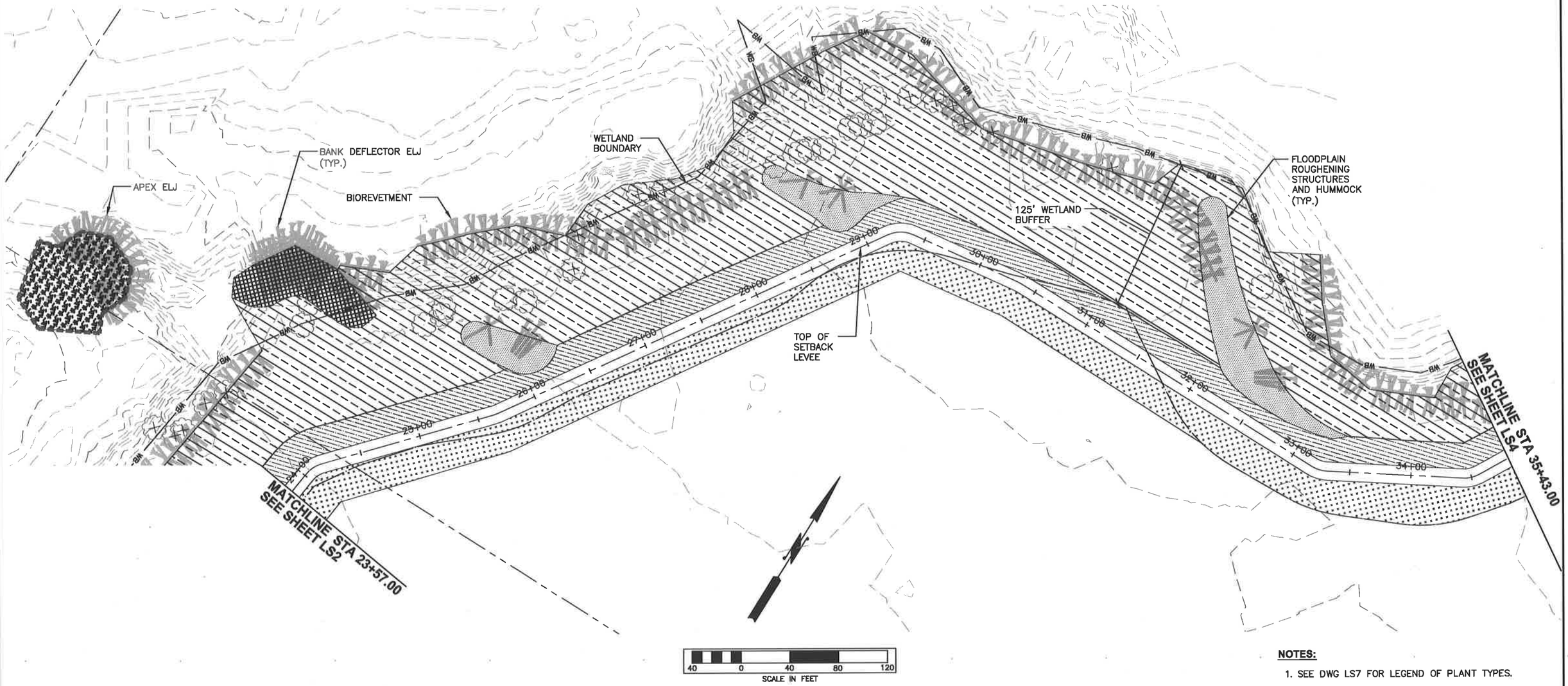
1. SEE DWG LS7 FOR LEGEND OF PLANT TYPES.

**LEGEND:**

EX. TREE
TO BE PROTECTED

EX. TREE
TO BE REMOVED

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FIELD BOOK: | | | | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C | | | King County Department of Natural Resources and Parks Water and Land Resources Division River and Floodplain Management Section Christie True, Director | COUNTYLINE LEVEE SETBACK WHITE RIVER, RIVER MILE 5.00-6.33 LEVEE MODIFICATION | SHEET 63 OF 69 SHEETS |
| SURVEYED: | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) | | | | PLANTING PLAN | LS2 |
| SURVEY BASE MAP: | | | | DESIGNED: KATE AKYUZ | 4-2013 | | | | | | |
| CHECKED: | | CADD / 60% 5-2013 | | ECOLOGIST: SARAH McCARTHY | 4-2013 | | | | | | |
| | | NUM. | REVISION | BY | DATE | DESIGN ENTERED: LICA DULAN | 4-2013 | | | | |




**NOTES:**

1. SEE DWG LS7 FOR LEGEND OF PLANT TYPES.

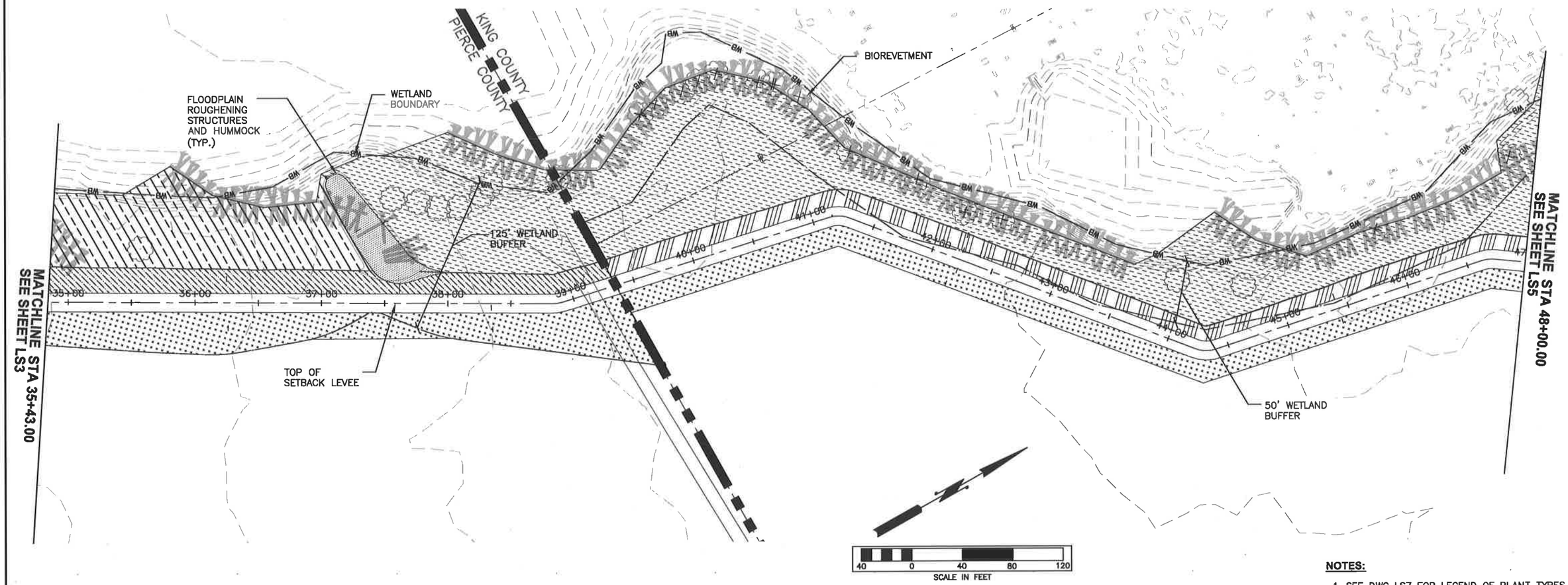
**LEGEND:**

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FIELD BOOK: | | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C | | King County Department of Natural Resources and Parks Water and Land Resources Division River and Floodplain Management Section Christie True, Director | COUNTYLINE LEVEE SETBACK WHITE RIVER, RIVER MILE 5.00-6.33 LEVEE MODIFICATION PLANTING PLAN | SHEET 64 OF 69 SHEETS |
| SURVEYED: | | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) | | | | LS3 |
| SURVEY BASE MAP: | | | | | | DESIGNED: KATE AKYUZ | 4-2013 | | | | | |
| CHECKED: | | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | | | | | |
| | | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | | | | | |

CADD / 60% 5-2013




**NOTES:**

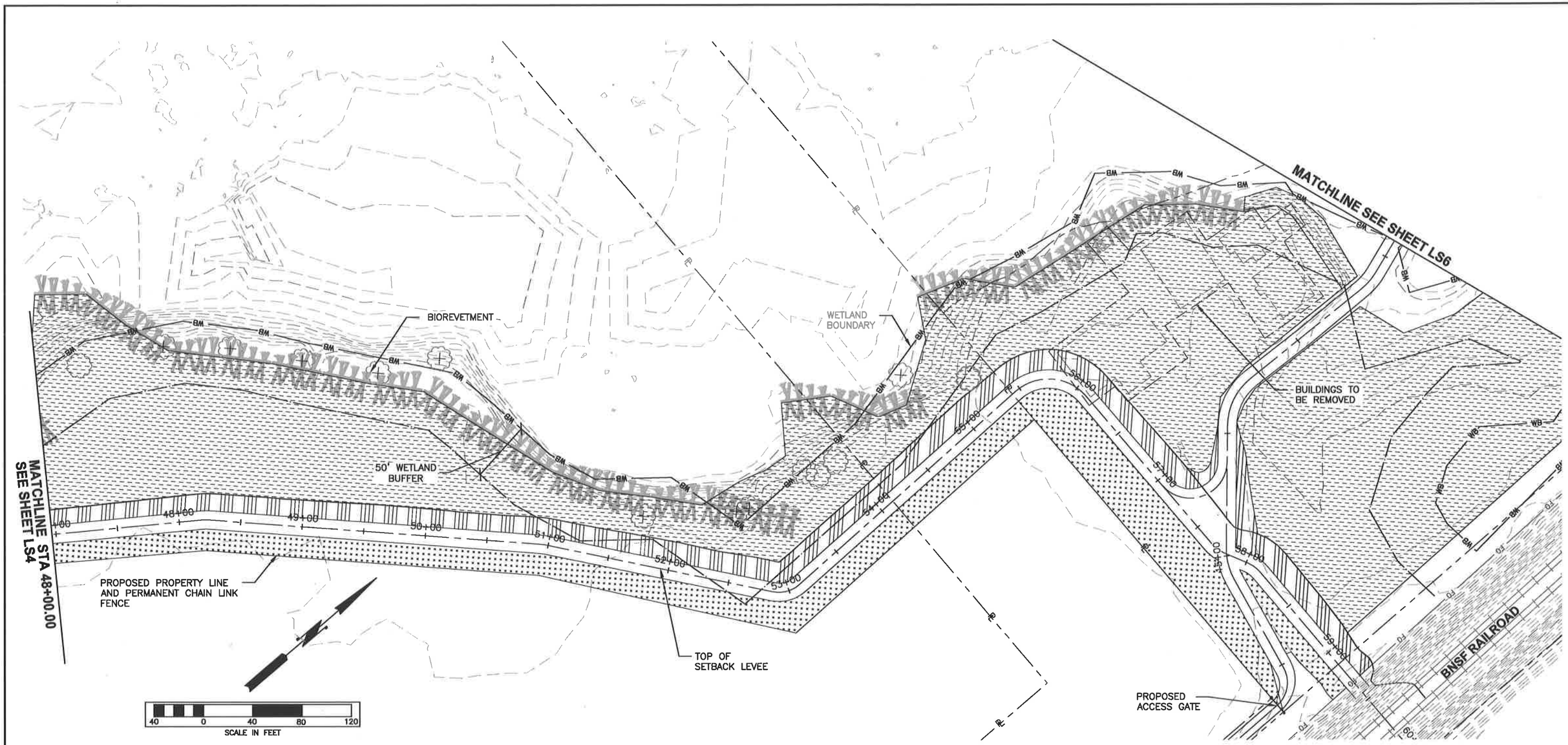
1. SEE DWG LS7 FOR LEGEND OF PLANT TYPES.

**LEGEND:**

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FIELD BOOK: | | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C | | King County Department of Natural Resources and Parks Water and Land Resources Division River and Floodplain Management Section Christie True, Director | COUNTYLINE LEVEE SETBACK WHITE RIVER, RIVER MILE 5.00-6.33 LEVEE MODIFICATION PLANTING PLAN | SHEET 65 OF 69 SHEETS |
| SURVEYED: | | | CADD / 60% 5-2013 | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) | | | | |
| SURVEY BASE MAP: | | | | | | DESIGNED: KATE AKYUZ | 4-2013 | | | | | |
| CHECKED: | | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | | | | | |
| | | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | | | | | LS4 |




**NOTES:**

1. SEE DWG LS7 FOR LEGEND OF PLANT TYPES.

**LEGEND:**

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FIELD BOOK: | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C |
| SURVEYED: | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) |
| SURVEY BASE MAP: | | CADD / 60% 5-2013 | | | DESIGNED: KATE AKYUZ | 4-2013 | |
| CHECKED: | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | |
| | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | |

King County
Department of Natural Resources and Parks
Water and Land Resources Division
**River and Floodplain Management Section**
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00–6.33
LEVEE MODIFICATION

PLANTING PLAN

SHEET 66 OF 69 SHEETS

LS5

WETLAND BOUNDARY

NORTH PERMANENT ACCESS ROAD, SEE DWG TC2

20+00

25+00

MATCHLINE SEE SHEET LS5

WETLAND BOUNDARY

40 0 40 80 120
SCALE IN FEET

**NOTES:**

1. SEE DWG LS7 FOR LEGEND OF PLANT TYPES.

**LEGEND:**

EX. TREE TO BE PROTECTED

EX. TREE TO BE REMOVED

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FIELD BOOK: | | NUM. | REVISION | BY | DATE | APPROVED: JEANNE STYPULA, PE | 4-2013 | SRFB # RCO 087-1910C | | King County Department of Natural Resources and Parks Water and Land Resources Division River and Floodplain Management Section Christie True, Director | COUNTYLINE LEVEE SETBACK WHITE RIVER, RIVER MILE 5.00-6.33 LEVEE MODIFICATION | SHEET 67 OF 69 SHEETS |
| SURVEYED: | | | | | | PROJECT MANAGER: CHRIS BRUMMER, PE | 4-2013 | PROJECT No. 1112049 (FL9001) | | | PLANTING PLAN | LS6 |
| SURVEY BASE MAP: | | | | | | DESIGNED: KATE AKYUZ | 4-2013 | | | | | |
| CHECKED: | | | | | | ECOLOGIST: SARAH McCARTHY | 4-2013 | | | | | |
| | | | | | | DESIGN ENTERED: LICA DULAN | 4-2013 | | | | | |

CADD / 60% 5-2013

| Symbol | Scientific Name | Common Name | Wetland Indicator Status | Area (ft2) | % Cover Goal1 | Spacing1 (ft o.c.) | Stock Type2 | Quantity |
|---|---|---|---|---|---|---|---|---|
| | **WETLAND BUFFER DRY** | | | | | | | |
| | *Acer Macrophyllum* | Big-leaf maple | FACU | 247,563 | 10.000000 | 10.000000 | SD, GAL | 248 |
| | *Populus trichocarpa* | Black cottonwood | FAC | 247,563 | 50.000000 | 10.000000 | LS3 | 1,238 |
| | *Psuedotsuga menziesii* | Douglas fir | FACU | 247,563 | 20.000000 | 10 000000 | PL, GAL | 495 |
| | *Alnus rubra* | Red alder | FAC | 247,563 | 20.000000 | 10 000000 | SD, GAL | 495 |
| | *Rhamnus purshiana* | Cascara | FAC | 247,563 | 10.000000 | 6.000000 | SD, GAL | 688 |
| | *Salix scouleriana* | Scouler's willow | FAC | 247,563 | 10.000000 | 6.000000 | SD, LS3 | 688 |
| | *Acer circinatum* | Vine maple | FAC | 247,563 | 10.000000 | 6.000000 | TR, GAL | 688 |
| | *Rosa gymnocarpa* | Bald-hip rose | FACU | 247,563 | 10.000000 | 4.000000 | SD, GAL | 1,547 |
| | *Corylus cornuta* | Hazelnut | FACU | 247,563 | 10.000000 | 6.000000 | TR, GAL | 688 |
| | *Oemleria cerasiformis* | Indian plum | FACU | 247,563 | 10.000000 | 6.000000 | TR, GAL | 688 |
| | *Vaccinium parvifolium* | Red huckleberry | FACU | 247,563 | 10.000000 | 6.000000 | GAL | 688 |
| | *Amelanchier alnifolia* | Saskatoon | FACU | 247,563 | 10.000000 | 6.000000 | TR, GAL | 688 |
| | *Symphoricarpos albus* | Snowberry | FACU | 247,563 | 20.000000 | 6.000000 | TR, GAL | 1,375 |
| | *Rubus parviflorus* | Thimbleberry | FACU | 247,563 | 10.000000 | 4.000000 | SD, GAL | 1,547 |
| | *Polystichum munitum* | Sword fern | FACU | 247,563 | 10.000000 | 4.000000 | GAL | 1,547 |
| | **WETLAND BUFFER WET** | | | | | | | |
| | *Populus trichocarpa* | Black cottonwood | FAC | 230,480 | 70.000000 | 10.000000 | LS3 | 1,613 |
| | *Alnus rubra* | Red alder | FAC | 230,480 | 20.000000 | 10.000000 | SD, GAL | 461 |
| | *Thuja plicata* | Western redcedar | FAC | 230,480 | 10.000000 | 10.000000 | PL, GAL | 230 |
| | *Rhamnus purshiana* | Cascara | FAC | 230,480 | 10.000000 | 6.000000 | SD, GAL | 640 |
| | *Salix hookeriana* | Hooker's willow | FACW | 230,480 | 10.000000 | 6.000000 | SD, LS3 | 640 |
| | *Salix sitchensis* | Sitka willow | FACW | 230,480 | 10.000000 | 6.000000 | SD, LS3 | 640 |
| | *Acer circinatum* | Vine maple | FAC | 230,480 | 10.000000 | 6.000000 | TR, GAL | 640 |
| | *Rosa nootkana* | Nootka rose | FAC | 230,480 | 10.000000 | 4.000000 | SD, GAL | 1,441 |
| | *Cornus sericea* | Red twig dogwood | FACW | 230,480 | 20.000000 | 6.000000 | TR, GAL | 1,280 |
| | *Rubus spectabilis* | Salmonberry | FAC | 230,480 | 10.000000 | 4.000000 | TR, GAL | 1,441 |
| | *Athyrium felix-femina* | Lady fern | FAC | 230,480 | 10.000000 | 4.000000 | 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 3' of slope adjacent to road seed with red fescue. Next 3' to be planted to sword fern and fringe cup. | | | | | | | |
| | *Acer circinatum* | Vine maple | FAC | 30,304 | 10.000000 | 6.000000 | GAL | 84 |
| | *Acer Macrophyllum* | Big-leaf maple | FACU | 2,252 LF | 10.000000 | 25' L | GAL | 45 |
| | *Cornus sericea* | Red twig dogwood | FACW | 30,304 | 20.000000 | 6.000000 | GAL | 168 |
| | *Corylus cornuta* | Hazelnut | FACU | 30,304 | 10.000000 | 6.000000 | GAL | 84 |
| | *Festuca rubra* | Red fescue | FAC | 30,304 | 5.000000 | 14 lbs/ac | SEED | 10 |
| | *Holodiscus discolor* | Oceanspray | FACU | 30,304 | 10 000000 | 6.000000 | GAL | 84 |
| | *Oemleria cerasiformis* | Indian plum | FACU | 30,304 | 10.000000 | 6.000000 | GAL | 84 |
| | *Polystichum munitum* | Sword fern | FACU | 30,304 | 10.000000 | 4.000000 | GAL | 189 |
| | *Psuedotsuga menziesii* | Douglas fir | FACU | 2,252 LF | 10.000000 | 25' L | GAL | 45 |
| | *Rhamnus purshiana* | Cascara | FAC | 30,304 | 10.000000 | 6.000000 | GAL | 84 |
| | *Rosa gymnocarpa* | Bald-hip rose | FACU | 30,304 | 10.000000 | 4.000000 | GAL | 189 |
| | *Rubus parviflorus* | Thimbleberry | FACU | 30,304 | 15.000000 | 4.000000 | GAL | 284 |
| | *Symphoricarpos albus* | Snowberry | FACU | 30,304 | 25.000000 | 6.000000 | GAL | 210 |
| | *Tellima grandiflora* | Fringe cup | FACU | 30,304 | 5.000000 | 4.000000 | POT | 95 |
| | WATERWARD LEVEE SLOPE WET - Plant Western redcedar 25' o.c. in undulating line on mid-lower slope position. First 3' of slope adjacent to road seed with red fescue. Next 3' to be planted to lady fern and piggy-back plant. | | | | | | | |
| | *Acer circinatum* | Vine maple | FAC | 67,881 | 10.000000 | 6.000000 | GAL | 189 |
| | *Alnus rubra* | Red alder | FAC | 67,881 | 20.000000 | 12.000000 | GAL | 94 |
| | *Athyrium felix-femina* | Lady fern | FAC | 67,881 | 10.000000 | 4.000000 | GAL | 424 |
| | *Cornus sericea* | Red twig dogwood | FACW | 67,881 | 25.000000 | 6.000000 | GAL | 471 |
| | *Corylus cornuta* | Hazelnut | FACU | 67,881 | 10.000000 | 6.000000 | GAL | 189 |
| | *Festuca rubra* | Red fescue | FAC | 67,881 | 5.000000 | 14 lbs/ac | SEED | 22 |
| | *Oemleria cerasiformis* | Indian plum | FACU | 67,881 | 10.000000 | 6.000000 | GAL | 189 |
| | *Rosa nootkana* | Nootka rose | FAC | 67,881 | 10.000000 | 4.000000 | GAL | 424 |
| | *Rubus spectabilis* | Salmonberry | FAC | 67,881 | 10.000000 | 4.000000 | GAL | 424 |
| | *Salix hookeriana* | Hooker's willow | FACW | 67,881 | 10.000000 | 6.000000 | LS3 | 189 |
| | *Salix sitchensis* | Sitka willow | FACW | 67,881 | 10.000000 | 6.000000 | LS3 | 189 |
| | *Sambucus racemosa* | Red elderberry | FACU | 67,881 | 10.000000 | 6.000000 | GAL | 189 |
| | *Symphoricarpos albus* | Snowberry | FACU | 67,881 | 25 000000 | 6 000000 | GAL | 471 |
| | *Thuja plicata* | Western redcedar | FAC | 3,856 | 10.000000 | 25' L | GAL | 154 |
| | *Tolmeia menziesii* | Piggy-back plant | FAC | 67,881 | 5.000000 | 4 000000 | POT | 212 |
| | LANDWARD LEVEE SLOPE - Plant shore pine in straight line 25' o.c. in mid-slope position only. First 3' of slope adjacent to road seed with red fescue. Next 3' to be planted to sword fern and fringe cup only. | | | | | | | |
| | *Amelanchier alnifolia* | Saskatoon | FACU | 152,170 | 10.000000 | 6.000000 | GAL | 423 |
| | *Corylus cornuta* | Hazelnut | FACU | 152,170 | 25.000000 | 6.000000 | GAL | 1,057 |
| | *Festuca rubra* | Red fescue | FAC | 152,170 | 5.000000 | 14 lbs/ac | SEED | 49 |
| | *Holodiscus discolor* | Oceanspray | FACU | 152,170 | 40.000000 | 6.000000 | GAL | 1,691 |
| | *Pinus contorta v. con.* | Shore pine | FAC | 6,000 LF | 25.000000 | 25' L | GAL | 240 |
| | *Polystichum munitum* | Sword fern | FACU | 152,170 | 10.000000 | 4.000000 | GAL | 951 |
| | *Symphoricarpos albus* | Snowberry | FACU | 152,170 | 25.000000 | 6.000000 | GAL | 1,057 |
| | *Tellima grandiflora* | Fringe cup | FACU | 152,170 | 5.000000 | 4.000000 | POT | 476 |
| | **BANK DEFLECTOR ELIS** | | | | | | | |
| | *Acer circinatum* | Vine maple | FAC | 15,497 | 10.000000 | 6.000000 | GAL | 43 |
| | *Acer Macrophyllum* | Big-leaf maple | FACU | 15,497 | 30.000000 | 12.000000 | GAL | 32 |
| | *Alnus rubra* | Red alder | FAC | 15,497 | 30.000000 | 12.000000 | GAL | 32 |
| | *Corylus cornuta* | Hazelnut | FACU | 15,497 | 20.000000 | 6.000000 | GAL | 86 |
| | *Oemleria cerasiformis* | Indian plum | FACU | 15,497 | 15.000000 | 6.000000 | GAL | 65 |
| | *Polystichum munitum* | Sword fern | FACU | 15,497 | 10.000000 | 4.000000 | GAL | 106 |
| | *Psuedotsuga menziesii* | Douglas fir | FACU | 15,497 | 25.000000 | 12.000000 | GAL | 27 |
| | *Rhamnus purshiana* | Cascara | FAC | 15,497 | 20.000000 | 6.000000 | GAL | 86 |
| | *Rosa gymnocarpa* | Bald-hip rose | FACU | 15,497 | 20.000000 | 4.000000 | GAL | 194 |
| | *Symphoricarpos albus* | Snowberry | FACU | 15,497 | 20.000000 | 6.000000 | GAL | 86 |
| | *Thuja plicata* | Western redcedar | FAC | 15,497 | 15.000000 | 12.000000 | GAL | 16 |

| Symbol | Scientific Name | Common Name | Wetland Indicator Status | Area (ft2) | % Cover Goal1 | Spacing1 (ft o.c.) | Stock Type2 | Quantity |
|---|---|---|---|---|---|---|---|---|
| | **APEX ELIs** | | | | | | | |
| | **Upper 1/2 of Apex ELIs** | | | | | | | |
| | *Acer circinatum* | Vine maple | FAC | 7,448 | 20.000000 | 6 000000 | GAL | 41 |
| | *Alnus rubra* | Red alder | FAC | 7,448 | 25.000000 | 12.000000 | GAL | 39 |
| | *Corylus cornuta* | Hazelnut | FACU | 7,448 | 10.000000 | 6.000000 | GAL | 21 |
| | *Oemleria cerasiformis* | Indian plum | FACU | 7,448 | 10 000000 | 6.000000 | GAL | 21 |
| | *Rosa gymnocarpa* | Bald-hip rose | FACU | 7,448 | 10 000000 | 4.000000 | GAL | 47 |
| | *Rubus parviflorus* | Thimbleberry | FACU | 7,448 | 20.000000 | 4.000000 | GAL | 93 |
| | *Sambucus racemosa* | Red elderberry | FACU | 7,448 | 10.000000 | 6.000000 | GAL | 21 |
| | *Symphoricarpos albus* | Snowberry | FACU | 7,448 | 20.000000 | 6.000000 | GAL | 41 |
| | *Thuja plicata* | Western redcedar | FAC | 7,448 | 25.000000 | 12.000000 | GAL | 13 |
| | *Vaccinium parvifolium* | Red huckleberry | FACU | 7,448 | 10.000000 | 6.000000 | GAL | 21 |
| | **Lower 1/2 of Apex ELIs** | | | | | | | |
| | *Cornus sericea* | Red twig dogwood | FACW | 7,448 | 10.000000 | 6.000000 | GAL | 21 |
| | *Populus trichocarpa* | Black cottonwood | FAC | 7,448 | 100.000000 | 12.000000 | LS3 | 52 |
| | *Rhamnus purshiana* | Cascara | FAC | 7,448 | 10.000000 | 6.000000 | GAL | 21 |
| | *Rosa nootkana* | Nootka rose | FAC | 7,448 | 10.000000 | 4.000000 | GAL | 47 |
| | *Rubus spectabilis* | Salmonberry | FAC | 7,448 | 20.000000 | 4.000000 | GAL | 93 |
| | *Salix hookeriana* | Hooker's willow | FACW | 7,448 | 20.000000 | 6.000000 | LS3 | 41 |
| | *Salix sitchensis* | Sitka willow | FACW | 7,448 | 20 000000 | 6.000000 | LS3 | 41 |
| | **ROUGHENING HUMMOCKS** | | | | | | | |
| | *Acer circinatum* | Vine maple | FAC | 18,794 | 10 000000 | 6.000000 | GAL | 52 |
| | *Athyrium felix-femina* | Lady fern | FAC | 18,794 | 10 000000 | 4.000000 | GAL | 117 |
| | *Cornus sericea* | Red twig dogwood | FACW | 18,794 | 20.000000 | 6.000000 | GAL | 104 |
| | *Polystichum munitum* | Sword fern | FACU | 18,794 | 10.000000 | 4.000000 | GAL | 117 |
| | *Populus trichocarpa* | Black cottonwood | FAC | 18,794 | 100.000000 | 12.000000 | LS3 | 131 |
| | *Rhamnus purshiana* | Cascara | FAC | 18,794 | 10.000000 | 6.000000 | GAL | 52 |
| | *Rosa nootkana* | Nootka rose | FAC | 18,794 | 10.000000 | 4.000000 | GAL | 117 |
| | *Rubus spectabilis* | Salmonberry | FAC | 18,794 | 10.000000 | 4.000000 | GAL | 117 |
| | *Salix hookeriana* | Hooker's willow | FACW | 18,794 | 20.000000 | 6.000000 | LS3 | 104 |
| | *Salix sitchensis* | Sitka willow | FACW | 18,794 | 20.000000 | 6.000000 | LS3 | 104 |
| | **ROCK FACED LEVEE** | | | | | | | |
| | Lower 1/2 of Rock Faced Levee - Install 6-8' 1-2" willow livestakes 2' o.c. in single layer in 2" topsoil immediately above rock layer of levee per design drawings. | | | | | | | |
| | *Salix scouleriana* | Scouler's willow | FAC | 1,731 | 100.000000 | 2 L | LS6 | 866 |

NOTES:

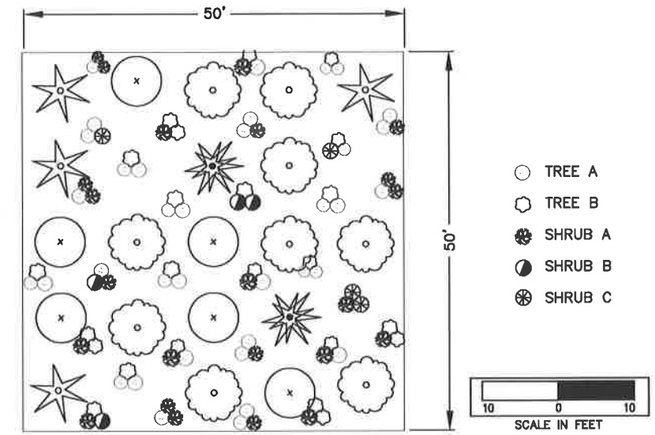
1. SPACING IN FT O.C. UNLESS LINEAR FT AS INDICATED BY "L". TREES TO BE PLANTED 10 OR 12 FEET O.C. FROM OTHER TREES IN PLANTING UNIT AS INDICATED. SHRUBS TO BE PLANTED 4 OR 6 FEET FROM OTHER SHRUBS AS INDICATED. QUANTITIES ARE BASED ON PERCENT COVER GOALS FOR EACH SPECIES AS OPPOSED TO SPACING.
2. ALTERNATIVE 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 QUANTIIES HALF AND HALF FOR EACH TYPE.

## GENERAL PLANTING NOTES:

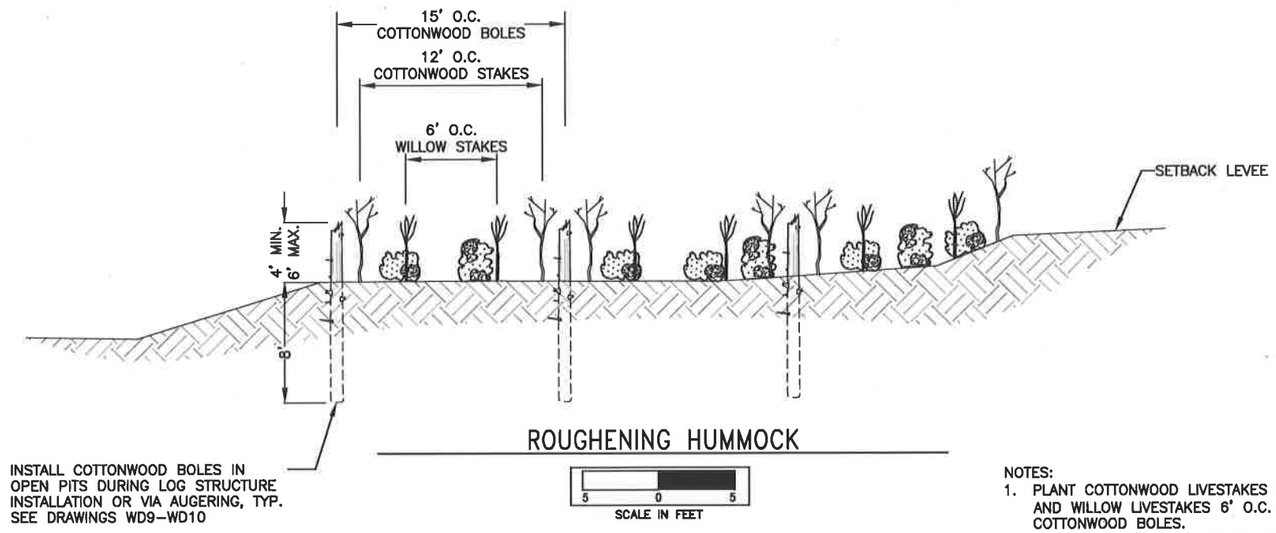
1. BIOREVETMENT WILL BE PLANTED WITH TALL SHRUBS (WILLOWS & DOGWOOD) ALONG THE EDGE OF THE STRUCTURE IN GAPS BETWEEN LOGS.
2. THE WETLAND BUFFER WET/DRY WILL BE PLANTED WITH A MIX OF TREES AND SHRUBS. SEE WETLAND BUFFER WET/DRY TYP. DETAIL, THIS SHEET.
3. THE LEVEE TOP/ACCESS ROAD WILL BE COVERED WITH 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.




WETLAND BUFFER WET/DRY
TYPICAL PLAN DETAIL




INSTALL COTTONWOOD BOLES IN OPEN PITS DURING LOG STRUCTURE INSTALLATION OR VIA AUGERING, TYP. SEE DRAWINGS WD9-WD10

ROUGHENING HUMMOCK

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.

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

CADD / 60%
5-2013

| NUM. | REVISION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | KATE AKYUZ | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

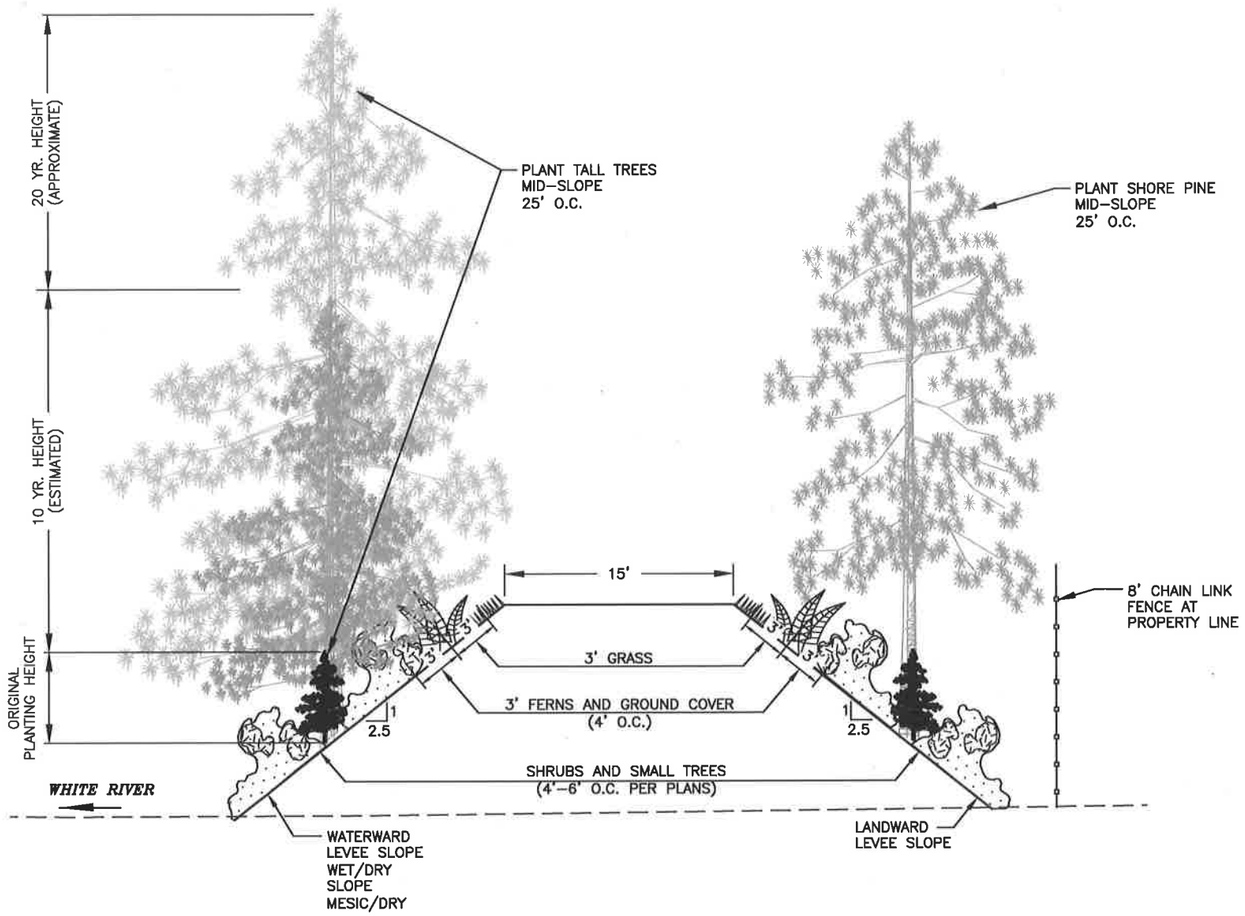
King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

PLANTING DETAILS

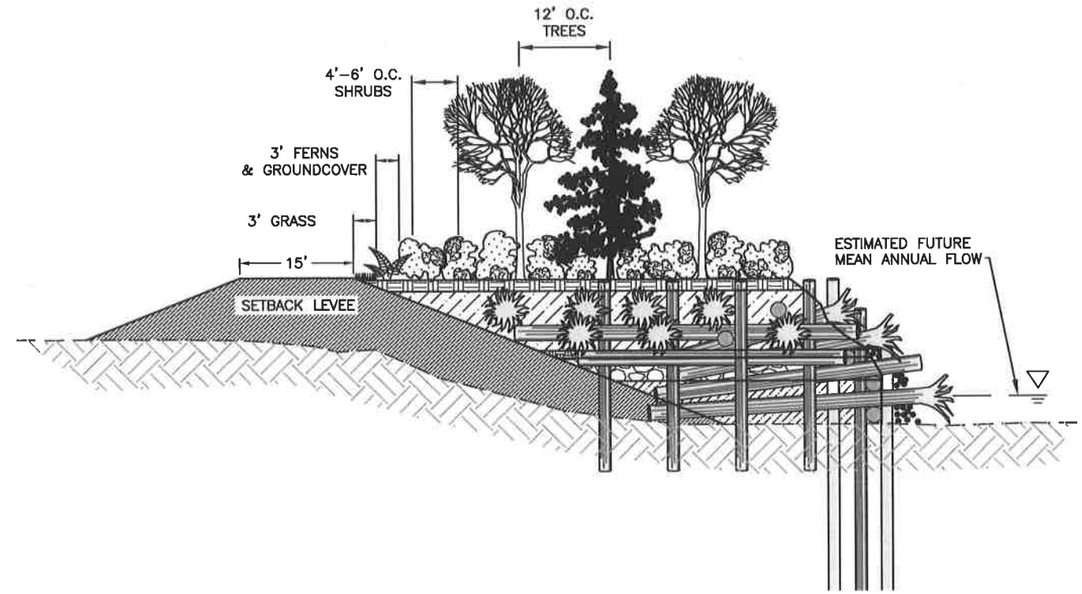
SHEET 68 OF 69 SHEETS

LS7



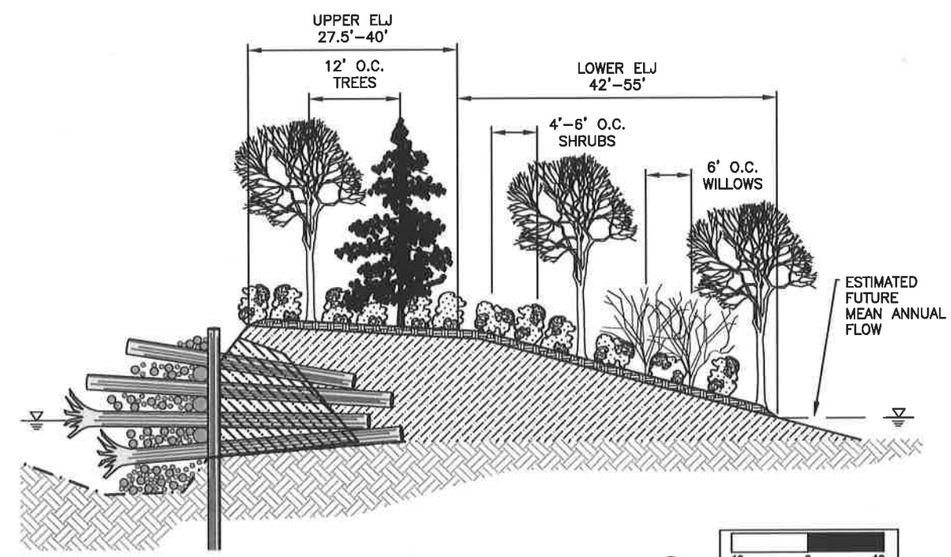

LEVEE PLANTINGS – TYPICAL SECTION (E / X-X)

NOT TO SCALE




BANK DEFLECTOR ELJ PLANTING-SECTION (X / X-X)

10 0 10 SCALE IN FEET




APEX ELJ PLANTING – SECTION (A / WD3)

10 0 10 SCALE IN FEET

NOTES:
1. SEE TABLE, DWG LS7 FOR PLANT SPACING.
2. PLANT "UPPER HALF ELJ" SPECIES AND "LOWER HALF ELJ" SPECIES ABOVE AND BELOW SLOPE BREAK, RESPECTIVELY.

FIELD BOOK:
SURVEYED:
SURVEY BASE MAP:
CHECKED:

| NUM. | REVISION | BY | DATE |
|---|---|---|---|
| | CADD / 60% 5-2013 | | |

| | | |
|---|---|---|
| APPROVED: | JEANNE STYPULA, PE | 4-2013 |
| PROJECT MANAGER: | CHRIS BRUMMER, PE | 4-2013 |
| DESIGNED: | KATE AKYUZ | 4-2013 |
| ECOLOGIST: | SARAH McCARTHY | 4-2013 |
| DESIGN ENTERED: | LICA DULAN | 4-2013 |

SRFB # RCO 087-1910C

PROJECT No. 1112049 (FL9001)

King County
Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section
*Christie True, Director*

COUNTYLINE LEVEE SETBACK
WHITE RIVER, RIVER MILE 5.00-6.33
LEVEE MODIFICATION

PLANTING DETAILS

SHEET 69 OF 69 SHEETS

LS8