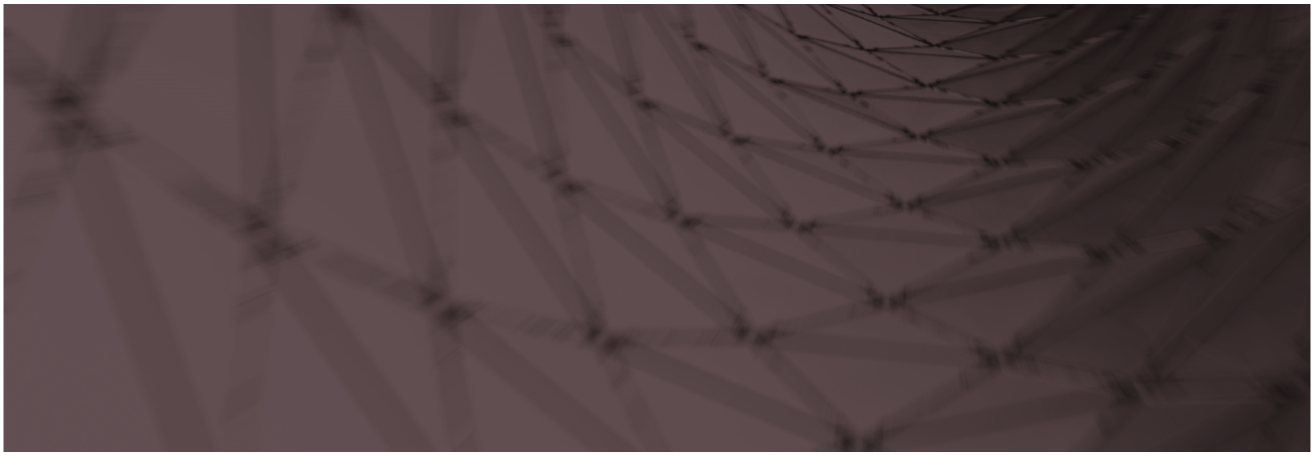

Coal Creek Bridge No. 3035A Replacement Project

Type, Size, and Location Report

June 2019 | Final Report

King County

kpff Consulting Engineers

Bridge No. 3035A

Type, Size, and Location Report

June 2019 | Final Report

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11/13/19

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1. Executive Summary

The objective of this study is to evaluate alternatives for the replacement of the Coal Creek Bridge No. 3035A and recommend a preferred bridge type, size and location. The next phase of the project includes design development of construction plans, specifications, estimate, acquiring necessary right-of-way, comprehensive environmental studies and acquiring construction permits and approvals for the preferred alternative.

Coal Creek Bridge No. 3035A is a structurally deficient bridge that carries SE Lake Walker Road across Coal Creek. The timber substructure was built in 1958 and the steel girder superstructure was repurposed from another bridge built by King County in 1912. The creosote timber piles, lagging and crossbeams and the steel superstructure are experiencing significant levels of deterioration. The bridge is approximately 41-feet long and 18-feet wide measured from curb-to-curb. There are two travel lanes with no shoulders and sub-standard timber guardrails with steel posts.

Per King County Road Design and Construction Standard 2016, SE Lake Walker Road is classified as a rural local access subcollector roadway with an average daily traffic (ADT) of 343 vehicles per day in a 2018 traffic count with approximately 2% truck traffic. Predicted increases in future traffic volumes are minimal as very few lots beyond the bridge have zoning that would allow additional subdividing. Any future subdivision would result in approximately 8 to 10 additional lots. The bridge provides sole access across Coal Creek for the community surrounding Walker Lake and a Department of Fish and Wildlife public boat launch at the lake. Principle users of the bridge are the local area residents and recreational users of Walker Lake.

The proposed typical roadway and bridge cross section is 30 feet measured from the edge of the roadway paved surface/shoulder (bridge curb/rail) and will transition with appropriate tapers into the existing roadway at each project limit. The roadway width was determined based on recommendations from the WSDOT Design Manual and AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400). The proposed length of the bridge is approximately 59.5 feet.

This Bridge Type Size and Location (TS&L) report evaluates three bridge substructure types, two superstructure types and three roadway alignments. The analysis considered costs, environmental impacts, construction staging/phasing, ROW needs and project schedule.

Based on the results of this report, the recommended preferred alternative for the Coal Creek Bridge No. 3035A Bridge Replacement Project is as follows:

- Roadway Alignment Alternative 2: This alignment alternative best satisfied all of the project evaluation criteria including the least ROW needs and long term maintenance.
- Voided Slab Girder Superstructure: This superstructure type allows for the shallowest possible girder for the anticipated span length thereby keeping increases in roadway profile to a minimum.
- Cast-in-place (CIP) Concrete Spread Footing Substructure: This substructure type is a proven, durable foundation system which is commonplace in bridge construction.

2. Introduction

On behalf of King County Department of Local Services (KCDLS) Road Services Division (RSD), KPFF has prepared this Bridge Type, Size, and Location (TS&L) Report that studies several replacement alternatives for the existing Coal Creek Bridge No. 3035A. This report was prepared for submittal to the Washington State Department of Transportation (WSDOT) and Federal Highway Administration (FHWA) for review and approval. FHWA is partially funding the project.

The Preliminary Design Phase of this project is estimated to be completed in June 2019. Full contract documents (plans, specifications, cost estimates, and permits) will be ready for advertisement in late 2020/early 2021. Construction is planned for the summer of 2021.

The following documents provide the basis for this TS&L Report:

- Draft Geotechnical Report, February 2019 – *King County DLS*
- Preliminary Critical Areas Memorandum, February 2019 – *King County DLS*
- Pre-Final Hydraulic Design Memorandum, May 2019 – *Indicator Engineering*
- Culture Resource Site Screening, February 2017 – *King County DLS*

The goal of this report is to select a preferred design type, size, and location/alignment for a new bridge to replace the existing, structurally deficient Coal Creek Bridge. The selected bridge type, size and location/alignment alternative will have the most favorable combination of the following criteria:

- Most cost-effective
- Least disruptions to traffic
- Least environmental impacts, most long term environmental benefits
- Least long-term maintenance
- Most easily constructible
- Least impact to private property
- Least construction duration

3. Existing Bridge & Site Conditions

VICINITY

The bridge site is located in unincorporated King County near the City of Black Diamond along SE Lake Walker Road at its intersection with Coal Creek. It is approximately 1.5 miles southeast of Veazie-Cumberland Road SE. The bridge provides sole access across Coal Creek to the community surrounding Walker Lake and a Department of Fish and Wildlife public boat launch at the lake. SE Lake Walker Road is a County-designated snow/ice route, school bus route, and lifeline route. Average daily traffic (ADT) crossing the bridge is approximately 343 vehicles with less than two percent truck traffic. Because the bridge provides sole access, replacing it is vital for the safety and function of the community. Project location and vicinity maps are provided in Figure 3-1.

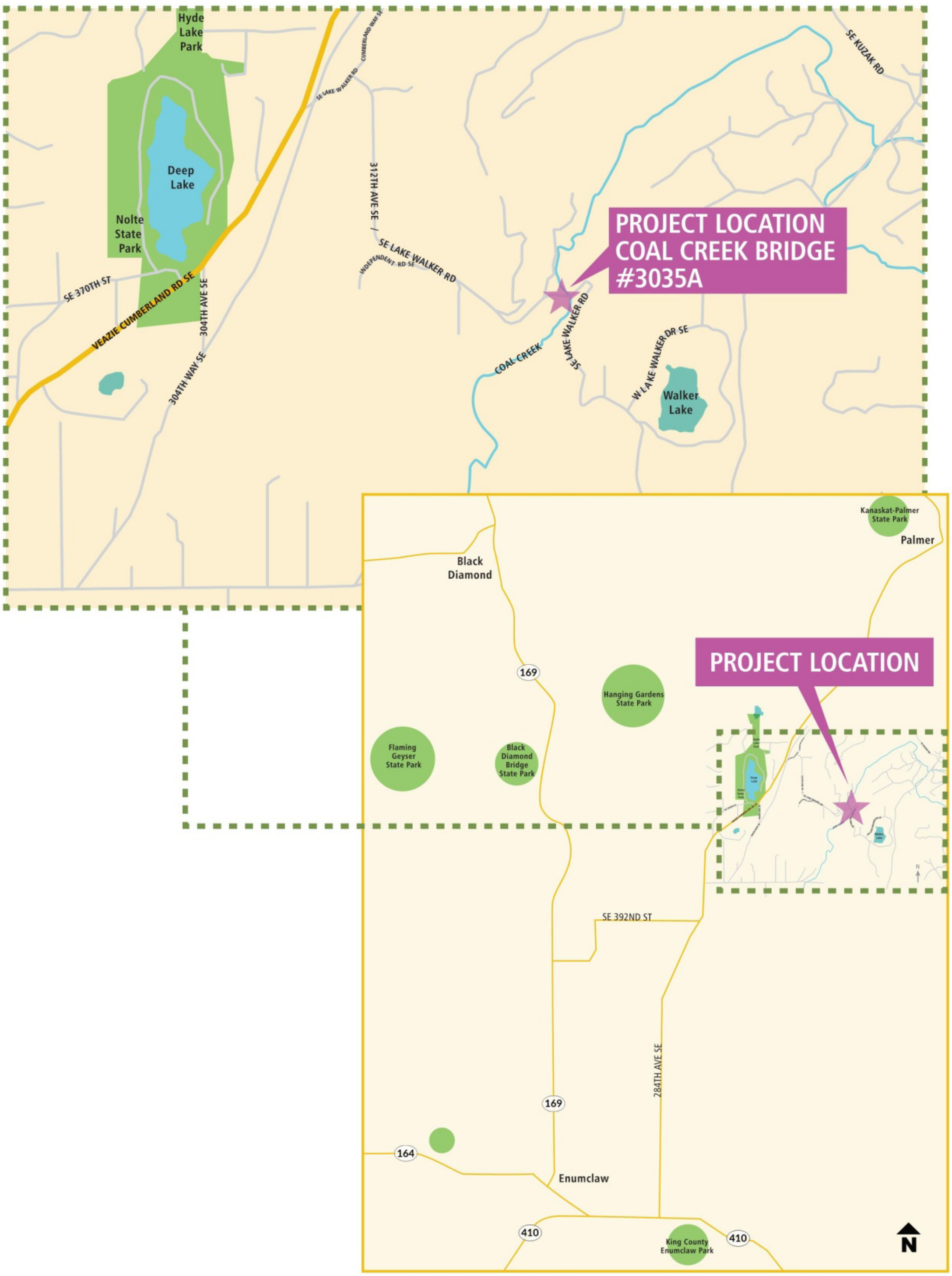

Figure 3-1: Project Vicinity and Location Map

EXISTING BRIDGE DESCRIPTION

The existing steel girder bridge is a single-span structure that is 41 feet long and 18 feet wide curb to curb. It is founded on creosote timber pile bents with timber bulkheads within the waterway. The substructure is believed to have been built in 1958. The plate girder superstructure originally came from Bridge 164E which was constructed by the County in 1912 on NE Union Hill Road over Bear Creek near Redmond. The structure was given to the City of Redmond in the mid 1920’s and then returned to the county in 1934. When Bridge 164E was widened in 1955, the plate girder superstructure was moved to SE Walker Lake Road to span Coal Creek. The existing bridge is shown in Figure 3-6.

The existing steel girder bridge is classified as structurally deficient with a sufficiency rating of 9.68 out of 100. The steel floorbeams are severly corroded with laminar rust and section loss. The substructure has rotten timber bulkhead planks and deteriorating timber piles. In 2012, due to the deteriorated condition, the bridge was temporarily posted for a 10 ton load limit. Shortly thereafter, temporary bracing repairs were installed and the load posting was removed. The bridge is currently posted for Specialized Hauling Vehicles (SHVs): SU 4 Axles = 26 Ton, SU 5 Axles = 30 Ton, SU 6 Axles = 32Ton, SU 7 Axles = 35 Ton. With the current condition, it is no longer feasible to repair or rehabilitate the bridge to meet current standards for structural, geotechnical, hydraulic, road design and environmental requirements. King County identifed the bridge as a priority for replacement in its 2017 Annual Bridge Report. Examples of this deterioration are shown in Figure 3-8 and Figure 3-9.

There are four private, residential properties immediately adjacent to the bridge. As shown in Figure 3-7, an existing home is located on the parcel at the NE corner of the bridge within 20 feet of the structure. The other parcels have homes located further away that are not expected to be impacted by this project. Figure 3-2 through Figure 3-9 show photos of the project site and existing bridge.

Figure 3-2: Existing Coal Creek Bridge No. 3035A Looking West

Figure 3-3: Existing Coal Creek Bridge No. 3035A Looking East

Figure 3-4: Looking Downstream (South) from Existing Coal Creek Bridge No. 3035A

Figure 3-5: Looking Upstream (North) from Existing Coal Creek Bridge No. 3035A

Figure 3-6: Existing Coal Creek Bridge No. 3035A Looking North

Figure 3-7: Private Residence near Roadway and NE Corner of Existing Coal Creek Bridge No. 3035A

Figure 3-8: Deterioration of Steel Floor Beams

Figure 3-9: Timber Piling & Bulkheads with Repairs

EXISTING SITE CONDITIONS & CONSTRAINTS

As shown in Figure 3-10, the publically-owned area surrounding the bridge is highly constrained. The existing right-of-way (ROW) along SE Lake Walker Road and at the bridge is 60 feet wide, is defined by meets and bounds without curves, and does not share a centerline with the existing roadway. Two residences to the north, Parcels #332107-9022 and #332107-9025, have houses immediately adjacent to the ROW. The parcel to the northwest, Parcel #332107-9022, has a home approximately one foot from the ROW and 21 feet from the road. The structure on Parcel #332107-9025 is approximately nine feet from the ROW and 19 feet from the road. At the bridge, the roadway alignment is off center in the ROW. It hugs the north edge of the ROW where the road, just to the east of Coal Creek, begins to curve to the north.

The existing two-lane roadway is approximately 20 feet wide and provides access to Walker Lake located one-half mile to the southeast. This roadway provides sole access to residences east of Coal Creek with no available detour. The roadway width, horizontal curves, and stopping sight-distances at the existing bridge location do not meet current King County standards per the 2016 Road Design and Construction Standards manual.

There are 15-mile-per-hour (mph) warning signs in both directions approaching the hairpin turn to the northeast of the bridge. Vehicles approaching/exiting the hairpin turn are assumed to be going 15 mph in either direction. Due to the low volume of traffic on the roadway, it is not expected that two vehicles will be within the hairpin turn at the same time.

Utilities present include the following:

- Overhead power: Owned by Puget Sound Energy. There are three utility poles in the immediate vicinity of the bridge
- CenturyLink telecom cables attached to the utility poles
- CenturyLink telecom cables attached to north side of the bridge with a pedestal near the NE corner of the existing structure

Regardless of the selected alternative, construction is likely to impact these facilities due to their close proximity to the existing bridge, which will be removed.

Homes in the area are on well and septic systems. There is no water distribution main or sanitary sewer in the County ROW. Additionally, there is no natural gas service in the area.

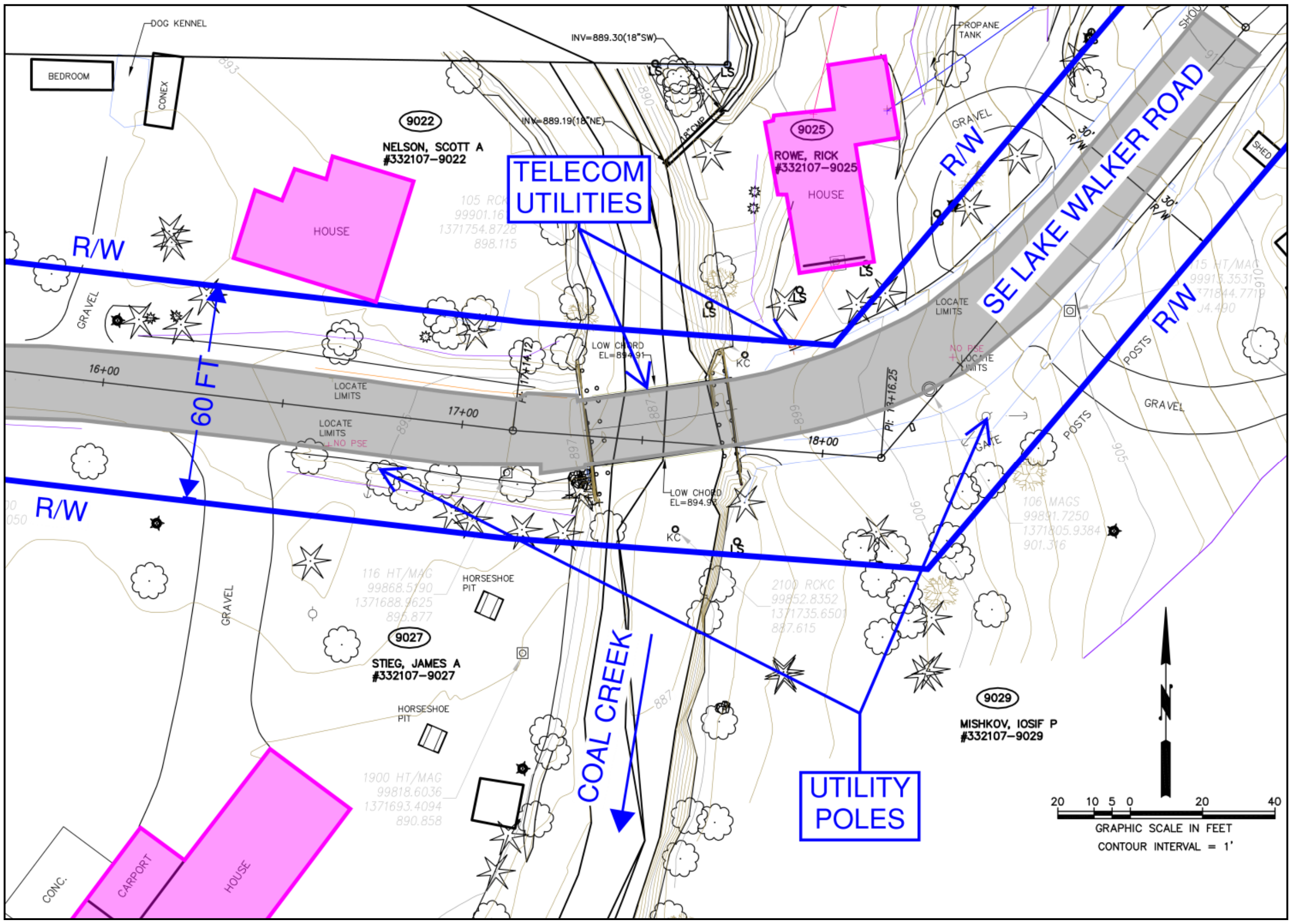

Figure 3-10: Existing Site Layout

EXISTING HYDRAULIC CONDITIONS

The existing hydraulic conditions are reported in *Coal Creek Bridge #3035A Replacement – Hydraulic Design Memo (Pre-Final),* dated May 2019 and included in Appendix E. Coal Creek is characterized as a somewhat incised channel with an unmapped, floodplain that is generally 2.5 to 5 feet above the thalweg and about 500 to 650 feet wide. The bridge crosses to the far east of the floodplain.

The inspection history indicates that the bridge abutment bulkheads have previously been undermined by as much as 1 foot, while the stream bed has aggraded by 1 to 1.5 feet between 1997 and 2018. Several locations in the reach have riprap to protect the banks from lateral migration, and at the bridge, are aligning the channel through the bridge. The report indicates isolated areas of undermining and bank erosion. Trees and vegetation along the bank are providing temporary resistance to migration and erosion. Woody debris and local scour were also present in the creek.

The hydraulic report provides design recommendations and guidance, such as 100-year flood elevations, design scour depths, and channel section properties, which are presented in Section 5 of this report.

EXISTING GEOTECHNICAL CONDITIONS

Geotechnical conditions are reported in *Geotechnical Report Coal Creek Bridge #3035A Replacement* dated February 2019, prepared by King County, and included in Appendix D. Soils generally consist of medium dense to dense cohesionless soils that range in depth from 38 to 47 feet, underlain by bedrock. Groundwater was found about 10 to 13 feet below ground surface. The seismic site conditions are characterized most closely with Site Class D. Lateral spreading due to liquefiable soils is likely not an issue. However, differential liquefaction settlement of 0.5 to 1.1 inches is likely. The report also indicates that this material can potentially scour.

The geotechnical report provides design recommendations and design parameters for the bridge structure, which are summarized in Section 7. It identifies geosynthetic reinforced soil (GRS) foundations, spread footings, and pile supported bridge abutments as feasible for this site.

4. Environmental Setting

The following section is an excerpt from the Preliminary Critical Areas Memo, which is included as Appendix F to this report. It establishes the environmental baseline of the project area and a synopsis of applicable regulations.

ENVIRONMENTAL BASELINE AND REGULATIONS

Desktop Resources

The environmental baseline for the project site was analyzed using existing literature and resources. The following desktop resources were reviewed:

- Washington Department of Fish and Wildlife (WDFW)
  - Priority Habitat and Species (PHS) on the Web – Interactive Mapping Tool
  - Salmonscape – Interactive Mapping Tool
- United States Fish and Wildlife Service (USFWS) information for Planning and Consultation – Interactive Mapping Tool
- National Marine Fisheries Service species list for Puget Sound
- King County iMap
  - Environmentally Critical Areas (Critical Areas Layer 2018)
  - Flooding Information
  - Hydrography and Hydrology
  - Groundwater
  - Planning/Miscellaneous Designations/Shoreline Management Designations

King County Critical Areas

King County defines critical areas under King County Code (KCC) 21A.24 and KCC 21A.06 as land with natural hazards or land that supports certain unique, fragile, or valuable resource areas. Critical areas and their buffers designated by King County include areas at high risk of erosion, landslides, earthquakes or flooding; coal mines; fish and wildlife habitat conservation areas, streams, lakes, wetlands or lands adjoining streams, rivers, and other water bodies. The following subsections describe critical areas present at the project site and a summary of applicable federal, state and local regulations.

Aquatic Areas/Streams

Aquatic Areas are streams regulated under KCC 21A.24.355, Chapter 75.20 of the Revised Code of Washington (RCW), Chapter 173-225 Washington Administrative Code (WAC), Chapter 220-110 WAC, Section 401 and 404 of the Clean Water Act (CWA). Coal Creek is a fish-bearing Type S (Shoreline of the State) perennial water body that has a minimum of a 165-foot-wide critical area buffer under KCC 21A.24. Shoreline jurisdiction extends 200 feet landward of the ordinary high water mark (OHWM).

Coal Creek is approximately 9.2 miles long and is within the upper sub-basin of Water Resource Inventory Area 08 (Duwamish/Green River Watershed), which outfalls eventually to Puget Sound. The main stem of Coal Creek empties into Fish Lake. This lake has no surface outflow and so is not directly linked by surface connection to the main stem of the Green River; however, it is likely that water from Fish Lake flows underground and surfaces as perched springs and/or riverbed springs in the Green River streambed in the vicinity of River Miles 48 – 50.

The channel width is approximately 40.5 feet wide at the bridge crossing. The OHWM and bankfull channel indicators will be identified in the field as the project design is developed. The 100-year flood elevation is given in Section 5 of this report. After the preferred alternative is selected, additional stream investigations will likely occur in support of federal regulatory compliance under the CWA, and local, state and federal permits. See the enclosed permit matrix for additional regulatory triggers.

Wetlands

Wetlands are regulated under KCC 21A.24.318 - 21A.24.345 and Section 404 of the Clean Water Act. According to the King County iMap, WDFW PHS data, and the USFWS National Wetland Inventory, there are no mapped wetlands within the anticipated project limits. However, smaller wetlands are not well represented in these inventories. County environmental staff observations during a limited preliminary site visit in January 2019 did not identify any suspected wetlands. Once the project footprint is known, additional site visits by county environmental staff will confirm if wetlands are indeed absent.

Groundwater

The project is within a Critical Aquifer Recharge Area that is highly susceptible to groundwater contamination. Groundwater was encountered at a depth of approximately 13 feet below road grade during geotechnical boring, which is about the same level as the approximate stream elevation.

Geological Critical Areas

The project's *Geotechnical Report* (September 2018), prepared by King County, characterizes the soil and groundwater conditions for the project. The project is in a mapped Seismic Hazard area, which is an area that is at risk for severe earthquake damage due to seismically induced settlement, soil liquefaction, or lateral spread.

Flood Hazard Areas – FEMA Floodplain/Floodway

Floodplains and floodways are regulated under KCC 21A.24.230 - 21A.24.271. The FEMA floodway and 100-year floodplain are not mapped within the project area. However, streams typically have unmapped floodplains the extent of which will be modeled according to methods prescribed by the latest version of the King County Surface Water Design Manual.

Wildlife Habitat

Wildlife habitat conservation areas and wildlife habitat networks are regulated under KCC 21A.24.382 - 21A.24.386. According to King County iMap, there are no fish and wildlife habitat conservation areas mapped within the project area. Presence of cutthroat trout in Coal Creek has been documented by several sources. Wildlife habitat within the project area has been impacted by anthropogenic influences.

Additional Regulations

National Environmental Policy Act

The lead federal agency for the project is the FHWA. The project will require a Documented Categorical Exclusion.

Endangered Species Act and Magnuson-Stevens Act

Federal ESA-listed threatened or endangered species are listed as potentially occurring within the project limits. The project area will be further analyzed in this respect as the design develops. The entire Coal Creek watershed is inaccessible to salmon and so the project will not result in adverse modification of Essential Fish Habitat under the Magnuson-Stevens Act (MSA).

Section 106 of the National Historic Preservation Act (Cultural Resources)

The King County Road Services Division (RSD) Archaeologist screened the project on February 14, 2017. The general setting of the project on a freshwater stream in the vicinity of a historically mapped trail suggests a high likelihood for unknown buried intact prehistoric archaeological deposits. In addition, the project area was historically mined for coal, as the name of the creek suggests. Unrecorded historic mining features and artifacts may be present in the project area. The project location includes a previously installed bridge and existing road prism. These factors reduce the likelihood of intact prehistoric archaeological deposits somewhat. Section 106 procedures, beginning with the formal definition of an Area of Potential Effects (APE) and consultation with the state and Tribes will be required. The APE will include the footprint of the new bridge, footprint of the existing bridge, any temporary by pass roads, staging areas, and mitigation areas. The existing bridge will be evaluated for historical significance.

Preliminary soil investigations received a Section 106 exemption from Washington Department of Transportation on June 13, 2018. An archaeological survey will be completed for the project with screened shovel probes as soon as the APE and corresponding private property Rights-of-Entry are available. As for all RSD projects, if cultural resources or human remains are encountered during construction all work will cease and RSD policies will be followed.

Shoreline Management Act

Shoreline Management Areas are regulated under KCC 20.20.100, KCC Title 25, RCW 90.58; WAC 173-27-050; WAC 173-14, 16, 17, 18.210, 19, & 22. According to iMap, the project is within both Aquatic and Conservancy shoreline designations.

Green Building Ordinance #17709 (2005)

The preferred alternative will be reviewed in accordance with the King County Green Building Ordinance upon development of 30-percent plans. This review will identify opportunities for design and construction measures to support sustainability goals in King County, including a project-level goal of reaching platinum-level performance to reduce greenhouse gas emissions. Measures will also focus on sustainable materials, construction demolition and diversion, preservation of natural site amenities, stormwater management, and social and equity issues.

Anticipated Permits, Approvals, and Coordination

The anticipated environmental permits, approvals, and coordination for the project are the same for the alternatives presented in this report.

5. Design Considerations

PROPOSED BRIDGE AND ROADWAY CROSS SECTIONS

The proposed bridge and roadway cross section will consist of two (2) eleven-foot travel lanes, one (1) two-foot shoulder to the north, and one (1) 6-foot shoulder to the south for a total width of 30 feet. Because this is a rural area with no existing or planned sidewalks or separate pathways in the area, a rural roadway section with shoulders is appropriate.

ROADWAY AND SITE DESIGN CRITERIA

The roadway and site layout design criteria for this project are based upon the following design standards:

- King County Road Design and Construction Standards (KC RDCS), 2016
- King County Computer-Aided Design and Drafting (CADD) Standards, 2016
- King County Surface Water Design Manual (SWDM), 2016
- AASHTO - A Policy on Geometric Design of Highways and Streets, 7th Edition, 2018
- AASHTO Guidelines for Geometric Design of Very Low-Volume Roads (ADT<= 400)
- AASHTO - Roadside Design Guide, 4th Edition, 2011
- FHWA MUTCD, 2009
- WSDOT - Local Agency Guidelines (LAG) Manual, June 2018
- WSDOT - Design Manual, July 2018
- WSDOT - Construction Manual, November 2018
- WSDOT - Standard Plans, August 2018
- WSDOT - Work Zone Traffic Control, June 2018
- WSDOT - Right of Way Manual, December 2018
- WSDOT - Highway Runoff Manual, 2019

The WSDOT Local Agency Guidelines (LAG) chapter 42.4.42 defines a 3R project as “3R projects focus primarily on the preservation and extending of the service life of existing facilities and on safety enhancements. Work may include: resurfacing, pavement structural and joint repair, lane and shoulder widening, alterations to vertical grades and horizontal curves, bridge repair, removal or protection of roadside obstacles, and improving bridges to meet current standards for structural loading and to accommodate the approach roadway width.”

Chapter 42.7 of the LAG Manual further states:

> “As a minimum, normally include the following for a 3R project:
>
> - Guardrail end treatments upgraded to current standards.
> - Appropriate transition and connection of approach rail to bridge rail.
> - Beveled end sections for both parallel and cross-drain structures located in the clear zone.
> - Relocating, protecting, or providing breakaway features for sign supports and luminaires.
> - Protection for exposed bridge piers and all abutments.
> - Modification of raised drop inlets that present a hazard in the clear zone.

It is desirable to provide a roadside clear of fixed objects and non-traversable obstacles. The priority for action relative to roadside obstacles is: (1) remove, (2) redesign, (3) relocate, (4) reduce severity by crashworthy features, (5) protect, or (6) delineate. On all projects, which include structures with deficient safety features, consideration must be given to correcting the deficient features. When complete upgrading is not practical, a partial or selective upgrading and/or other improvements should be considered to mitigate the effects of the substandard elements.

King County Road Design and Construction Standards define a 3R project as "Resurfacing, restoration, and rehabilitation of existing roadways with minimal changes to alignment or grade."

Based on the definitions listed above, this is a 3R Project meaning that the project involves improvements to an existing roadway to extend the service life and improve safety. However, the scope of work should be considered within the site context. The finished roadway and bridge will attempt to adhere to the design standards listed in this Section and, more specifically, the standards listed in the "Roadway Design Criteria" sheet shown in Table 5-1. Given the roadway's existing deficiencies (geometrics and width), existing homes in close proximity to the ROW, and that this is a low-volume roadway, design criteria was evaluated in the context of the site for meeting the funding agency's and King County's design standards. Refer to Table 5-1 for a summary of the applied design criteria.

AASHTO Guidelines for Geometric Design of Very Low-Volume Roads (ADT<= 400) Exhibit 1 allows for new construction on a low-volume recreational and scenic road to have an 18-foot-wide roadway. The existing roadway width is 20 feet, and the AASHTO low-volume manual allows more design flexibility for an existing roadway project in regards to maintaining existing roadway geometry. King County standards for a Rural Local Access Roadway Subcollector classification are lanes 11 feet wide and shoulders 6 feet wide. Although the proposed roadway could be designed to be only 20 feet wide, the proposed roadway is 30 feet wide to allow for an increased lane width of 11 feet and additional 2 feet of shoulder room north and 6 feet of shoulder room south for improved safety approaching the bridge from either direction.

Traffic during construction will be accommodated with single-lane access that is 13 feet wide on either the existing roadway/bridge or on a temporary detour roadway/bridge to be constructed, depending on the selected alternative. Alternating traffic will be controlled by a temporary portable signal, with a posted speed limit of 15 mph, and with concrete barriers placed along the access to protect the work zone as appropriate.

SE Lake Walker Road is a long dead end road that serves greater than 100 lots. The bridge is approximately 6000 feet from the intersection with Cumberland Way SE. Beyond the bridge the road serves 76 addressed lots and approximately 106 total lots. There are very few that have zoning that would allow additional subdividing (approximately 8 –10 total additional lots). All of this points to classifying the road as a rural subcollector road. A rural subcollector requires a minimum traveled way of 34 feet and design speed of 30 mph. A 30 mph design speed would also require a curve radius at the bridge of 210 feet (current radius 120-feet).

The road is posted at 35 mph with speed advisory warning of 20 mph at the curve west of the bridge and 15 mph at the bridge (for the curve to the east). ADT counts were taken in 2018 approximately 400 feet west of the bridge and the results were 343 daily trips with a 50 percentile speed of 23.4 mph and 85 percentile speed of 28 mph. An ADT was taken in 2003 and the results were 310 daily trips.

A variance from the Road Standards is recommended for the following reasons:

1. The ADT of 343 cars per day over the bridge equates to approximately 35 homes. A subaccess street can serve up to 50 homes (500 daily trips).

2. SE Lake Walker Road currently serves over 100 lots for the length from where it tees into Cumberland Way SE to its terminus. Any subdivision potential would require a variance from the KCRDCS for the 100 lot rule or a second access be created.
3. AASHTO allows for a 30 mph design speed in rolling terrain and 20 mph design speed in mountainous terrain for traffic volumes of 250 to 400 ADT.
4. The bridge is currently posted with a warning speed of 15 mph due to the very sharp curve to the east.
5. The horizontal curve to the east will never be improved as it traverses steep terrain.
6. Improving the horizontal radius at the bridge will allow for increased vehicle speeds for approximately 300-feet, then they will either be exiting or entering the 15 mph curve.
7. The cost of increasing the radius from 145-feet to 210-feet adds little if no benefit to the traveling public.
8. The cross section of the bridge would increase from approximately 20-feet to 30-feet with the proposed subaccess standard (two, 11-foot lanes and two, 2-foot shoulders). The road section on either side of the bridge ranges between 18-feet and 20-feet total with no shoulders.

The following variances to KC RDCS will be prepared for this project:

1. Design Speed/Horizontal and Vertical Curvature – 25 MPH proposed; 30 MPH per KCRDCS

2. Roadway Width – 30 feet proposed; 34 feet per KCRDCS

Design Element	Coal Creek Bridge 3035A Proposed Design*	Existing Condition	Standards: WSDOT	Standards: AASHTO	Standards: King County	Design Criteria Reference/Comment
General						
Roadway Classification		Rural Local Roadway Subcollector	Rural Local	Rural Recreational and Scenic Roads	Rural Local Roadway Subcollector	WSDOT DM - Exhibit 1103-4 / AASHTO LV - Page 7 / KC RDCS - 2.02
Design Level		-	R3-AE	-	-	
Design Vehicle		-	-	Recreational Vehicle	-	AASHTO 2018 - 2.8.1
Posted Speed Limit (MPH)	25	25	-	-	-	
Design Speed (MPH)	25	15-25	25	25	30	KC RDCS 2-0(B) Subcollector Classification
Object Height	2 ft	2 ft	2 ft	2 ft	2 ft	WSDOT DM - 1260.03 / AASHTO LV - Page 31 / KC RDCS - 2.02(B)
Eye height	3.5 ft	3.5 ft	3.5 ft	3.5 ft	3.5 ft	WSDOT DM - 1260.03 / AASHTO LV - Page 31 / KC RDCS - 2.02(B)
Right-of-Way Width (Feet)	60'	60'	-	-	60' Minimum	KC RDCS - 2.02(B)
Horizontal Alignment Criteria						
Curve Radius (Feet) Min	145 ft (e=6%)	120 ft	145 ft (e=6%)	115 ft (e=6%)	231 ft (e=6%)	WSDOT DM - Exhibit 1250-4c / AASHTO LV - Exhibit 6 / KC RDCS - Table 2.1
Stopping Sight Distance <3% (Feet)	158 ft	-	158 ft	115 ft	205 ft	WSDOT DM - Exhibit 1260-2 / AASHTO LV - Exhibit 14 / KC RDCS Exhibit 2-1
Stopping Sight Distance 6% (Feet)	165 ft	-	165 ft	127 ft	215 ft	WSDOT DM - Exhibit 1260-2 / AASHTO LV - Exhibit 15 / KC RDCS Exhibit 2-1
Stopping Sight Distance 9% (Feet)	173 ft	-	173 ft	-	227 ft	WSDOT DM - Exhibit 1260-2 / KC RDCS Exhibit 2-1
Clear Zone (Feet)	10 ft	2.5 ft	-	6 ft	10 ft	WSDOT LAG - 42.5 / AASHTO LV - Page 49 / KC RDCS - 5.10
Lateral Clearance (ie utilities, lights, etc) (Feet)			-	4 ft	-	AASHTO 7th ed 6.2.4.2
Superelevation (e max)	6%	5%	10%	12%	6%	WSDOT DM - Exhibit 1250-4a / AASHTO LV / KC RDCS - 2.02(B)
Number of Lanes	2	2	-	-	2	KC RDCS - 2.02(B)
Lane Widths (Feet)	11 ft	10 ft	9 ft	9 ft	11 ft	WSDOT LAG - 42.5 / AASHTO LV - Exhibit 1 / KC RDCS - 2.02(B)
Shoulder Widths						
Left Inside (Feet)	2 ft	-	2 ft	2 ft	6 ft	WSDOT LAG - 42.5 / AASHTO Table 5-5/ KC RDCS - 2.02(B)
Right Outside (Feet)	6 ft	-	2 ft	2 ft	6 ft	WSDOT LAG - 42.5 / AASHTO Table 5-5 / KC RDCS - 2.02(B)
Side Slopes						
Cut Slope Max	2:1	2:1	4:1	4:1	2:1	WSDOT LAG - 42.5 / AASHTO2018 - 5.4.4.2 / KC RDCS - 5.02
Fill Slope Max	2:1	2:1	4:1	4:1	2:1	WSDOT LAG - 42.5 / AASHTO2018 - 5.4.4.2 / KC RDCS - 5.02
Rounding (Feet)		-	-	-	-	
Taper Length - Merge		-	25:1	11:1	-	WSDOT DM -1210.05(1)(a) / AASHTO 2018 - Equation 3-38
Redirect Taper		-	25:1	11:1	-	WSDOT DM -1210.05(1)(a) / AASHTO 2018 - Equation 3-38
Vertical Alignment Criteria						
Minimum Length of Vertical Curves						
For Crest and Sag (Feet)	Calculation based	-	-	125	-	AASHTO LV - Exhibit 12
K-Value Minimums						
Crest Vertical Curve	-		12	8	-	WSDOT DM - Exhibit 1260-1 / AASHTO LV - Exhibit 12
Sag Vertical Curve			26	26	-	WSDOT DM - Exhibit 1260-1 / AASHTO Table 5-3
Grade						
Maximum	14.5%	14.5%	11%	14%	12%	WSDOT DM - 1220.02(6) Table 1 / AASHTO 2018 - 3.4.2.2.1 / KC RDCS - 2.02(B)
Minimum		-	0.3%-0.5%	0.3%-0.5%	-	WSDOT DM - 1220.02(4) / AASHTO 2018 - 3.4.2.2.2
Minimum Vertical Clearance at Structures						
Highways/Streets (Feet)		-	16.5 ft	14 ft	16.5 ft	WSDOT LAG 42.6 / AASHTO 2018 - 6.3.3.2 / KC RDCS - 6.02

Notes:

WSDOT -
LAG Manual Chapter 42, June 2018
Design Manual, July 2018

AASHTO -
A Policy on Geometric Design of Highways and Streets, 7th edition, 2018
This code references Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<=400), 2001, "AASHTO LV" in the table.

King County -
RDCS, 2016

Table 5-1: Roadway Design Criteria

STORMWATER DESIGN CRITERIA

The stormwater drainage design criteria for this project will be based upon the following design standards:

- King County Surface Water Design Manual, 2016
- King County Code, Ordinances, and Executive Orders
- WSDOT – Highway Runoff Manual
- WSDOT – Hydraulics Manual

Proposed collection, conveyance, flow control, and treatment will be evaluated during final design.

STRUCTURAL DESIGN CRITERIA

The structural design criteria for this project will be based on the following design standards:

- WSDOT Bridge Design Manual M 23-50.18 (June 2018).
- AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 8th Ed. (2017).
- AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd Ed. (2011 – with 2012, 2014, and 2015 Interim Revisions).
- WSDOT Geotechnical Design Manual M 46-03.11 (May 2015).
- WSDOT Standard Specifications for Road, Bridge, and Municipal Construction (2019)

Loading for structures is based on the following criteria:

Dead Loads

- Reinforced Concrete: 155 pounds-per-cubic-foot (pcf)
- Prestressed Concrete: 165 pcf
- Steel: 490 pcf
- Wearing Surface: 140 pcf
- Soil: 125 pcf

Live Loads

- Vehicular: HL-93 plus Dynamic Loading (IM) for proposed and detour bridges
- Pedestrian: No pedestrian facilities will be provided.
- Crash Rails: AASHTO Crash Tested Rail, TL-4. Type to be determined

Wind Loads

- Basic Wind Speed: 110 mph
- Wind Exposure Category: Wind Exposure Category B
- Wind on Vehicles: 0.10 kips per lineal foot (klf) transverse and 0.04 klf (longitudinal) at 6 feet above the roadway
- Vertical Upward Wind Load: 0.020 ksf at the windward quarter point of the bridge deck width

Thermal Loads

- Temperature Range: 0˚F to 100˚F for concrete bridges and 0˚F to 120˚F for steel bridges (Western Washington)

Seismic Design Criteria

Seismic design will be in accordance with AASHTO LRFD Bridge Design Specifications, AASHTO Guide Specifications for LRFD Seismic Bridge Design, and the WSDOT BDM. The spectral response parameters are provided below. Additional recommendations for site specific seismic hazards are provided in *Geotechnical Report Coal Creek Bridge #3035A Replacement (*February 2019) found in Appendix D.

- Site Class, SC: D
- Peak Ground Acceleration,PGA: 0.340g (Site Class B)
- Spectral Acceleration, S_s: 0.769g (Site Class B)
- Spectral Acceleration, S_1: 0.223g (Site Class B)
- Zero Period Site Factor, F_{pga}: 1.260g (Site Class D)
- Short Period Site Factor, F_a: 1.192g (Site Class D)
- Zero Period Spectral Response, A_s: 0.428g (Site Class D)
- Short Period Spectral Response, S_{DS}: 0.917g (Site Class D)
- Long Period Spectral Reponse, S_{D1}: 0.480g (Site Class D)
- Seismic Design Category, SDC: C

HYDRAULIC DESIGN CRITERIA

Hydraulic design will be in accordance with *Coal Creek Bridge #3035A Replacement – Hydraulic Design Memo – Pre-Final* (May 2019), prepared by Indicator Engineering and provided in Appendix E. The hydraulic design criteria are summarized below.

- 100-yr Water Elevation: 893.3 feet (NAVD 88)
- Freeboard: 3 feet
- Low Chord Elevation: 896.3 feet (NAVD 88)
- 200-yr Scour Elevation: 882.5 feet (NAVD 88)
- Minimum Hydraulic Opening (Vertical Walls): 41 feet
- Minimum Hydraulic Opening (Sloped): 32 feet bottom width; 2:1 slopes

The recommended design would result in a replacement bridge with an initial scour code of 8, due to the bridge foundations determined to be stable for calculated scour conditions as scour is above top of footing or by installation of properly designed countermeasures.

The existing upstream revetment should be maintained to prevent lateral channel migration upstream of the proposed crossing. It should be tied smoothly into the surrounding upstream and downstream banks, and surface protection of the road fill should be installed at the bridge. Depending on the specific bridge design, bank protection should be placed in areas that may experience increased erosion.

GEOTECHNICAL DESIGN CRITERIA

Geotechnical design will be in accordance with *Geotechnical Report Coal Creek Bridge #3035A Replacement (*February 2019). The geotechnical report is provided in Appendix D. Based on subsurface investigation, the geotechnical report recommends a shallow foundation system using spread footings or a geosynthetic reinforced soil integrated bridge system (GRS-IBS) bridge abutments. If design cannot accommodate liquefaction-induced differential settlement, low displacement H-pile foundations are recommended.

Shallow foundations should bear in at least medium dense native sand and gravel or on structural fill bearing on the medium dense to dense native sands and gravels. This soil layer is estimated to be approximately 10 feet below the road surface.

Scour counter measures, such as bank rip-rap, sheet piling, or alternative armoring, are recommended to prevent undermining of the bridge abutment. The County's stated preference is to found shallow foundations below the scour elevation and to minimize the need for scour counter measures placed in the channel.

The water table was measured at between 10 and 13 feet below ground surface, which is approximately at the bottom of channel. The hydraulic analysis indicates that the design scour depth is approximately 4 feet below the water table. Cofferdams and dewatering will likely be required where foundations are located below the water table.

Deep foundation H-piles should be driven to bedrock, which is estimated to be 24 to 30 feet below ground surface. Encountering obstructions during pile installations is a significant concern. Large boulders, several feet in diameter, were encountered during the geotechnical explorations. In addition, the limited depth to bedrock must be considered in evaluating the lateral stability of the foundation. If pile foundations are selected, preconstruction surveys should be conducted to document the existing condition and signs of distress of nearby structures, including underground facilities such as wells and septic tanks.

ROW CONSIDERATIONS

A preliminary evaluation of the adjacent properties and estimated comparable land values in the vicinity was performed and the following ROW costs are assumed for the project:

- Fee Take: $2.30/SF
- Temporary Construction Easement (12 months): $0.23/SF
- Administrative, condemnation, statutory and miscellaneous costs: $15,750

If full parcel takes are required, then full property values and relocation costs are available and will be included. ROW costs are included for each alternative considered and can be found in Appendix C.

6. Roadway and Site Layout Alternatives Analysis

Three roadway alignment alternatives were studied and are summarized below. Each of these alternatives will be evaluated using an Evaluation Criteria Matrix described later in this section. Preliminary Plans showing the three alignments studied are included in Appendix A of this report.

ROADWAY ALTERNATIVE 1

Alternative 1 provides for a 30-foot roadway to the south of the existing roadway alignment as one approaches the creek from the west. A temporary detour road and bridge will be constructed to the north of the work zone and maintain a single lane of traffic during construction so the new bridge can be completed in a single phase. The horizontal and vertical geometry meets AASHTO requirements for stopping sight distance for a 25 mph road. The roadway connects midway into the hairpin turn to allow for a 25 mph vertical curve stopping sight distance. The horizontal geometry of the hairpin turn will match the existing roadway curvature.

The proposed roadway from west to east includes a tangent section leading to a 300-foot radius followed by an approximately 175-foot tangent connecting to a 145-foot radius connecting into the existing hairpin turn. The 300-foot radius is a best-fit curve to match into existing following the existing right-of-way and roadway, and the 145-foot curve is designed to the minimum radius allowed for a 6% superelevation according to both King County and WSDOT for a 25 mph roadway. *AASHTO Guidelines for Geometric Design of Very Low-Volume Roads (ADT<= 400)* Exhibit 6 allows for a horizontal radius of 115 feet with a 6% superelevation, but based on the existing horizontal geometry and engineering judgement a 145 foot radius was chosen for the curve leading to the hairpin turn. The temporary roadway contains 100-foot radius curves.

The vertical geometry from west to east includes a -3.0% grade leading to a 400-foot sag curve to a 3.91% tangent section followed by a 375-foot vertical sag curve leading to a 14.3% existing tangent in the middle of the hairpin turn. The two sag curves were chosen as best fit based on the existing roadway conditions that allow the bridge to be above the elevation required based on the hydraulic report. The temporary roadway will match the existing topography as closely as possible.

ROADWAY ALTERNATIVE 2

Alternative 2 will provide a 30-foot roadway constructed essentially on the existing alignment with the temporary detour roadway and bridge to the south. The limits of work are shorter in length because it aligns with the existing roadway alignment and the proposed alignment can match existing sooner. The horizontal and vertical geometry meets AASHTO requirements for stopping sight distance for a 25 mph road. The roadway connects midway into the hairpin turn to allow for a 25 mph vertical curve stopping sight distance. The horizontal geometry of the hairpin turn will remain unchanged. Construction of the bridge can be completed in a single phase.

The proposed roadway from west to east includes a short tangent section leading to a 375-foot radius followed by an approximately 140-foot tangent connecting to a 145-foot radius followed by a tangent leading into the existing hairpin turn where the proposed roadway will match the existing curvature as closely as possible before the roadway ties into the middle of the hairpin turn. The 375-foot radius is a best fit curve to match into existing following the existing right-of-way and roadway, and the 145-foot curve is designed to the minimum radius allowed for a 6% superelevation according to both King County and WSDOT for a 25 mph roadway. *AASHTO Guidelines for Geometric Design of Very Low-Volume Roads (ADT<= 400)* Exhibit 6 allows for a horizontal radius of 115 feet with a 6% superelevation, but based on the existing horizontal geometry and engineering judgement a 145-foot radius was chosen for the curve leading to the hairpin turn. The temporary roadway contains 100-foot radius curves.

The vertical geometry from west to east includes a 0.1% grade leading to a 200-foot sag curve to a 4.18% tangent section followed by a 360-foot vertical sag curve leading to a 14.3% existing tangent in the middle of the hairpin turn. The two sag curves were chosen as a best fit based on the existing roadway conditions that allow the bridge to be above the elevation required based on the hydraulic report. The temporary roadway will match the existing topography as closely as possible.

ROADWAY ALTERNATIVE 3

Alternative 3 would construct the proposed bridge in two phases. The goal is to minimize property impacts and save construction costs by using the existing roadway and bridge for vehicular access during construction. The southern portion of the bridge would be constructed to the extent feasible while maintaining approximately five feet of clearance from the existing bridge to allow for equipment and construction activities. Traffic would then be shifted to the finished portion of the roadway, the existing bridge demolished, and the remainder of the bridge constructed.

The horizontal and vertical geometry meets AASHTO requirements for stopping sight distance for a 25 mph road. The roadway connects midway into the hairpin turn to allow for a 25 mph vertical curve stopping sight distance. The horizontal geometry of the hairpin turn will match the existing roadway curvature.

The proposed roadway from west to east includes a tangent section leading to a 300-foot radius followed by an approximately 175-foot tangent connecting to a 145-foot radius connecting into the existing hairpin turn. The 300-foot radius is a best fit curve to match into existing following the existing right-of-way and roadway, and the 145-foot curve is designed to the minimum radius allowed for a 6% superelevation according to both King County and WSDOT for a 25 mph roadway. *AASHTO Guidelines for Geometric Design of Very Low-Volume Roads (ADT<= 400)* Exhibit 6 allows for a horizontal radius of 115-ft with a 6% superelevation, but based on the existing horizontal geometry and engineering judgment a 145-foot radius was chosen for the curve leading to the hairpin turn.

The vertical geometry from west to east includes a -3.0% grade leading to a 400-foot sag curve to a 3.9% tangent section followed by a 375-foot vertical sag curve leading to a 14.3% existing tangent in the middle of the hairpin turn. The two sag curves were chosen as a best fit based on the existing roadway conditions allowing for the bridge to be above the minimum elevation required based on the hydraulic report.

7. Bridge Alternatives Analysis

Three bridge substructure and two superstructure alternatives were evaluated. Conceptual drawings for these alternatives are provided in Appendix B. This section presents each alternative and discusses how they address key aspects of the project. The following are the key factors considered in evaluating the alternatives:

- Phased construction to maintain access
- Structural performance and maintenance
- Scour resistance
- Feasibility of construction
- Community impacts
- Environmental impacts
- Project cost

BRIDGE LAYOUT ASSUMPTIONS

To provide an accurate comparison between the bridge alternatives discussed below, the following baseline assumptions were used:

- **Permanent substructure elements are placed outside of the OHWM and bankfull width of the stream channel.** The maximum width is approximately 40 feet.

- **Foundation elements would be placed below the 200-year scour elevation.** At the time of this analysis, it was determined that extensive use of rip rap and other scour protection countermeasures would be difficult to permit even with the use of a layer of streambed materials as a covering layer. Therefore, it is assumed that bridge foundation elements would be placed below the scour elevation and that scour protection would be minimized

- **Minimum hydraulic opening of 41 feet.** The draft hydraulics analysis shows that a 41-foot-wide hydraulic opening results in a no-rise condition to the 100-year flood elevation. In all cases, placement of the foundations outside of the assumed bank full width resulted in a hydraulic opening width of greater than 41 feet.

Based on these assumptions, the minimum bridge is assumed to be 32 feet wide outside to outside and 51 feet long measured from face of support to face of support. Actual bridge lengths vary slightly based on superstructure type, which is discussed in the following sections.

SUPERSTRUCTURE ALTERNATIVES

Conventional bridge superstructures commonly use concrete (e.g., prestressed concrete girders, CIP box girders, etc.) or steel elements (e.g., plate girders, box girders, etc.). A precast, prestressed girder superstructure would be the most economical, straightforward to construct, and cost-effective to maintain. Deck bulb-tee girders and voided slab girders are strong candidates for this span length and application. A preliminary layout of the deck bulb-tee girder and voided slab superstructure alternatives are shown in Figure 7-1and Figure 7-2, respectively.

The roadway alignment is shown off center of the section due to the curved alignment of the roadway on the bridge. For this short span, constructing a straight bridge will be more cost-effective and straightforward than constructing a curved bridge. The additional bridge chorded surface could be taken up behind the barriers. Alternatively, the bridge can be built straight and the roadway can be striped to accommodate the curve. In either case, the bridge area is the same.

These girder types eliminate the need for constructing formwork and casting a concrete deck over the creek. They can be quickly erected and, once joined together, opened to traffic. For high volume roads or where long-term durability is a concern, it is recommended to apply a 5-inch cast-in-place topping. For lower volume roads, they can be left bare or receive an HMA overlay and waterproofing membrane as a cost- and time-savings option. For this analysis, a 5-inch CIP topping slab is assumed for both superstructure types.

Steel was not considered for this project due to concerns with the higher maintenance costs associated with the material. Steel structures typically need repainting on a 20-30-year cycle. These costs are amplified for structures that cross environmentally-sensitive areas due to containment systems required to prevent contamination from paint removal and re-application from impacting the creek below. Although weathering steel can be a lower-maintenance option, its performance in continuously wet environments can result in corrosion rates similar to conventional steel.

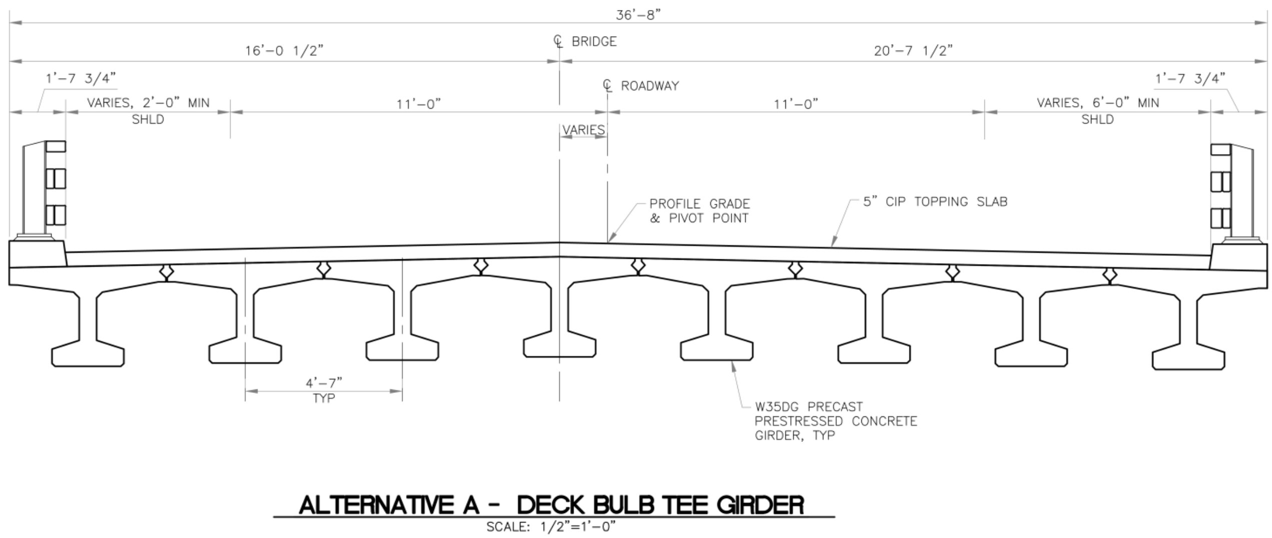

Figure 7-1: Deck Bulb-Tee Girder Superstructure

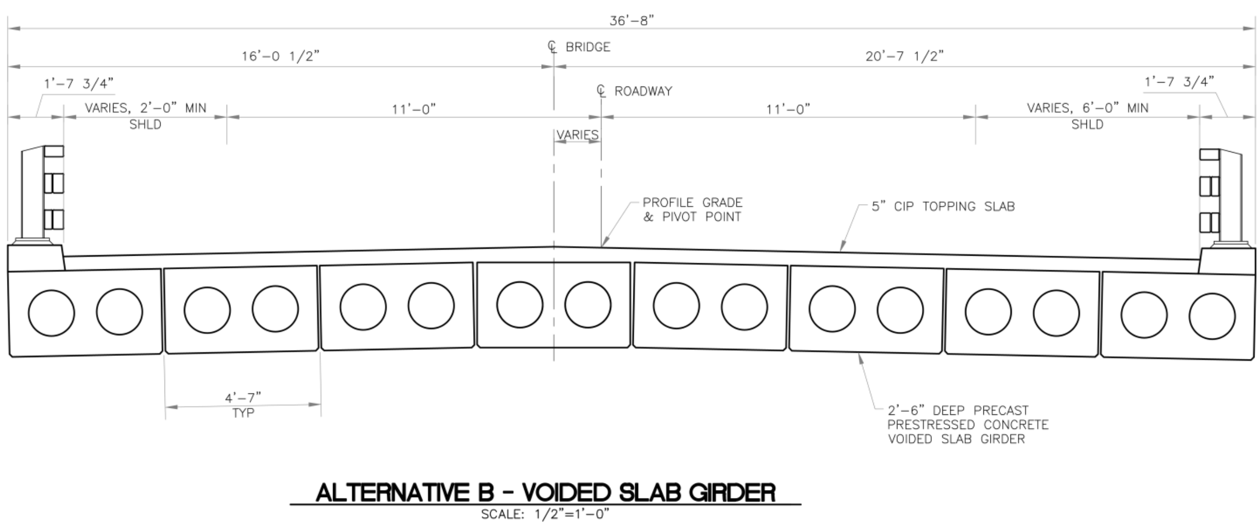

Figure 7-2: Voided Deck Slab Girder Superstructure

Table 7-1: Superstructure Alternatives Pros and Cons

	Pros	Cons
Deck Bulb-Tee Girder	• More efficient structural section • Lighter weight reduces foundation loads • Often times, slightly less costly • Interior space for utilities	• Taller structural section raises roadway profile and/or reduces freeboard • Requires end diaphragm to be constructed before opening to traffic • For the GRS-IBS abutment, additional spread footings will be required
Voided Slab Girder	• Shallow structural section reduces raising road profile and/or improves freeboard • Able to be opened to traffic immediately after girders are joined • Stability of the slab improves constructability by eliminating bracing • For a GRS-IBS abutment, slabs can be placed directly on the GRS	• Heavier weight increases foundation demands • Often times, is slightly more costly • Utilities must be outboard or special accommodations to place between

BRIDGE SUBSTRUCTURE ALTERNATIVE 1 – GOESYNTHETIC REINFORCED SOIL-INTEGRATED BRIDGE SYSTEM

This alternative would construct a Geosynthetic Reinforced Soil–Integrated Bridge System (GRS–IBS). GRS-IBS is a reinforced earth structural system that consists of closely-spaced alternating layers of geosynthetic reinforcement and compacted granular fill to form the bridge substructure. Concrete masonry units or other precast concrete block is commonly used as the facing units. The superstructure would be supported directly on the reinforced earth.

To provide bearing width and prevent scour, the GRS-IBS abutment would be founded on a reinforced soil foundation (RSF) at or below the design scour depth. RSF is composed of compacted granular fill material encapsulated within a geotextile fabric.

The GRS-IBS alternative is illustrated in Figure 7-3, with two variations to found the GRS-IBS and protect it from scour. Scour protection is commonly installed to protect the RSF and GRS facing from unraveling during a scour event. On the right side of the figure, localized rip-rap is used at the base of the substructure to prevent scour. On the left side, sheet piling is used as scour protection. The variations of this alternative are identified as Alternative 1A and 1B, respectively. Figure 7-5 and Figure 7-5 also show photo examples of rip-rap and sheet piling used for scour protection. Based on the geotechnical report, excavation of the footings will likely require a cofferdam and dewatering. Sheet piling can be used as both a temporary cofferdam and permanent scour protection. It also may allow for the GRS to be founded higher up, thus reducing excavation and dewatering.

This alternative would require a bridge superstructure that is approximately 60 feet long. Voided slabs would be best suited for this option, so it can be supported directly on the GRS-IBS substructure with the use of a small, precast concrete grade beam. This creates a transition between the bridge and approach roadway without joints, approach slabs, or cast-in-place concrete. This helps alleviate the “bump at the end of the bridge” problem typically caused by differential settlement between the bridge abutment and approaching roadway. Deck bulb tee girders can also be used with GRS-IBS. However, a CIP concrete spread footing would need to be provided. This would raise the roadway beyond what is required with a voided slab superstructure.

GRS-IBS construction involves basic earthwork methods and practice, without requiring highly skilled labor, and employs commonly available equipment and materials. According to the FHWA Every Day Counts initiative, projects using GRS-IBS can be completed faster and at a lower cost. Constructing a GRS-IBS bridge can cost 25 to 60 percent less than one built with conventional methods, depending on the construction standard and contracting method. Once built, GRS-IBS bridges are also durable and easy to maintain. This, combined with fewer components compared to traditional construction, also provides the potential for lower life-cycle costs.

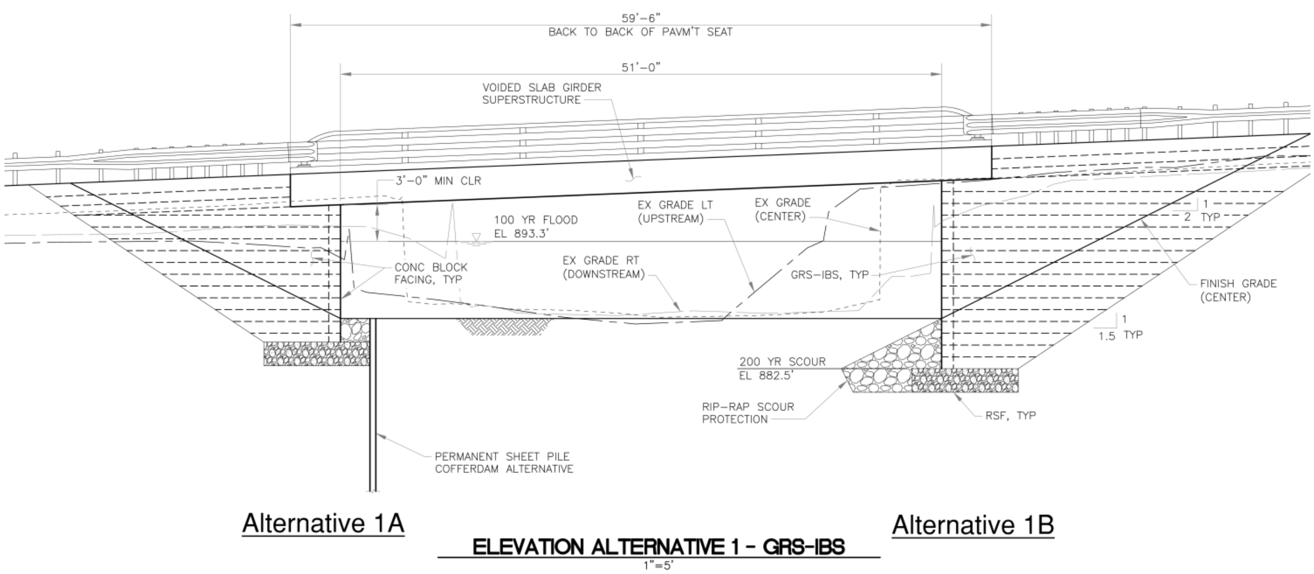

Figure 7-3: GRS-IBS Alternative

Figure 7-4: Example Photograph of GRS-IBS

Figure 7-5: Photograph of Sheet Piling Scour Protection

Supports Maintaining Community Access

- Construction of GRS-IBS requires smaller equipment to construct, requiring less staging and laydown area.
- GRS-IBS can be constructed in phases as necessary.

Structural Performance and Long-Term Maintenance

- GRS-IBS has fewer components than conventional bridges (no expansion joints, bridge bearings, and approach slabs) and is constructed with durable materials, leading to potentially lower life-cycle costs.
- The common "bump" at the end of the bridge is eliminated, which decreases the impact loads the bump normally causes, reducing structure and pavement maintenance.
- GRS-IBS is a flexible system that better accommodates liquefaction-induced differential settlement.

Scour Resistance

- This system is expected to be less robust than a cast-in-place spread footing or pile supported bridge abutment. Scour must be mitigated to prevent the structure from unraveling.
- Design must consider the fluctuating water levels within and behind the GRS-IBS system.
- Selection of the block facing must consider the potential for debris collision.

Feasibility of Construction

- Flexible design: GRS-IBS bridges employ a simple design that can be adapted to suit environmental or other needs. The layout can be easily modified in the field to adjust to unexpected site conditions.

- Installing the reinforced soil foundation (RSF) at or below the scour depth will be challenging. The depth of excavation would be approximately 18 feet below the existing roadway and about 4 feet below the water table. Cofferdams and dewatering may be required to construct the RSF. Temporary shoring may also be required given the limit ROW and close proximity of neighboring structures.

Community Impacts

- Accelerated construction: GRS-IBS bridges are easily built with smaller equipment and common materials, resulting in projects that are completed faster.
- Construction uses smaller equipment, requiring less laydown and staging.

Environmental Impacts

- GRS-IBS provides environmental advantages. Construction of the abutment is contained within its footprint, and deep foundations are not needed.
- Environmental impacts are also minimized through shortened construction time and the reduced amount of steel and cast-in-place concrete required.

Construction Cost

- The estimated construction cost for bridge alternative 1A (sheet pile cofferdam) is approximately $840,000.
- The estimated construction costs for bridge alternative 1B (rip rap scour protection) is approximately $805,000

These costs are inclusive to the bridge elements described above and do not include roadway, detour, bridge removal, etc.

BRIDGE SUBSTRUCTURE ALTERNATIVE 2 – SPREAD FOOTING ABUTMENTS

This alternative would construct conventional concrete bridge abutments founded on spread footings. Alternative 2 is shown in Figure 7-6. Structural earth (SE) walls would be constructed behind the bridge abutments to retain the roadway prism. The superstructure would be approximately 56 feet long, and both deck bulb-tee and voided slab girders are appropriate. Constructing an integral connection between the superstructure and substructure has several advantages: eliminates bridge bearings and joints and could be used to reduce the footing size necessary to retain the soil.

Similar to Bridge Alternative 1, the footings would be constructed at or below the design scour depth to protect the bridge against scour. This would result in tall abutment walls and large footings to retain the approach embankments. An integral superstructure could be used to restrain the top of the abutment wall, reducing the spread footings.

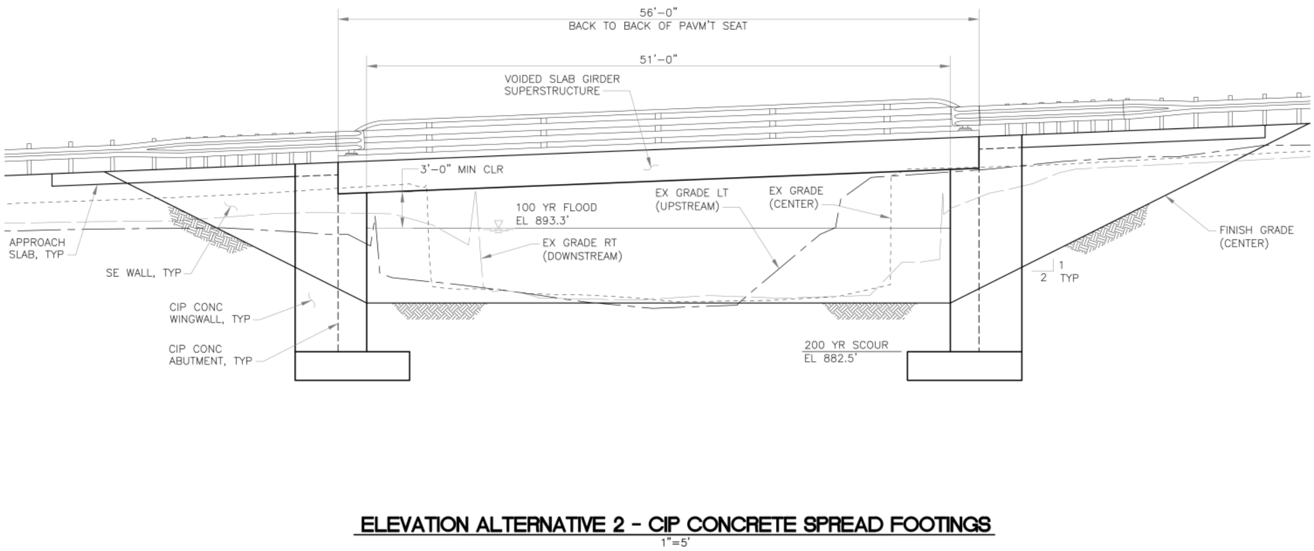

Figure 7-6: Alternative 2 Spread Footing Abutments

Supports Maintaining Community Access

- This alternative can be constructed in phases as necessary.

Structural Performance and Maintenance

- Cast-in-place concrete is a proven durable system.
- Integral bridge abutments have no bearings and joints to maintain.
- Design will need to accommodate liquefaction-induced differential settlement. The system will be more rigid that a GRS-IBS.

Scour Resistance

- A cast-in-place integral structure will be highly resistant to scour. Founding the spread footings at or below the design scour elevation will ensure the bridge remains stable after a scour event.

Feasibility of Construction

- Uses conventional construction techniques
- Similar to Alternative 1, large excavations approximately 18 feet deep and 4 feet below the water table will be required to construct the bridge abutments. Shoring, cofferdams, and/or dewatering may be required.

Community Impacts

- This alternative is expected to require more laydown and staging to construct (concrete trucks, pump trucks, cranes, and formwork).

Environmental Impacts

- Cast-in-place concrete will need to be cast adjacent to the creek. Final design should consider use of precast elements to reduce casting concrete near environmentally sensitive areas.

Construction Cost

- The estimated construction cost for this bridge alternative is approximately $805,000

These costs are inclusive to the bridge elements described above and do not include roadway, detour, bridge removal, etc.

BRIDGE ALTERNATIVE 3 – H-PILE SUPPORTED ABUTMENTS

This alternative would construct conventional pile-supported bridge abutments, as illustrated in Figure 7-7. Low displacement H-piles would be driven into bedrock and support a concrete pier cap and abutment wall. The toe of the abutment wall would extend to or below the design scour depth to ensure the approach is retained after a scour event. Constructing an integral connection between the substructure and superstructure has several advantages: eliminates bridge bearings and joints and could be used to reduce the pile sizes.

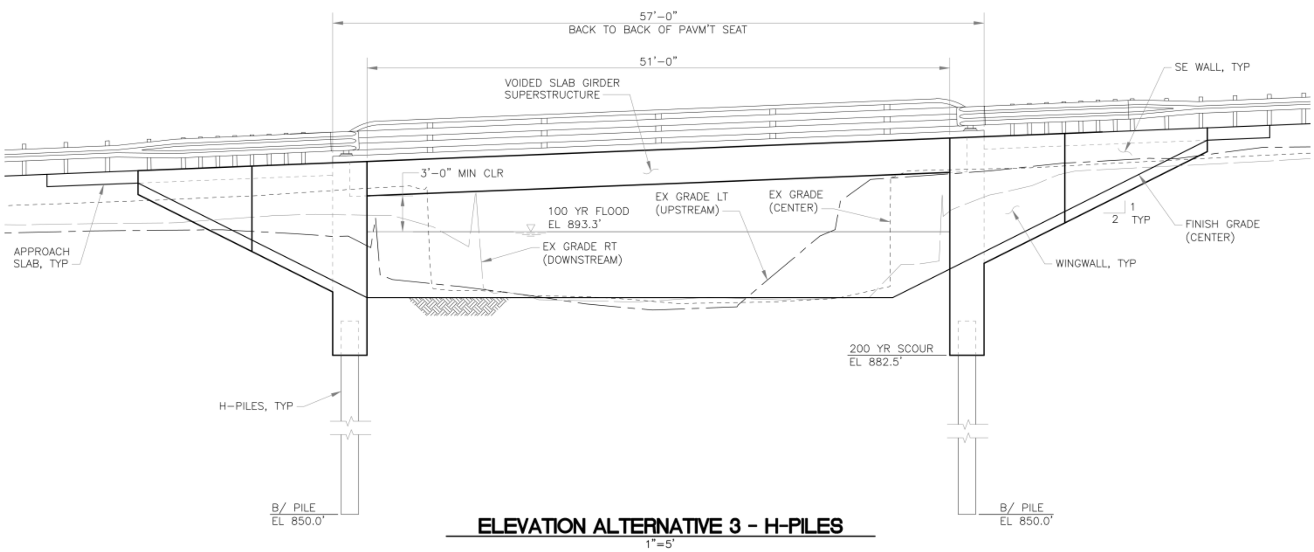

Figure 7-7: Alternative 3 - H-pile Supported Abutments

Supports Maintaining Community Access

- This alternative can be constructed in phases as necessary.

Structural Performance and Maintenance

- Cast-in-place concrete is a proven durable system.
- Integral bridge abutments have no bearings and joints to maintain.
- Deep foundations eliminate concerns with liquefaction-induced differential settlement.

Scour Resistance

- A cast-in-place integral structure with deep foundations will be highly resistant to scour and can accommodate scour depths exceeding design scour.

Feasibility of Construction

- Uses conventional construction techniques.
- Encountering pile obstructions, such as boulders, is a construction risk that could lead to additional cost and delays. Design should consider and accommodate offset piles and needing to remove obstructions. The Contract should provide means to address the uncertainty.
- The size of excavation would be reduced, compared to Alternative 1 and 2. Smaller standard trench shoring may be feasible to support excavations for cap construction beneath the scour depth.

Community Impacts

- The footprint of the abutment is less than Alternatives 1 and 2. It is expected to also require less laydown and staging to construct than Alternative 2, but more than Alternative 1.
- Pile driving could affect nearby structures and could generate significant noise, depending on the type and size of the machinery.

Environmental Impacts

- Cast-in-place concrete will need to be cast adjacent to the creek. Final design should consider use of precast elements to reduce casting wet concrete within the environmentally sensitive areas
- Pile driving will generate significant noise, depending on the type and size of the machinery.
- Installing scour protection measures within the channel may not be necessary with deep foundations.

Construction Cost

- The estimated construction cost for this bridge alternative is approximately $870,000

These costs are inclusive to the bridge elements described above and do not include roadway, detour, bridge removal, etc.

SUMMARY OF FINDINGS

Based upon the results of this analysis, the following superstructure and substructure types are recommended:

- **Superstructure:** Precast, prestressed concrete voided slabs. These girders keep the depth of the superstructure at a minimum, which helps reduce overall project length and costs. With this type of superstructure the maximum feasible span is 75 feet.

- **Substructure:** Both Alternative 1A – GRS-IBS foundation or Alternative 2 – CIP spread footings offer similar benefits and costs.

These alternatives best meet the previously stated design criteria and are feasible to construct for all three roadway alignment alternatives considered. For the purposes of the cost estimate for the roadway alternatives analysis, the precast voided slab superstructure and GRS-IBS substructure are assumed.

8. Alternatives Evaluation and Recommendations

The following section evaluates the previously described roadway alignment alternatives for a variety of criteria discussed and agreed upon with the County. The alternatives are compared to one another and rated on a scale from very favorable to very unfavorable. The results of this evaluation are summarized in the Evaluation Criteria Matrix shown in Table 8-1 at the end of this section.

ENVIRONMENTAL IMPACTS

As mentioned previously, all alternatives for the new bridge place the permanent bridge structures outside of the limits of the OHWM. Additionally, the existing bridge will be removed entirely from the creek channel including creosote treated timbers for all three alternatives. Environmental impacts are primarily focused on the removal of large caliper trees (greater than 4-inches in diameter measured at breast height (DBH)) and riparian vegetation necessary to complete construction.

Alternative 1: Unfavorable

With this alternative, approximately 24 large caliper trees would need to be removed during construction of the detour roadway/bridge and new roadway/bridge.

Alternative 2: Favorable

With this alternative, approximately 13 large caliper trees would need to be removed during construction of the detour roadway/bridge and new roadway/bridge.

Alternative 3: Favorable

With this alternative, approximately 13 large caliper trees would need to be removed during construction of the detour roadway/bridge and new roadway/bridge.

ROW NEEDS

The alternatives are evaluated based on their anticipated ROW needs, including partial ROW takes and Temporary Construction Easements (TCE).

Alternative 1: Very Unfavorable

With this alternative, approximately 3,600 square feet of additional ROW will need to be acquired along the southern edge of the roadway to provide the desired 10-foot-wide buffer. Approximately 500 square feet of TCE will be required at the NE corner of the existing bridge to accommodate construction of the detour roadway/bridge.

Alternative 2: Favorable

With this alternative, there is no need to acquire additional ROW. Approximately 13,840 square feet of TCE will be required along the southern edge of the project to accommodate construction of the detour roadway/bridge.

Alternative 3: Unfavorable

With this alternative, approximately 3,200 square feet of additional ROW will need to be acquired along the southern edge of the roadway to provide the desired 10-foot-wide buffer. TCEs are not anticipated for this alternative.

ROADWAY GEOMETRIC CONSTRAINTS

The alternatives are evaluated based on roadway geometric constraints. In this case, all final roadway alignments for these alternatives are nearly identical.

Alternative 1: Neutral

This alternative is essentially identical to all other alternatives considered

__Alternative 2:__ **Neutral**

This alternative is essentially identical to all other alternatives considered

__Alternative 3:__ **Neutral**

This alternative is essentially identical to all other alternatives considered

TRAFFIC IMPACTS DURING CONSTRUCTION

The alternatives are evaluated based on their anticipated impacts to the travelling public during construction activities. All alternatives will maintain a detour roadway/bridge throughout construction.

__Alternative 1:__ **Neutral**

With this alternative, a detour roadway/bridge is installed to the north of the existing bridge. This will require two shifts in the traffic patterns during construction that may impact area traffic.

__Alternative 2:__ **Neutral**

With this alternative, a detour roadway/bridge is installed to the south of the existing bridge. This will require two shifts in the traffic patterns during construction that may impact area traffic.

__Alternative 3:__ **Unfavorable**

With this alternative, the existing bridge is used as the detour bridge, and the new bridge is constructed to the south in phases. This alternative will require three shifts in the traffic patterns during construction, which may impact area traffic.

CONSTRUCTION STAGING/PHASING

The alternatives are evaluated based on their available construction staging areas, and the phasing required to construct the project.

__Alternative 1:__ **Favorable**

This alternative provides a significant construction laydown area between the west side of the proposed bridge location and the detour area. There is also a construction laydown area on the east side of the creek between the proposed bridge and detour roadway. The proposed bridge can be constructed in a single phase.

__Alternative 2:__ **Favorable**

This alternative is similar to Alternative 1 in terms of available construction laydown area. The proposed bridge can be constructed in a single phase.

__Alternative 3:__ **Very Unfavorable**

This alternative provides the least amount of construction laydown area as the first phase of roadway and bridge construction occurs immediately adjacent to the detour roadway/bridge. This will also require phased construction of the proposed bridge, which will incur additional mobilization costs.

CONSTRUCTION DURATION

The alternatives are evaluated based on their anticipated construction duration. Longer construction durations have impacts to the surrounding community as well as on construction costs. Construction schedules for each alternative are contained within Appendix C of this report.

Alternative 1: Favorable

Primary construction activities are anticipated to last approximately 7.5 months.

Alternative 2: Favorable

Similar to Alternative 1, primary construction activities are anticipated to last approximately 7.5 months.

Alternative 3: Very Unfavorable

This alternative has the longest construction duration, which is anticipated to last 9 months.

UTILITY IMPACTS

The alternatives are evaluated based on their impacts to existing utilities in the project area.

Alternative 1: Neutral

All existing utilities will be impacted.

Alternative 2: Neutral

All existing utilities will be impacted.

Alternative 3: Neutral

All existing utilities will be impacted.

LONG TERM MAINTENANCE

The alternatives are evaluated based on their anticipated long-term maintenance needs. It is assumed that the bridge maintenance needs are similar for all alternatives. Additional costs for long-term maintenance are primarily associated with the acquisition of additional ROW.

Alternative 1: Unfavorable

Additional ROW is acquired, which increases long-term maintenance costs.

Alternative 2: Favorable

No additional ROW is acquired for this alternative

Alternative 3: Unfavorable

Additional ROW is acquired, which increases long-term maintenance costs.

CONSTRUCTION COSTS

The alternatives are evaluated based upon their estimated construction costs. Detailed estimates of these costs are given in Appendix C.

Alternative 1: **Unfavorable**

The estimated construction cost for this alternative is approximately $2,497,000

Alternative 2: **Neutral**

The estimated construction cost for this alternative is $2,362,000

Alternative 3: **Unfavorable**

The estimated construction costs for this alternative is $2,551,000

PROJECT SCHEDULE

The alternatives are evaluated based on their estimated impacts on the overall project schedule.

Alternative 1: **Unfavorable**

This alternative requires the acquisition of additional ROW along the southern edge of the roadway. ROW acquisition can be an onerous task depending on the cooperativeness of private property owners.

Alternative 2: **Favorable**

This alternative does not require the acquisition of additional ROW. However, TCE are required, because the roadway and new bridge will be constructed essentially in the same location of the existing roadway and bridge. It is likely that the private property owner will be amenable to a temporary impact to their property.

Alternative 3: **Unfavorable**

This alternative requires the acquisition of additional ROW along the southern edge of the roadway. ROW acquisition can be an onerous task depending on the cooperativeness of private property owners.

Table 8-1: Evaluation Criteria Matrix

Evaluation Criteria Matrix - CC#3035A Bridge Replacement Project			
	Alternative 1	**Alternative 2**	**Alternative 3**
Environmental Impacts	↓	↑	↑
ROW Needs	↓↓	↑	↓
Roadway Geometric Constraints	■	■	■
Traffic Impacts During Construction	■	■	↓
Construction Staging/Phasing	↑	↑	↓↓
Construction Duration	↑	↑	↓↓
Utility Impacts	■	■	■
Long Term Maintenance	↓	↑	↓
Construction Costs	↓	■	↓
Project Schedule	↓	↑	↓

KEY	
↑↑	Very Favorable
↑	Favorable
■	Neutral
↓	Unfavorable
↓↓	Very Unfavorable

9. Public Outreach

King County hosted a project open house on March 26th from 6 to 7:30PM at the Enumclaw Fire Department Cumberland Station. Residents and other stakeholders were invited to learn about and provide comments on the three roadway alternatives and two superstructure alternatives.

The open house was promoted through a variety of methods:

- Website: Information about the open house was posted on the project webpage.
- Media: Information about the open house was sent to the Enumclaw Courier-Herald.
- Signage: Information about the project and the open house was posted near the existing bridge site.
- Door-to-door notification: Brent Champaco, King County Community Relations Planner, conducted door-to-door outreach and delivered flyers to the properties east of the existing bridge site.

Approximately 32 people attended the open house. As people arrived, they were greeted, asked to sign-in, informed of the format and oriented about the setup of the room. Participants were encouraged to view the boards, fill out a comment form and to share comments and questions with project staff.

There were eight boards on display which provided information on:

- Welcome
- Project location
- Project schedule

- Why replace the existing bridge?
- Bridge type
- Alternative 1
- Alternative 2
- Alternative 3

Open house participants were also encouraged to take a project handout, FAQ and Road Alert information.

The comments below are a high-level summary of what the public shared with study staff during the open house and on the comment forms that were submitted.

Comments on bridge alternatives

- Overall, open house attendees agreed that the bridge needs to be replaced.
- Open house participants were glad to see that the road approach and the new bridge will both be wider than the existing conditions. Some people suggested that this will help keep traffic moving in two directions even during a snow event.
- A few open house participants mentioned that during high water events, the river overtops the road approach on the west side of the existing bridge. They said the creek needs to be fixed and/or a higher bridge should be put in.

Comments on bridge construction

- Open house participants agreed that the one-lane temporary bridge width is enough for the volume of traffic that uses this route.
- They were also glad to hear that the temporary bridge will be signalized.

Appendix G contains a more detailed report of the open house event as well as the public comments received and their responses.

10. Summary of Recommendations

Based on the results of this report, the recommended preferred alternative for the Coal Creek Bridge No. 3035A Bridge Replacement Project is as follows:

- Roadway Alignment Alternative 2: This alignment alternative best satisfied all of the project evaluation criteria including the least ROW needs and reduced long term maintenance.
- Voided Slab Girder Superstructure: This superstructure type allows for the shallowest possible girder for the span length thereby keeping increases in roadway profile to a minimum.
- CIP Concrete Spread Footing Substructure: This substructure type is a proven, durable foundation system which is commonplace in bridge construction.

11. Areas of Further Study

At the time of this report, the following pieces of information were unavailable, which may impact the results of the study:

- Mapping of Critical Areas: The OHWM, bank full channel features of the aquatic area stream were delineated for approximately 100 feet upstream and downstream of the bridge. Wetlands were not delineated prior to this report because no wetland vegetation was observed on parcels where rights-of-entry were available. Wetland presence will be investigated further with the selected preferred alternative and acquisition of outstanding rights-of-entry. It is not expected that the results of this TS&L study will be significantly affected by the on-site delineation of the wetlands.
- Traffic Analysis: No formal traffic report for this roadway was available at the time of this study. Future roadway volumes are unknown. Feedback from the public indicted that there are some issues along the roadway to/from the bridge. However, considering the location of the project site, significant increases in traffic volume are not expected.

Appendix A

Roadway and Site Layout Alternatives

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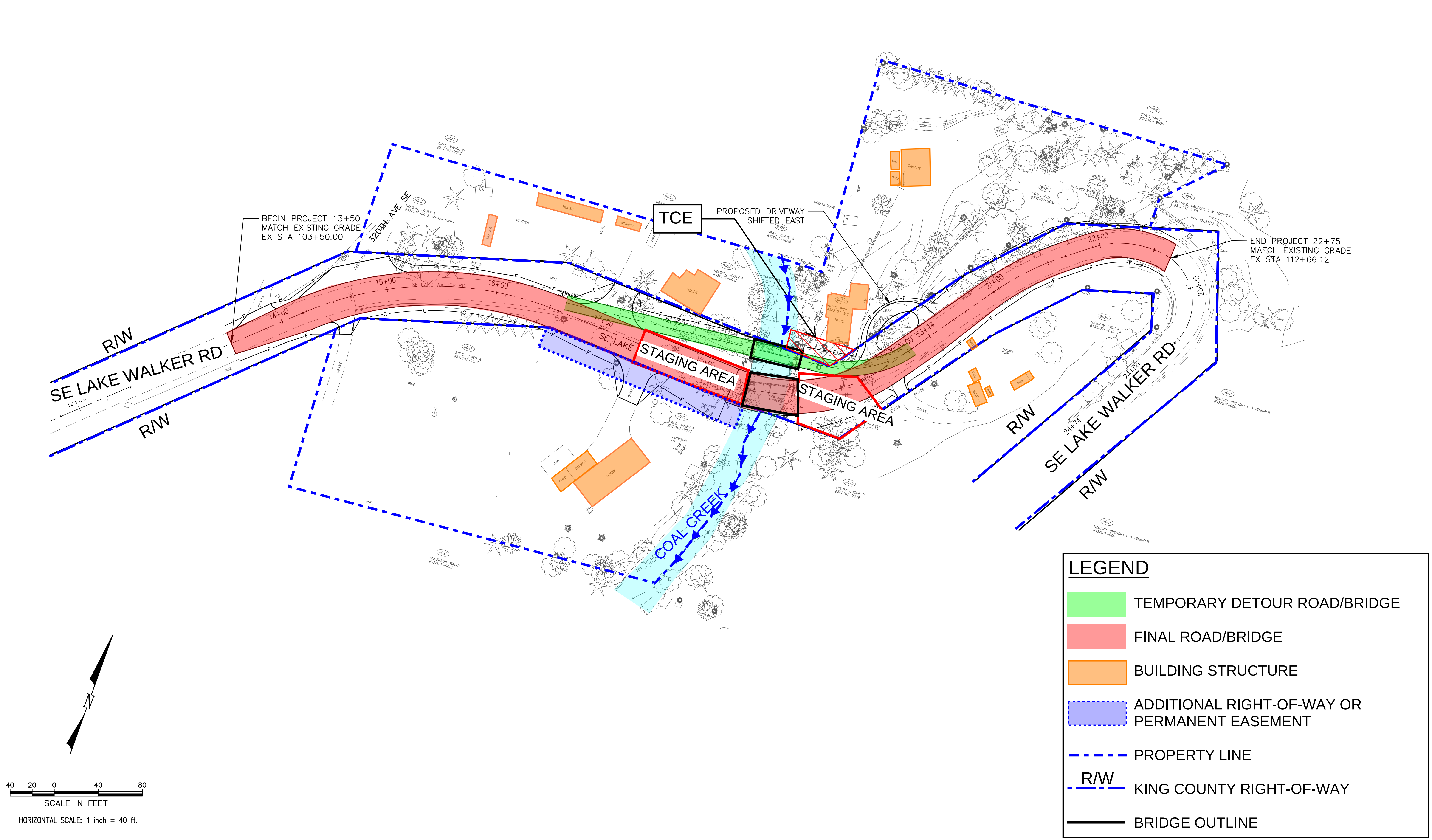
SITE LAYOUT: ALIGNMENT ALTERNATIVE 1



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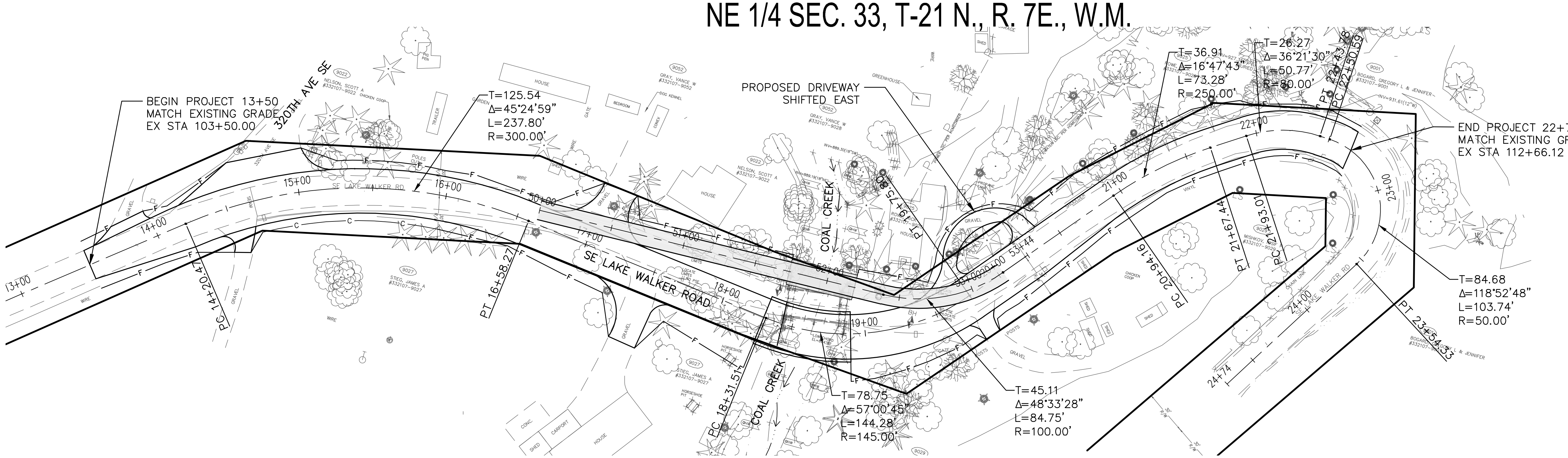
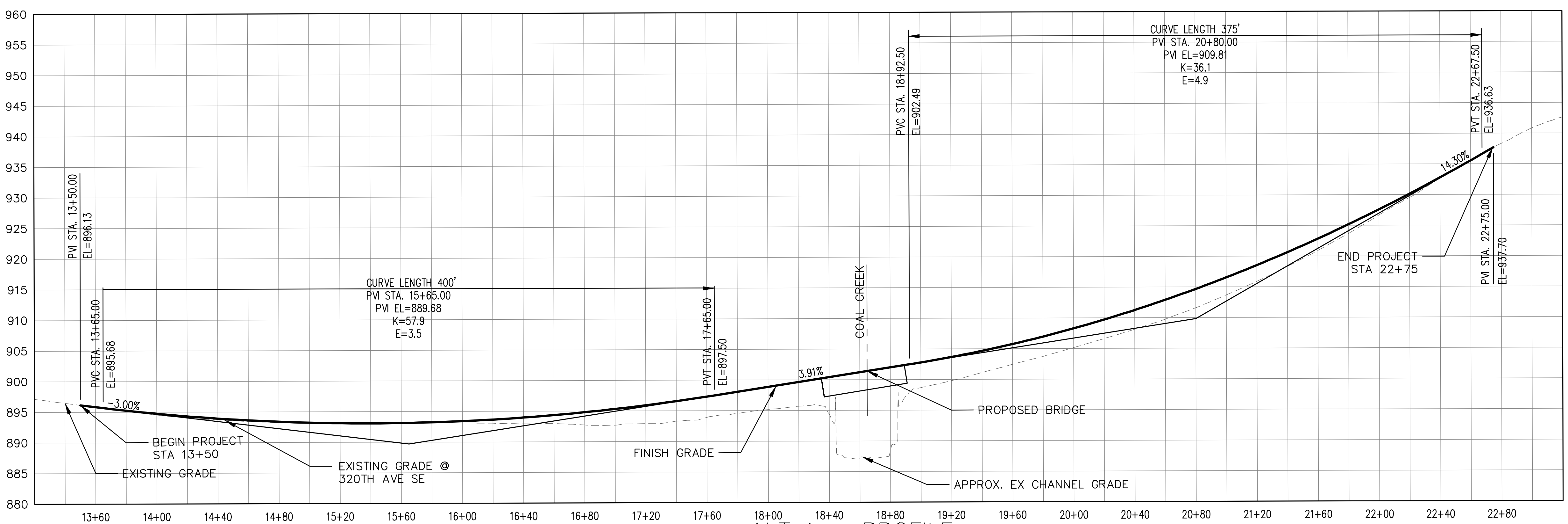


ALT 1 – PLAN



ALT 1 – PROFILE

LEGEND

ROW	
TEMP ROAD	
CENTER LINE	
STREAM LINE	
F	FILL LINE
C	CUT LINE

N

MERIDIAN
WASHINGTON STATE
LAMBERT GRID
NORTH ZONE
NAD 83/91
VERTICAL DATUM
NAVD88

40 20 0 40 80
SCALE IN FEET
HORIZONTAL SCALE: 1 inch = 40 ft.

10 5 0 10 20
SCALE IN FEET
VERTICAL SCALE: 1 inch = 10 ft.

811
Know what's below.
Call before you dig.

Name: michaelv Date: Jun 13, 2019–01:51:16pm File: Z:\1800001–1800999\1800398 Coal Creek Bridge 3035A\CADD\Design\1135997_RDPP ALT1.dwg

SURVEY JOB NO:	18069	10/18				
CHECKED:	J. EVANS	10/18				
CAD ENTERED:	M. VU	06/19				
DESIGNED:	D. WORTHEN	06/19				
CHECKED:	P. SLOAN	06/19				
SUPERVISOR:	R. LEIMKUHLER	06/19				
			NUM.	REVISION	BY	DATE

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Seattle, WA 98101
206.622.5822
www.kpff.com

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PROJECT No. 1135997
MAINTENANCE DIVISION No. 4

PRELIMINARY
NOT FOR
CONSTRUCTION

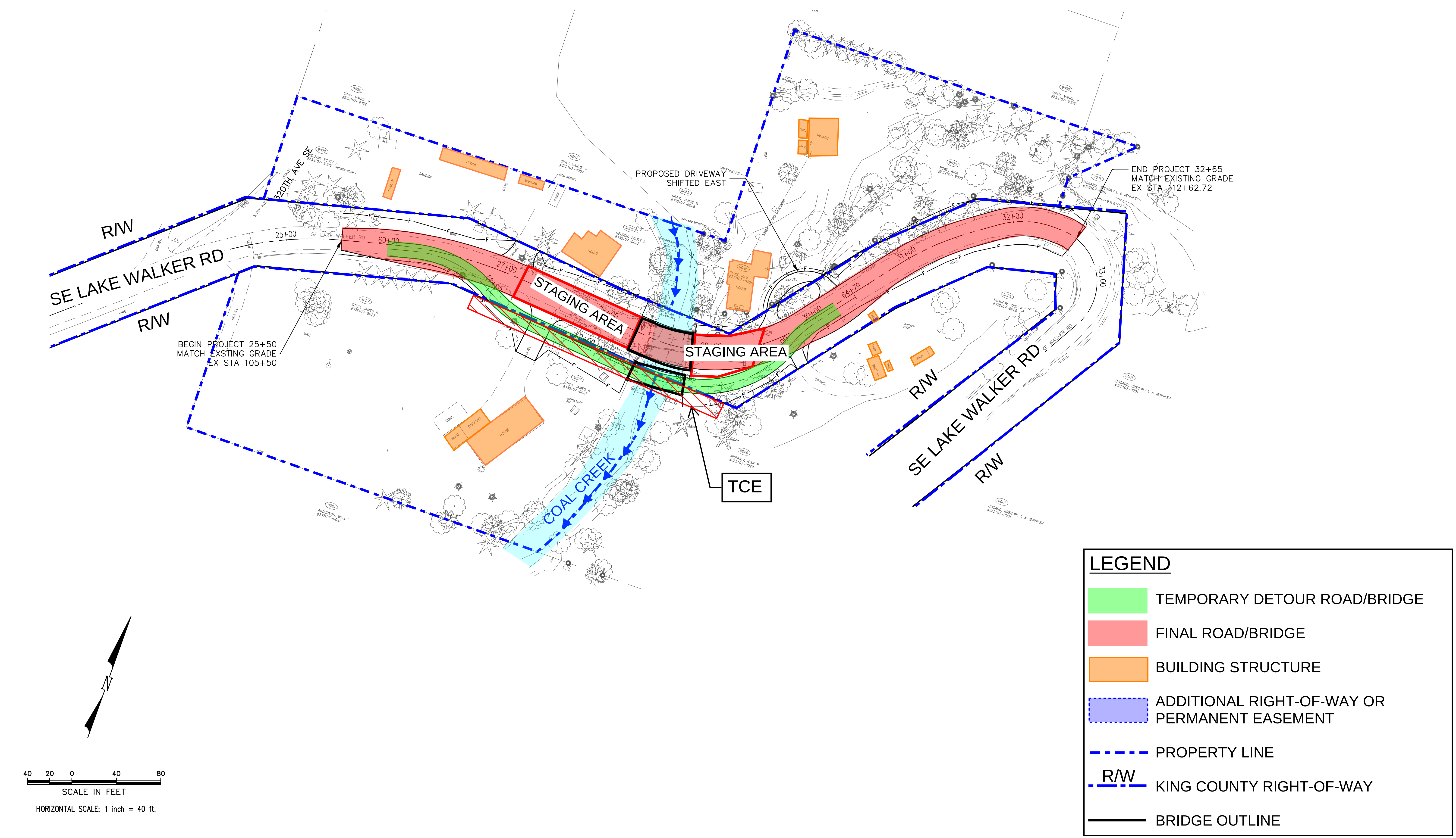
KING COUNTY DEPT. OF LOCAL SERVICES
JOHN TAYLOR, DIRECTOR
COAL CREEK BRIDGE NO. 3035A
REPLACEMENT
BRIDGE LOCATION
ALTERNATIVE 1
ALIGNMENT 10+00 – 24+74

King County

SHEET
1
OF
7
SHEETS

320 - 67(1)

SITE LAYOUT: ALIGNMENT ALTERNATIVE 2



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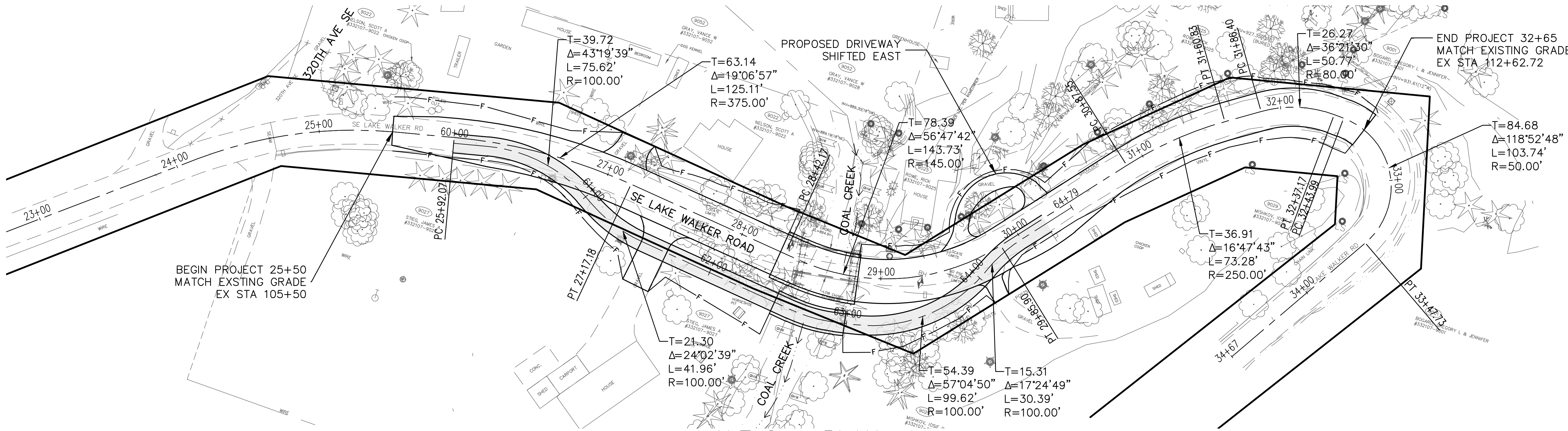
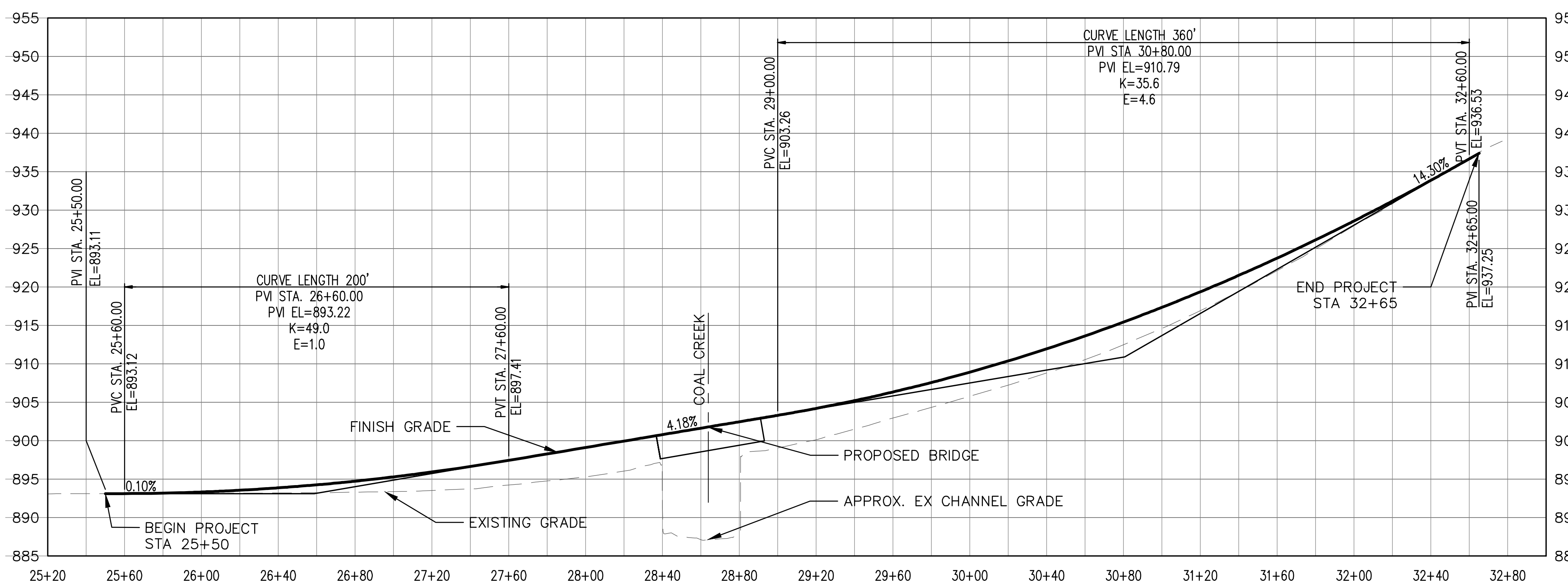


ALT 2 – PLAN



ALT 2 – PROFILE

LEGEND

- ROW
- TEMP ROAD
- CENTER LINE
- STREAM LINE
- FILL LINE
- CUT LINE

N

MERIDIAN
WASHINGTON STATE
LAMBERT GRID
NORTH ZONE
NAD 83/91
VERTICAL DATUM
NAVD88

40 20 0 40 80
SCALE IN FEET
HORIZONTAL SCALE: 1 inch = 40 ft.

10 5 0 10 20
SCALE IN FEET
VERTICAL SCALE: 1 inch = 10 ft.

811
Know what's below.
Call before you dig.

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SURVEY JOB NO:	18069	10/18
CHECKED:	J. EVANS	10/18
CAD ENTERED:	M. VU	06/19
DESIGNED:	D. WORTHEN	06/19
CHECKED:	P. SLOAN	06/19
SUPERVISOR:	R. LEIMKUHLER	06/19

NUM.	REVISION	BY	DATE

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KING COUNTY DEPT. OF LOCAL SERVICES
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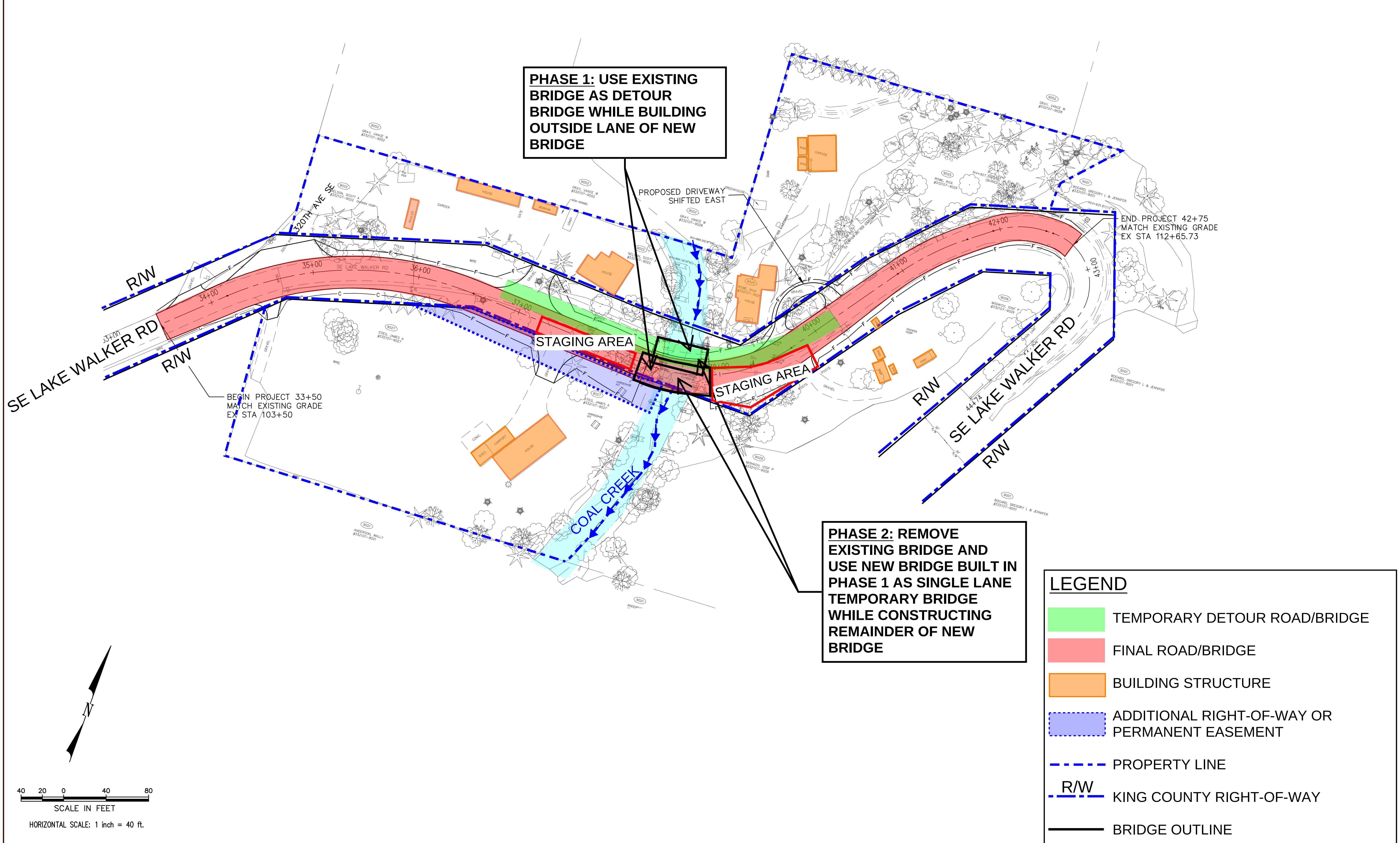
COAL CREEK BRIDGE NO. 3035A REPLACEMENT
BRIDGE LOCATION
ALTERNATIVE 2
ALIGNMENT 20+00 – 34+67

King County

SHEET 2 OF 7 SHEETS

320 - 67(2)

SITE LAYOUT: ALIGNMENT ALTERNATIVE 3



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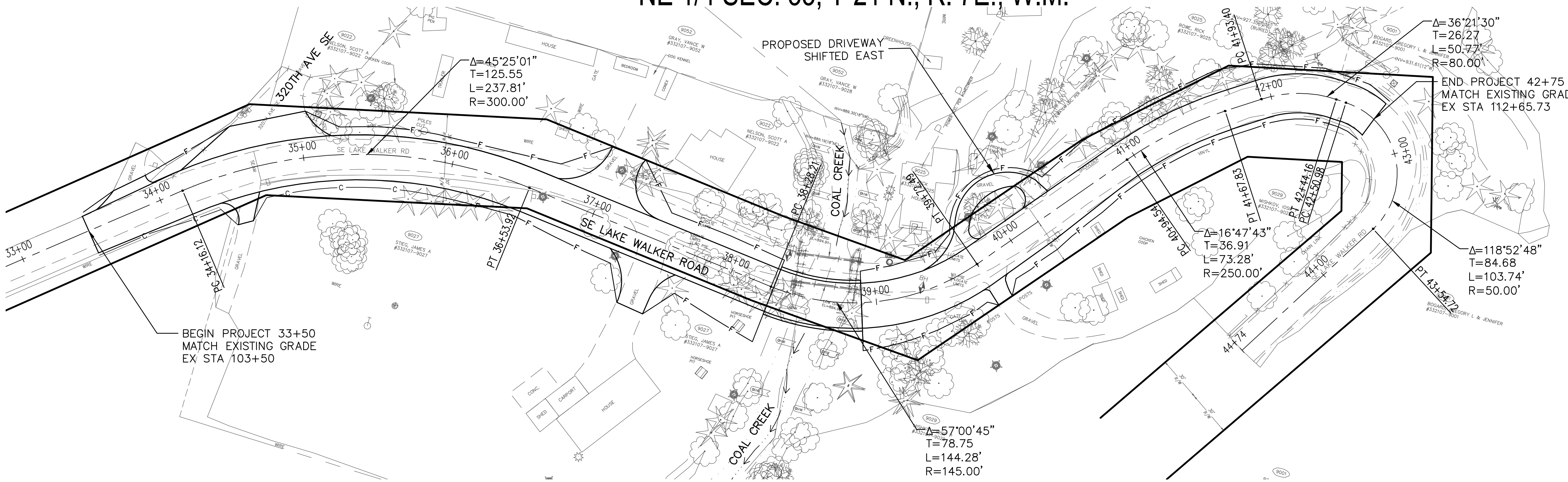
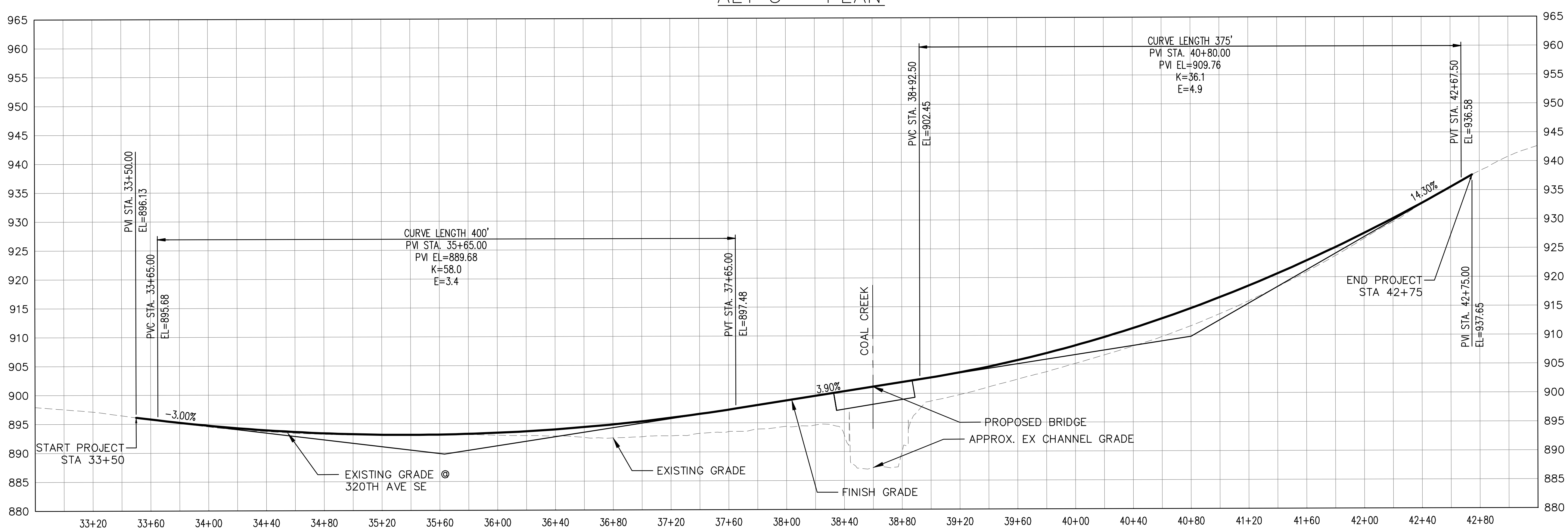


ALT 3 – PLAN

LEGEND

- ROW
- CENTER LINE
- STREAM LINE
- FILL LINE
- CUT LINE



ALT 3 – PROFILE

MERIDIAN
WASHINGTON STATE
LAMBERT GRID
NORTH ZONE
NAD 83/91
VERTICAL DATUM
NAVD88

SCALE IN FEET
HORIZONTAL SCALE: 1 inch = 40 ft.

SCALE IN FEET
VERTICAL SCALE: 1 inch = 10 ft.

811
Know what's below.
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SURVEY JOB NO:	18069	10/18
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CAD ENTERED:	M. VU	06/19
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NUM.	REVISION	BY	DATE

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BRIDGE LOCATION
ALTERNATIVE 3
ALIGNMENT 30+00–44+74

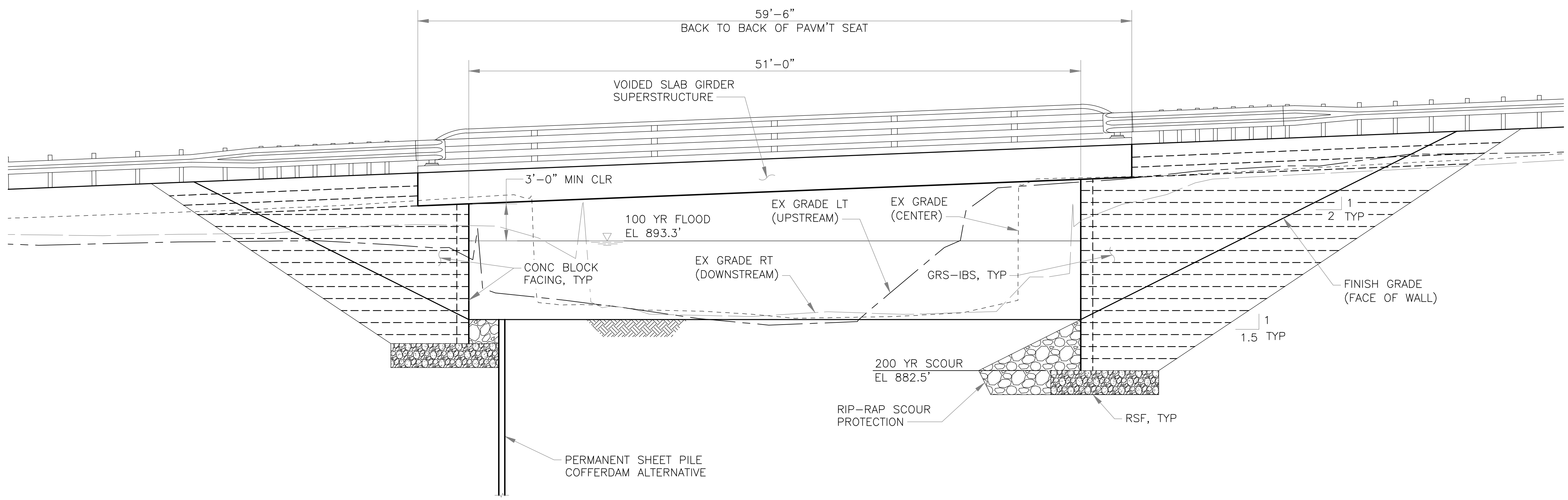
King County

SHEET 3 OF 7 SHEETS

320 - 67(3)

Appendix B

Bridge Alternatives



ELEVATION ALTERNATIVE 1 - GRS-IBS

1"=5'

5 2.5 0 5 10
SCALE IN FEET

811
Know what's below.
Call before you dig.

SURVEY JOB NO:	--	--
CHECKED:	--	--
CAD ENTERED:	--	--
DESIGNED:	--	--
CHECKED:	--	--
SUPERVISOR:	--	--

NUM.	REVISION	BY	DATE

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PROJECT No. 1135997
MAINTENANCE DIVISION No. 4

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CONSTRUCTION

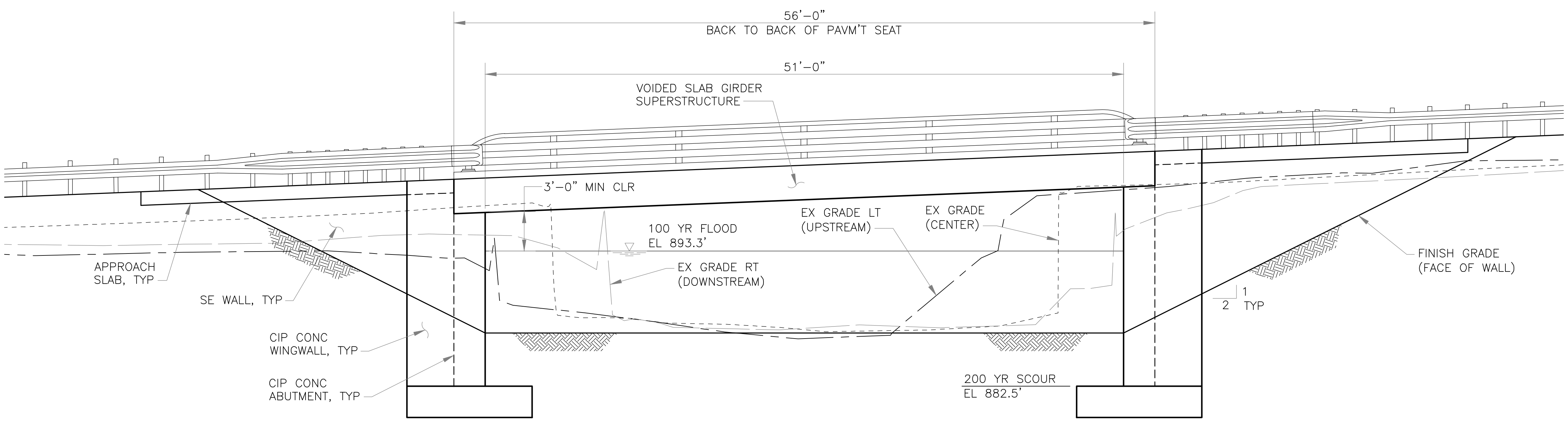
KING COUNTY DEPT. OF LOCAL SERVICES
JOHN TAYLOR, DIRECTOR
COAL CREEK BRIDGE #3035A
ALTERNATIVE ANALYSIS

BRIDGE FOUNDATION
ALTERNATIVE 1 – GRS–IBS

King County

SHEET 4 OF 7 SHEETS

XXX-XX (4)



ELEVATION ALTERNATIVE 2 - CIP CONCRETE SPREAD FOOTINGS

1"=5'

5 2.5 0 5 10
SCALE IN FEET

Know what's below.
Call before you dig.

SURVEY JOB NO: --	--	
CHECKED: --	--	
CAD ENTERED: --	--	
DESIGNED: --	--	
CHECKED: --	--	
SUPERVISOR: --	--	

NUM.	REVISION	BY	DATE

FED. AID No. BROS-2017(148)

PROJECT No. 1135997

MAINTENANCE DIVISION No. 4

PRELIMINARY NOT FOR CONSTRUCTION

KING COUNTY DEPT. OF LOCAL SERVICES
JOHN TAYLOR, DIRECTOR

COAL CREEK BRIDGE #3035A
ALTERNATIVE ANALYSIS

BRIDGE FOUNDATION
ALTERNATIVE 2 - CIP CONCRETE SPREAD FOOTINGS

King County

SHEET 5 OF 7 SHEETS

XXX-XX (5)

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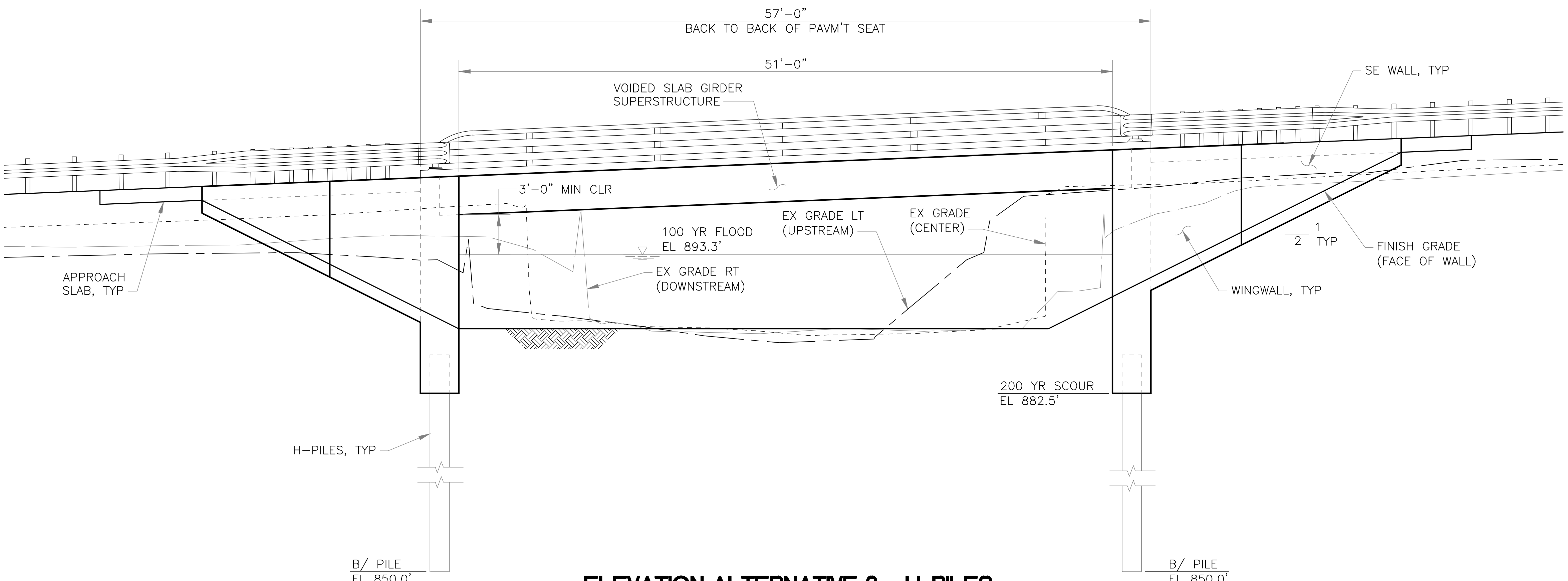

ELEVATION ALTERNATIVE 3 - H-PILES

1"=5'

5 2.5 0 5 10
SCALE IN FEET

Know what's below.
Call before you dig.

SURVEY JOB NO:	--	--
CHECKED:	--	--
CAD ENTERED:	--	--
DESIGNED:	--	--
CHECKED:	--	--
SUPERVISOR:	--	--

NUM.	REVISION	BY	DATE

FED. AID No. BROS-2017(148)

PROJECT No. 1135997

MAINTENANCE DIVISION No. 4

PRELIMINARY NOT FOR CONSTRUCTION

KING COUNTY DEPT. OF LOCAL SERVICES
JOHN TAYLOR, DIRECTOR

COAL CREEK BRIDGE #3035A
ALTERNATIVE ANALYSIS

BRIDGE FOUNDATION
ALTERNATIVE 3 – H-PILES

King County

SHEET 6 OF 7 SHEETS

XXX-XX (6)

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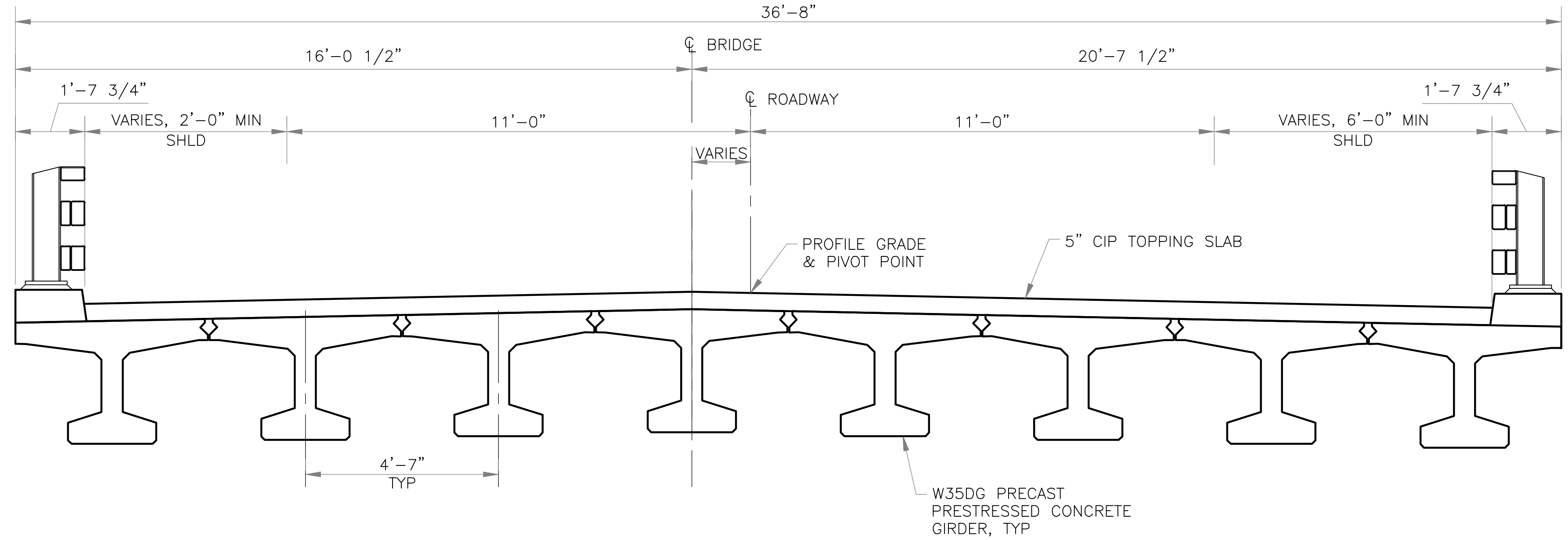
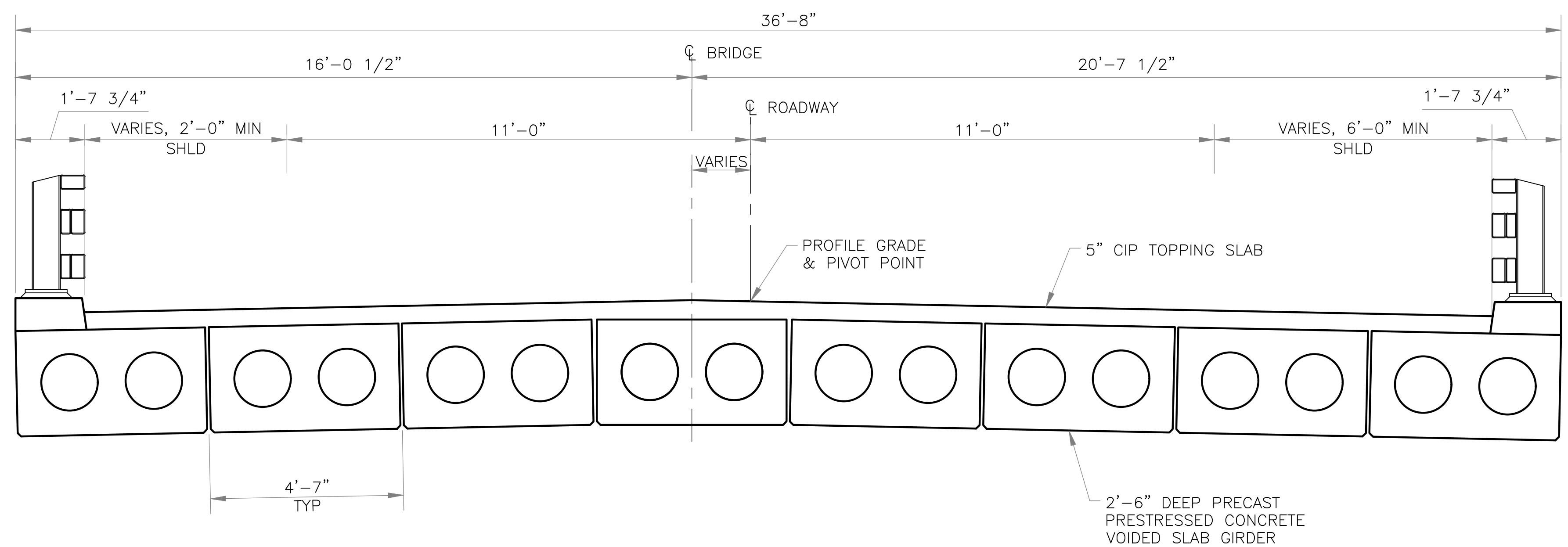


ALTERNATIVE A - DECK BULB TEE GIRDER

SCALE: 1/2"=1'-0"



ALTERNATIVE B - VOIDED SLAB GIRDER

SCALE: 1/2"=1'-0"

Know what's below.
Call before you dig.

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DESIGNED:	--	--
CHECKED:	--	--
SUPERVISOR:	--	--

NUM.	REVISION	BY	DATE

FED. AID No. BROS-2017(148)

PROJECT No. 1135997

MAINTENANCE DIVISION No. 4

PRELIMINARY NOT FOR CONSTRUCTION

KING COUNTY DEPT. OF LOCAL SERVICES
JOHN TAYLOR, DIRECTOR

COAL CREEK BRIDGE #3035A
ALTERNATIVE ANALYSIS

BRIDGE
ALTERNATIVE TYPICAL SECTIONS

King County

SHEET 7 OF 7 SHEETS

XXX-XX (7)

Appendix C

Cost Estimates & Construction Schedules

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Client:	King County
Project:	Coal Creek Bridge No. 3035A Replacement
KPFF Job #:	1800398
By:	KPFF
Date:	10/22/2019

ENGINEER'S ESTIMATE OF PROBABLE COST - ALT 1 COAL CREEK BRIDGE No. 3035A REPLACEMENT, 30 FT WIDTH

Estimated % Design Completion: TS&L

ITEM NO.	SPECS REF.	ITEM NAME	UNIT	UNIT PRICE	Quantity	Cost	NOTES
		PREPARATION					
1	1-09	Mobilization	LS	See Below	1	See Below	10% of total before contigency
2	2-02.5SP	Removing Existing Bridge - Coal Creek Bridge No. 3035A	LS	$ 100,000	1	$ 100,000	
3	SP	Removal of Structures and Obstructions	LS	$ 10,000	1	$ 10,000	provided by King County
4	2-02.5	Clearing and Grubbing	AC	$ 15,000	0.7	$ 10,500	
5	SP	Temporary Detour Bridge	LS	$ 100,000	1	$ 100,000	
		GRADING					
6	2-03.5	Roadway Excavation Incl. Haul	CY	$ 65	710	$ 46,150	includes removing detour
7	2-03.5	Embankment Compaction	CY	5	1,750	$ 8,750	
8	2-03.3	Gravel Borrow Incl. Haul	TON	$ 40	3,220	$ 128,800	
		DRAINAGE					
9		Drainage Estimate	EST	$ 200,000	1	$ 200,000	
		SURFACING					
10	4-04.5	Crushed Surfacing Base Course	TON	$ 50	1,560	$ 78,000	
		HOT MIX ASPHALT					
11	5-04.5SP	HMA Class 1/2" PG 58H-22	TON	$ 180	1,070	$ 192,600	
		EROSION CONTROL AND PLANTING					
12		Erosion Control	LS	$ 40,000	1	$ 40,000	
		TRAFFIC					
13	8-11.5	Beam Guardrail Non-Flared Terminal	EA	$ 4,000	2	$ 8,000	
14	8-11.5	Beam Guardrail Transition Section Type 24	EA	$ 5,000	4	$ 20,000	
15	8-11.5	Beam Guardrail Anchor Type 10	EA	$ 1,500	2	$ 3,000	
16	8-22.5	Paint Line	LF	$ 1.50	4,400	$ 6,600	
17	8-22.5	Plastic Stop Line	LF	$ 2	20	$ 40.00	
18	1-10.5	Portable Temporary Traffic Control Signal	LS	$ 50,000	1	$ 50,000	
19	1-10.5	Project Temporary Traffic Control	LS	$ 25,000	1	$ 25,000	
		STRUCTURE					
20	2-09	Structure Excavation Class A Incl. Haul	CY	$ 60	886	$ 53,143	
21	2-09	Structure Excavation Class A	CY	$ 35	384	$ 13,440	
22	2-09	Shoring or Extra Excavation Cl. A	LS	$ 100,000	1	$ 100,000	
23	8-15	Heavy Loose Riprap	CY	$ 70	99	$ 6,960	
24	SP	Crushed Surfacing Base Course	CY	$ 40	688	$ 27,520	Recommended GRS backfill per Geotech
25	6-13	Structural Earth Wall	SF	$ 40	2,530	$ 101,200	
26	6-02	Concrete Class 4000D for Bridge	CY	$ 900	49	$ 44,229	
27	6-02	Concrete Class 4000 for Bridge	CY	$ 800	87	$ 69,486	
28	6-02	Epoxy Coated St. Reinf Bar for Bridge	LB	$ 2.00	13,003	$ 26,007	
29	6-02	St. Reinf. Bar for Bridge	LB	$ 1.25	20,110	$ 25,137	
30	6-02	Prestressed Conc. Girder - 30 Inch Slab Unit	LF	$ 530	477	$ 252,383	
31	6-02	Precast Concrete Beam	LF	$ 350	74	$ 26,000	
32	6-06	Bridge Railing	LF	$ 250	119	$ 29,750	
		OTHERS					
33		Mitigation	LS	$ 25,000	1	$ 25,000	provided by King County
34		Planting	LS	$ 15,000	1	$ 15,000	provided by King County
35		Training	HR	$ 15	480	$ 7,200	provided by King County

Subtotal		=	$1,849,894	
Contingency	25%	=	$462,474	
Mobilization	10%	=	$184,989	
Construction Cost Total (no sales tax)		=	$2,497,357	
Construction Management & Administration incl. Inspection	35%	=	$874,074.92	% Const Cost, provided by King County
Preliminary Engineering (Design) Cost	30%		$749,207.07	% Const Cost, provided by King County
ROW Costs (ROW management and administration, appraisals, acquisitions, & other tasks associated w/ ROW acquisition)		=	$25,000	3600SF of ROW take @ $2.30/SF, 500SF of TCE @ $0.23/SF, $15,750 in negotiation, statuatory and condemnation costs
TOTAL ESTIMATED PROJECT COST		=	**$4,146,000**	

Note: Estimated costs are in 2019 dollars. They are for planning purposes only.

kpff

Client: King County
Project: Coal Creek Bridge No. 3035A Replacement
KPFF Job #: 1800398
By: KPFF
Date: 11/13/2019

ENGINEER'S ESTIMATE OF PROBABLE COST - ALT 2 COAL CREEK BRIDGE No. 3035A REPLACEMENT, 30 FT WIDTH
Estimated % Design Completion: TS&L

ITEM NO.	SPECS REF.	ITEM NAME	UNIT	UNIT PRICE	Quantity	Cost	NOTES
		PREPARATION					
1	1-09	Mobilization	LS	See Below	1	See Below	10% of total before contigency
2	2-02.5SP	Removing Existing Bridge - Coal Creek Bridge No. 3035A	LS	$ 100,000	1	$ 100,000	removing existing bridge
3	SP	Removal of Structures and Obstructions	LS	$ 10,000	1	$ 10,000	provided by King County
4	2-02.5	Clearing and Grubbing	AC	$ 15,000	0.7	$ 10,500	
5	SP	Temporary Detour Bridge	LS	$ 100,000	1	$ 100,000	
		GRADING					
6	2-03.5	Roadway Excavation Incl. Haul	CY	$ 65	450	$ 29,250	includes removing detour
7	2-03.5	Embankment Compaction	CY	$ 5	2,000	$ 10,000	
8	2-03.3	Gravel Borrow Incl. Haul	TON	$ 40	3,700	$ 148,000	
		DRAINAGE					
9		Drainage Estimate	EST	$ 150,000	1	$ 150,000	
		SURFACING					
10	4-04.5	Crushed Surfacing Base Course	TON	$ 50	1,260	$ 63,000	
		HOT MIX ASPHALT					
11	5-04.5SP	HMA Class 1/2" PG 58H-22	TON	$ 180	860	$ 154,800	
		EROSION CONTROL AND PLANTING					
12		Erosion Control	LS	$ 40,000	1	$ 40,000	
		TRAFFIC					
13	8-11.5	Beam Guardrail Non-Flared Terminal	EA	$ 4,000	2	$ 8,000	
14	8-11.5	Beam Guardrail Transition Section Type 24	EA	$ 5,000	4	$ 20,000	
15	8-11.5	Beam Guardrail Anchor Type 10	EA	$ 1,500	2	$ 3,000	
16	8-22.5	Paint Line	LF	$ 1.50	3,750	$ 5,625	
17	8-22.5	Plastic Stop Line	LF	$ 2	20	$ 40.00	
18	1-10.5	Portable Temporary Traffic Control Signal	LS	$ 50,000	1	$ 50,000	
19	1-10.5	Project Temporary Traffic Control	LS	$ 25,000	1	$ 25,000	
		STRUCTURE					
20	2-09	Structure Excavation Class A Incl. Haul	CY	$ 60	886	$ 53,143	
21	2-09	Structure Excavation Class A	CY	$ 35	384	$ 13,440	
22	2-09	Shoring or Extra Excavation Cl. A	LS	$ 100,000	1	$ 100,000	
23	8-15	Heavy Loose Riprap	CY	$ 70	99	$ 6,960	
24	SP	Crushed Surfacing Base Course	CY	$ 40	688	$ 27,520	Recommended GRS backfill per Geotech
25	6-13	Structural Earth Wall	SF	$ 40	2,530	$ 101,200	
26	6-02	Concrete Class 4000D for Bridge	CY	$ 900	49	$ 44,229	
27	6-02	Concrete Class 4000 for Bridge	CY	$ 800	87	$ 69,486	
28	6-02	Epoxy Coated St. Reinf Bar for Bridge	LB	$ 2.00	13,003	$ 26,007	
29	6-02	St. Reinf. Bar for Bridge	LB	$ 1.25	20,110	$ 25,137	
30	6-02	Prestressed Conc. Girder - 30 Inch Slab Unit	LF	$ 530	477	$ 252,383	
31	6-02	Precast Concrete Beam	LF	$ 350	74	$ 26,000	
32	6-06	Bridge Railing	LF	$ 250	119	$ 29,750	
		OTHERS					
33		Mitigation	LS	$ 25,000	1	$ 25,000	provided by King County
34		Planting	LS	$ 15,000	1	$ 15,000	provided by King County
35		Training	HR	$ 15	480	$ 7,200	provided by King County

Subtotal		=	$1,749,669	
Contingency	25%	=	$437,417	
Mobilization	10%	=	$174,967	
Construction Cost Total (no sales tax)		=	$2,362,053	
Construction Management & Administration incl. Inspection	35%	=	$826,718.60	% Const Cost, provided by King County
Preliminary Engineering (Design) Cost	30%		$708,615.95	% Const Cost, provided by King County
ROW Costs (ROW management and administration, appraisals, acquisitions, & other tasks associated w/ ROW acquisition)		=	$19,000	13840SF of TCE @ $0.23/SF, $15,750 in negotiation, statuatory and condemnation costs
TOTAL ESTIMATED PROJECT COST		=	**$3,917,000**	

Note: Estimated costs are in 2019 dollars. They are for planning purposes only.

kpff

Client: King County
Project: Coal Creek Bridge No. 3035A Replacement
KPFF Job #: 1800398
By: KPFF
Date: 10/22/2019

ENGINEER'S ESTIMATE OF PROBABLE COST - ALT 3 COAL CREEK BRIDGE No. 3035A REPLACEMENT, 30 FT WIDTH

Estimated % Design Completion: TS&L

ITEM NO.	SPECS REF.	ITEM NAME	UNIT	UNIT PRICE	Quantity	Cost	NOTES
		PREPARATION					
1	1-09	Mobilization	LS	See Below	1	See Below	20% of total before contigency
2	2-02.5SP	Removing Existing Bridge - Coal Creek Bridge No. 3035A	LS	$ 100,000	1	$ 100,000	removing existing bridge
3	SP	Removal of Structures and Obstructions	LS	$ 10,000	1	$ 10,000	provided by King County
4	2-02.5	Clearing and Grubbing	AC	$ 15,000	0.7	$ 10,500	
		GRADING					
5	2-03.5	Roadway Excavation Incl. Haul	CY	$ 65	520	$ 33,800	
6	2-03.5	Embankment Compaction	CY	5	1,670	$ 8,350	
7	2-03.3	Gravel Borrow Incl. Haul	CY	$ 40	3,080	$ 123,200	
		DRAINAGE					
8		Drainage Estimate	EST	$ 200,000	1	$ 200,000	
		SURFACING					
9	4-04.5	Crushed Surfacing Base Course	TON	$ 50	1,400	$ 70,000	
		HOT MIX ASPHALT					
10	5-04.5SP	HMA Class 1/2" PG 58H-22	TON	$ 180	990	$ 178,200	
		EROSION CONTROL AND PLANTING					
11		Erosion Control	LS	$ 40,000	1	$ 40,000	
		TRAFFIC					
12	8-11.5	Beam Guardrail Non-Flared Terminal	EA	$ 4,000	2	$ 8,000	
13	8-11.5	Beam Guardrail Transition Section Type 24	EA	$ 5,000	4	$ 20,000	
14	8-11.5	Beam Guardrail Anchor Type 10	EA	$ 1,500	2	$ 3,000	
15	8-22.5	Paint Line	LF	$ 1.50	4,300	$ 6,450	
16	8-22.5	Plastic Stop Line	LF	$ 2.00	20	$ 40	
17	1-10.5	Portable Temporary Traffic Control Signal	LS	$ 50,000	1	$ 50,000	Higher traffic control for phased const.
18	1-10.5	Project Temporary Traffic Control	LS	$ 50,000	1	$ 50,000	
		STRUCTURE					
19	2-09	Structure Excavation Class A Incl. Haul	CY	$ 60	886	$ 53,143	
20	2-09	Structure Excavation Class A	CY	$ 35	384	$ 13,440	
21	2-09	Shoring or Extra Excavation Cl. A	LS	$ 150,000	1	$ 150,000	Extra shoring req'd for phased const
22	8-15	Heavy Loose Riprap	CY	$ 70	99	$ 6,960	
23	SP	Crushed Surfacing Base Course	CY	$ 40	688	$ 27,520	Recommended GRS backfill per Geotech
24	6-13	Structural Earth Wall	SF	$ 40	2,530	$ 101,200	
25	6-02	Concrete Class 4000D for Bridge	CY	$ 900	49	$ 44,229	
26	6-02	Concrete Class 4000 for Bridge	CY	$ 800	87	$ 69,486	
27	6-02	Epoxy Coated St. Reinf Bar for Bridge	LB	$ 2.00	13,003	$ 26,007	
28	6-02	St. Reinf. Bar for Bridge	LB	$ 1.25	20,110	$ 25,137	
29	6-02	Prestressed Conc. Girder - 30 Inch Slab Unit	LF	$ 530	477	$ 252,383	
30	6-02	Precast Concrete Beam	LF	$ 350	74	$ 26,000	
31	6-06	Bridge Railing	LF	$ 250	119	$ 29,750	
		OTHERS					
32		Mitigation	LS	$ 25,000	1	$ 25,000	provided by King County
33		Planting	LS	$ 15,000	1	$ 15,000	provided by King County
34		Training	HR	$ 15	480	$ 7,200	provided by King County

Subtotal		=	$1,783,994	
Contingency	25%	=	$445,999	
Mobilization	18%	=	$321,119	Higher mobilization for phased construction
Construction Cost Total (no sales tax)		=	$2,551,111	
Construction Management & Administration incl. Inspection	35%	=	$892,889.00	% Const Cost, provided by King County
Preliminary Engineering (Design) Cost	30%		$765,333.43	% Const Cost, provided by King County
ROW Costs (ROW management and administration, appraisals, acquisitions,		=	$24,000	3600SF of ROW take @ $2.30/SF, $15,750 in negotiation, statuatory and condemnation costs
TOTAL ESTIMATED PROJECT COST		=	**$4,234,000**	

Note: Estimated costs are in 2019 dollars. They are for planning purposes only.

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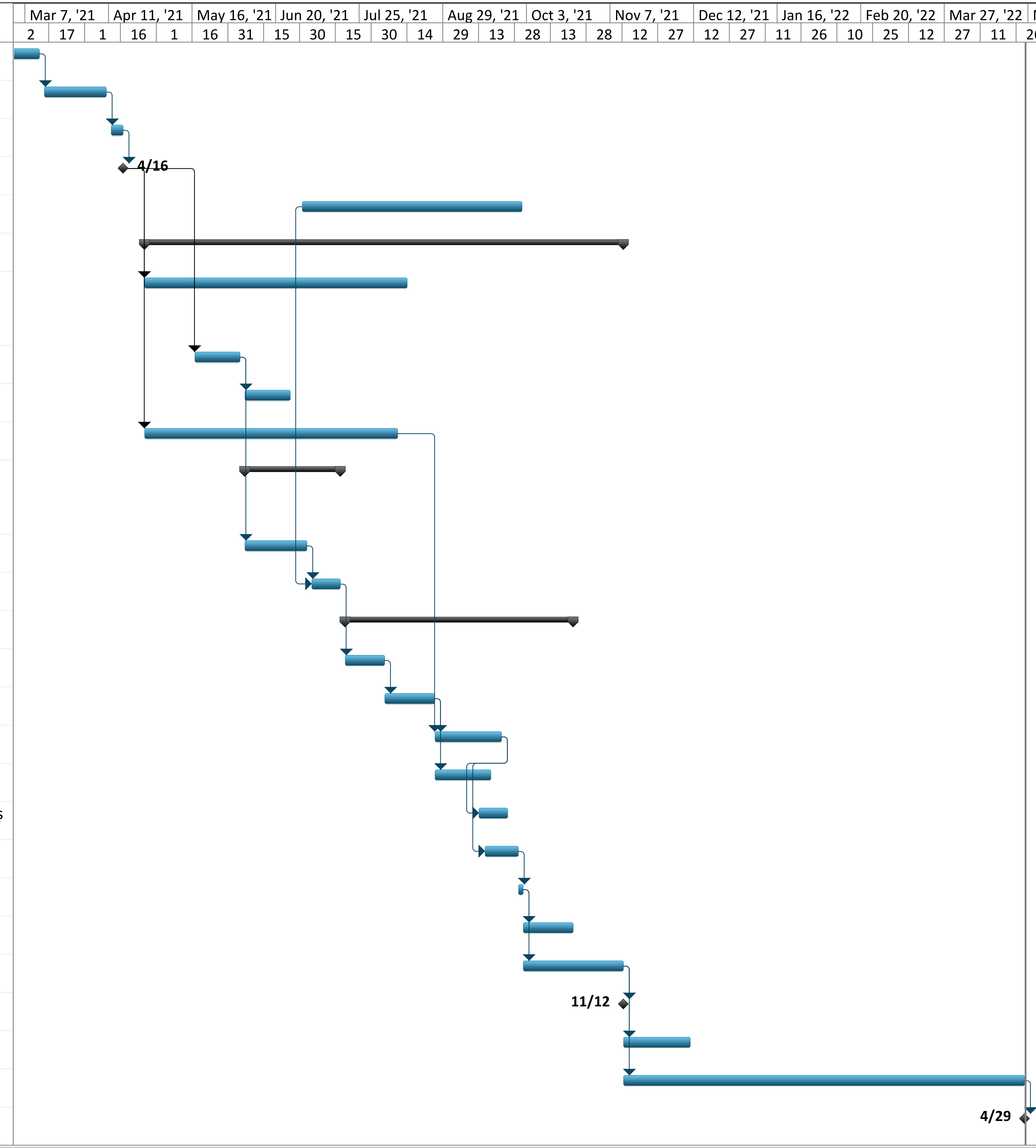
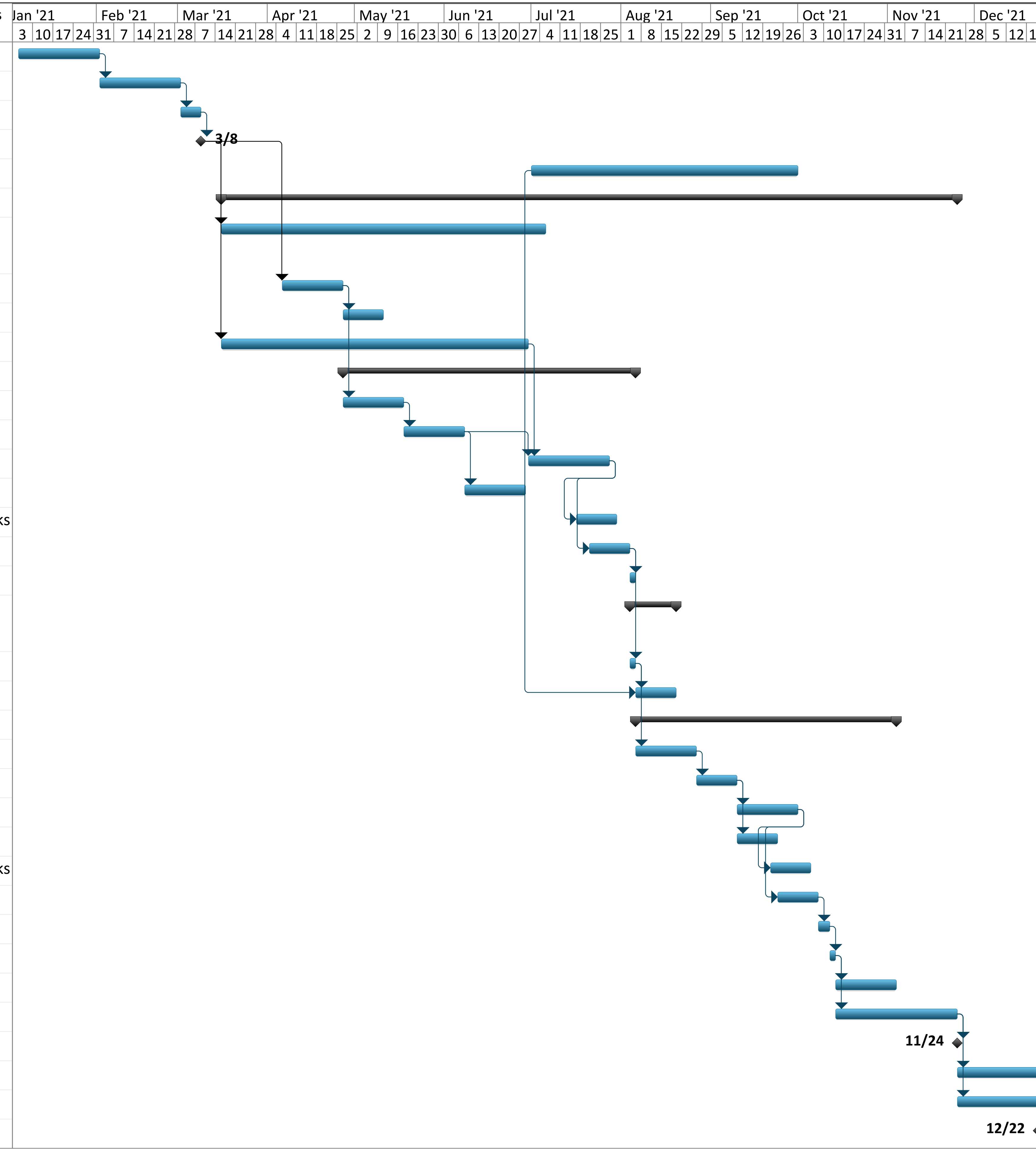
CONSTRUCTION SCHEDULE: ALTERNATIVES 1 & 2

ID	Task Name	Duration	Start	Finish	Predecessors
1	Advertise for Construction	1 mon	Mon 2/15/21	Fri 3/12/21	
2	Award Review	1 mon	Mon 3/15/21	Fri 4/9/21	1
3	County Approval of Award	5 days	Mon 4/12/21	Fri 4/16/21	2
4	Contract Award	0 days	Fri 4/16/21	Fri 4/16/21	3
5	**Fish Window**	66 days	Thu 7/1/21	Thu 9/30/21	
6	**Construction**	**144.5 day**	**Mon 4/26/21**	**Fri 11/12/21**	
7	Submittal and Document Preparation and Reviews	4 mons	Mon 4/26/21	Fri 8/13/21	4FS+1 wk
8	Mobilization	3 wks	Mon 5/17/21	Fri 6/4/21	4FS+1 mon
9	Site Prep and Utility Relocates	3 wks	Mon 6/7/21	Fri 6/25/21	8
10	Girder Fabrication	3.8 mons	Mon 4/26/21	Mon 8/9/21	4FS+1 wk
11	**Stage 1 - Install Single Lane Detour & Remove Exist Bridge**	**30 days**	**Mon 6/7/21**	**Fri 7/16/21**	
12	Install Detour Roadway & Bridge	20 days	Mon 6/7/21	Fri 7/2/21	8
13	Remove Existing Bridge	10 days	Mon 7/5/21	Fri 7/16/21	12,5SS
14	**Stage 2 - Construct Bridge**	**69.5 days**	**Mon 7/19/21**	**Fri 10/22/21**	
15	Shoring and Excavation	2.5 wks	Mon 7/19/21	Wed 8/4/21	13
16	Foundations	3 wks	Wed 8/4/21	Wed 8/25/21	15
17	Superstructure	4 wks	Wed 8/25/21	Wed 9/22/21	10,16
18	Roadway Approaches	3.5 wks	Wed 8/25/21	Fri 9/17/21	16
19	Approach Slabs	2 wks	Mon 9/13/21	Fri 9/24/21	17FS-1.5 wks
20	Barriers and Guardrails	2 wks	Wed 9/15/21	Wed 9/29/21	17FS-1 wk
21	Pavement	2 days	Wed 9/29/21	Fri 10/1/21	20
22	Site Restoration & Planting	15 days	Fri 10/1/21	Fri 10/22/21	21
23	Punchlist	6 wks	Fri 10/1/21	Fri 11/12/21	21
24	Construction Complete	0 days	Fri 11/12/21	Fri 11/12/21	23
25	Perform Load Rating	1 mon	Fri 11/12/21	Fri 12/10/21	23
26	Project Closeout	6 mons	Fri 11/12/21	Fri 4/29/22	23
27	*Project Complete*	0 days	Fri 4/29/22	Fri 4/29/22	26



CONSTRUCTION SCHEDULE: ALTERNATIVE 3

ID	Task Name	Duration	Start	Finish	Predecessors
1	Advertise for Construction	1 mon	Tue 1/5/21	Mon 2/1/21	
2	Award Review	1 mon	Tue 2/2/21	Mon 3/1/21	1
3	County Approval of Award	5 days	Tue 3/2/21	Mon 3/8/21	2
4	Contract Award	0 days	Mon 3/8/21	Mon 3/8/21	3
5	**Fish Window**	66 days	Thu 7/1/21	Thu 9/30/21	
6	**Construction**	**182 days**	**Tue 3/16/21**	**Wed 11/24/21**	
7	Submittal and Document Preparation and Reviews	4 mons	Tue 3/16/21	Mon 7/5/21	4FS+1 wk
8	Mobilization	3 wks	Tue 4/6/21	Mon 4/26/21	4FS+1 mon
9	Site Prep and Utility Relocates	2 wks	Tue 4/27/21	Mon 5/10/21	8
10	Girder Fabrication	3.8 mons	Tue 3/16/21	Tue 6/29/21	4FS+1 wk
11	**Stage 1 - Construct Phase 1 Bridge**	**73 days**	**Tue 4/27/21**	**Thu 8/5/21**	
12	Shoring and Excavation	3 wks	Tue 4/27/21	Mon 5/17/21	8
13	Foundations	3 wks	Tue 5/18/21	Mon 6/7/21	12
14	Superstructure	4 wks	Wed 6/30/21	Tue 7/27/21	10,13
15	Roadway Approaches	3 wks	Tue 6/8/21	Mon 6/28/21	13
16	Approach Slabs	2 wks	Fri 7/16/21	Fri 7/30/21	14FS-1.5 wks
17	Barriers and Guardrails	2 wks	Wed 7/21/21	Tue 8/3/21	14FS-1 wk
18	Pavement	2 days	Wed 8/4/21	Thu 8/5/21	17
19	**Stage 2 - Switch Detour and Remove Structure**	**12 days**	**Wed 8/4/21**	**Thu 8/19/21**	
20	***Switch traffic to New Bridge***	2 days	Wed 8/4/21	Thu 8/5/21	17
21	**Remove Existing Bridge**	**2 wks**	**Fri 8/6/21**	**Thu 8/19/21**	**20,5SS**
22	**Stage 3 - Construct Phase 2 Bridge**	**64 days**	**Fri 8/6/21**	**Wed 11/3/21**	
23	Shoring and Excavation	3 wks	Fri 8/6/21	Thu 8/26/21	20
24	Foundations	2 wks	Fri 8/27/21	Thu 9/9/21	23
25	Superstructure	3 wks	Fri 9/10/21	Thu 9/30/21	24
26	Roadway Approaches	2 wks	Fri 9/10/21	Thu 9/23/21	24
27	Approach Slabs	2 wks	Tue 9/21/21	Tue 10/5/21	25FS-1.5 wks
28	Barriers and Guardrails	2 wks	Fri 9/24/21	Thu 10/7/21	25FS-1 wk
29	Pavement	2 days	Fri 10/8/21	Mon 10/11/21	28
30	Remove Traffic Control	2 days	Tue 10/12/21	Wed 10/13/21	29
31	Site Restoration & Planting	15 days	Thu 10/14/21	Wed 11/3/21	30
32	Punchlist	6 wks	Thu 10/14/21	Wed 11/24/21	30
33	Construction Complete	0 days	Wed 11/24/21	Wed 11/24/21	32
34	Perform Load Rating	1 mon	Thu 11/25/21	Wed 12/22/21	32
35	Project Closeout	1 mon	Thu 11/25/21	Wed 12/22/21	32
36	***Project Complete***	0 days	Wed 12/22/21	Wed 12/22/21	35



Appendix D

Geotechnical Report

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King County

Geotechnical Investigation

Geotechnical Report
Coal Creek Bridge #3035A Replacement
SE Lake Walker Road (Near 320th Ave SE)
King County, Washington

February 6, 2019

Prepared By:

King County

Department of Local Services
Road Services Division
Materials Laboratory
155 Monroe Avenue NE, Bldg. D
Renton, WA 98056-4199

King County
Road Services Division
Materials Laboratory
Department of Local Services
RSD-TR-0100
155 Monroe Avenue Northeast, Building D
Renton, WA 98056-4199
www.metrokc.gov/roads

February 6, 2019

TO: Trinh Truong, P.E., Supervising Engineer, Bridge Operations, Engineering Services Section, King County DOT

VIA: Alan D. Corwin, P.E., Materials Engineer, Materials Laboratory, Utility and Materials Group, Engineering Services Section, King County DOT

FM: Doug Walters, P.E., Engineer III, Materials Laboratory,
Casey Wagner, Engineer II, Materials Laboratory
Utility and Materials Group, Engineering Services Section, King County DOT

RE: **Geotechnical Report**
Coal Creek Bridge #3035A Replacement
SE Lake Walker Road (Near 320th Ave SE)
King County, Washington

As requested, we have completed a geotechnical investigation for the planned Coal Creek Bridge #3035A Replacement Project.

This report characterizes soil and groundwater conditions and includes recommended seismic design parameters, an evaluation of liquefaction impacts, preliminary bridge foundation alternatives, and other design and construction considerations.

Should you have question, require clarification, or desire additional information, please contact Doug Walters (206-477-2112), Casey Wagner (206-477-1910), or Alan Corwin (206-477-1853) at your convenience.

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COAL CREEK BRIDGE #3035 REPLACEMENT
PROJECT NO. 1135997

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GEOTECHNICAL ENGINEERING REPORT
COAL CREEK BRIDGE #3035A REPLACEMENT

1.0 INTRODUCTION

1.1 Background

This report presents the results of our geotechnical investigation for the proposed replacement of Coal Creek Bridge #3035A. The purpose of this study is to evaluate the site-specific soil and groundwater conditions in order to provide geotechnical recommendations for the design and construction of the new bridge foundation, wing walls, and approach fills. Our work included drilling soil borings, performing laboratory testing of representative soil samples, developing general design and construction recommendations, and preparation of this report. Coal Creek Bridge #3035A is located on SE Lake Walker Road, approximately 400 feet east of the intersection with 320th Avenue SE, near the community of Cumberland in SE King County, Washington. The general location is shown on the Vicinity Map, Figure 1, at the conclusion of the text.

1.2 Project Setting

Coal Creek Bridge #3035A was built in 1958 and is generally aligned west-to-east. The superstructure is a two-lane single span bridge that is 41 feet long and 18 feet in width. The bridge is founded on timber piles driven to an unknown depth. The bridge abutment consists of timber piles with lagging. Bridge deficiencies include a restricted hydraulic opening, rotten backwall planks, deteriorated timber piles, widespread steel floor beam corrosion, and poor deck performance. The east and west fill approaches to the bridge are elevated about ten feet above the elevation of the original ground. The left bank (east bank) of Coal Creek in the area of the bridge is generally armored with riprap while the right bank surface is generally composed of river gravel and cobbles. Though scour appears to be minimal at the immediate bridge site, significant bank undermining from scour is occurring on the left bank downstream of the bridge.

2.0 SUBSURFACE CONDITIONS

2.1 Geologic Mapping

Online geologic mapping (scale 1:24,000) of the project area was accessed from the Washington State Department of Natural Resources (DNR) Subsurface Geology Portal and the United States Geologic Survey (USGS) databases. Geologic mapping indicates the surficial soils in the general site vicinity consist of the following:

Quaternary alluvium (Qal): Moderately sorted deposits of cobble gravel, pebbly sand, and sandy silt along major rivers and stream channels. Mapping indicates alluvium is the primary surficial deposit underlying the bridge site.

Quaternary mass-wasting deposits (Ql): Mass wasting is the geomorphic process by which soil and rock move downslope typically as a solid, continuous or discontinuous mass, largely under the force of gravity, but frequently with characteristics of a flow as in debris flows and mudflows.

Puget Group (Tp): Middle to late Eocene bedrock consisting of sedimentary bedrock of the Puget Group but also includes local outcrops of volcanic rock. In the Cumberland quadrangle, the sedimentary bedrock consists of arkosic and felspathic micaceous sandstone, siltstone, claystone, and coal. Exposures of Tp bedrock can be seen east of the project site on the uphill side of SE Lake Walker Road.

Intrusive Rock (Ti): Oligocene igneous rock consisting chiefly of porphrytic andesite and basalt in the Cumberland quadrangle. Exposures of Ti bedrock can be seen east of the project site on the uphill side of SE Lake Walker Road.

2.2 Subsurface Exploration

Subsurface conditions were explored by drilling one boring (B-1) west and two borings (B-2 and B-3) east of the existing bridge. Boring B-1 was drilled on July 11, 2018 to a depth of 43 feet below the ground surface (bgs). Boring B-2 was drilled on July 9, 2018 to a depth of 66.5 feet bgs and was completed as a groundwater monitoring well to a depth of 44 feet bgs. Boring B-3 was drilled on July 10, 2018 to a depth of 61.5 feet bgs.

The borings were drilled using a Geoprobe 8140LC Rotary Sonic Rig that allows for collection of almost continuous representative four-inch diameter disturbed soil samples. In addition, Standard Penetration Tests (SPT) were performed at 5.0-foot vertical intervals as the borings were advanced. The SPT provides a measure of compaction or relative density of granular soils, and consistency or stiffness of cohesive fine-grained soils. Disturbed but representative soil samples were collected at each testing interval and returned to our laboratory for testing and analysis. Approximate boring locations are shown in Figure 2. Detailed copies of the boring logs, along with laboratory test results, are provided in Appendix A.

Boring B-1

Boring B-1 was drilled on the west end of the bridge in the westbound travel lane. In B-1, 2 inches of asphalt concrete pavement (ACP) overlies loose to medium dense silty sand with gravel fill to a depth of 10 feet bgs. Within the fill, beginning at 5 feet bgs, a 2 foot diameter boulder was encountered. Below the fill, medium dense silty gravel with sand was observed to 13 feet bgs. From 13 feet to a depth of 30 feet, the soils consist of highly disturbed, medium dense to dense silty gravel to silty sand, scattered cobbles, occasional boulders, with intermittent coal debris (mass-wasting deposit?) to a depth of 30 feet. Below 30 feet, the soils consist of a medium dense silty gravel to silty sand with trace coal. At 37 feet, hard fine grained mafic bedrock was encountered to the termination depth of the boring at 43 feet bgs. Throughout the depth of exploration for boring B-1, the soil moisture content generally ranged from a wet to a saturated condition.

Boring B-2

Boring B-2 was drilled east of the bridge in the northern road shoulder. In B-2, the soils consist of loose to medium silty sand with gravel fill to a depth of 13 feet bgs. Below the fill, we encountered highly disturbed, medium dense to dense silty gravel with scattered cobbles and intermittent coal debris (mass-wasting deposit?) to a depth of 28 feet bgs. At 28 feet, the soils consist of medium dense poorly graded gravel with silt to silty gravel to a depth of 40 feet. Soils from 40 feet to 44 feet bgs consist of loose silty sand with gravel. At 44 feet, hard fine grained mafic bedrock was encountered to the termination depth of the boring at 66 feet bgs. Throughout the depth of exploration for boring B-2, the soil moisture content generally ranged from a wet to a saturated condition.

Boring B-3

Boring B-3 was drilled east of the bridge in the eastbound travel lane. In B-3, 2 inches of asphalt concrete pavement (ACP) overlies loose to medium dense silty sand with gravel fill to a depth of 13 feet bgs. Within the fill, beginning at 2.5 feet bgs, a 5.5 foot diameter boulder was encountered. Below the fill, the soils consist of highly disturbed, medium dense to dense silty gravel to silty sand with scattered cobbles and intermittent coal debris (mass-wasting deposit?) to a depth of 30 feet. Soils from 30 to 47 feet bgs consist of medium dense silty sand with gravel and scattered coal debris. At 47 feet bgs, a hard fine grained mafic bedrock was encountered to the termination depth of the boring at 61.5 feet. Throughout the depth of exploration for boring B-3, the soil moisture content generally ranged from a wet to a saturated condition.

2.3 Groundwater

In Boring B-1, groundwater was encountered during drilling at an approximate depth of 13.0 feet bgs. Groundwater was encountered while drilling Borings B-2 and B-3 at an approximate depth of 14.0 feet bgs.

A monitoring well was installed in Boring B-2 for monitoring ground water levels over time. The monitoring well consists of a two-inch inside diameter blank PVC pipe with 20-slot well screen. The 20-slot well screen, ten feet in length, is installed from 44 to 34 feet bgs. Blank PVC casing is installed above the screened well section to the original ground surface. The annular space around the screen is filled with a clean 10-20 uniform sand filter to a depth of about 31 feet bgs. The remaining depth to the near surface elevation is backfilled with bentonite chips and capped with redi-mix concrete. The well is protected with a flush mount protective steel covers. Monitoring Well B-2 is constructed in general accordance with the Washington State Department of Ecology (WSDOE) WAC 173-160 "Minimum Standards for Construction and Maintenance of Water Wells" and is identified by the WSDOE discrete well tag number ACB-345.

Measured groundwater depths to date for monitoring well B-2 are provided below in Table 1.

Table 1: B-2 Measured Groundwater Depths

Date	Water Depth Below Ground Surface (ft)	Estimated Groundwater Elevation (ft)
7/12/2018	12.18	886.7
9/5/2018	11.36	887.5
2/6/2019	10.15	888.7

3.0 HAZARD REVIEW

3.1 Seismic Hazard

An earthquake is a trembling motion caused by a sudden release of stress along a fault. Primary sources of earthquakes in the Puget Lowland include shallow, deep, and subduction-zone earthquakes. Shallow earthquakes occur within the North American Plate at depths of 6 to 15 miles below ground. One of the largest strong shallow earthquakes that occurred in the Pacific Northwest was the North Cascade Earthquake of 1872, estimated at a magnitude of 7.4.

Deep earthquakes are generated within the subducted Juan de Fuca plate and occur at depths of 24 to 36 miles below the ground and have estimated maximum magnitudes of 7.5. Three recent large deep earthquake events are the 7.1 magnitude Olympia Earthquake of 1949, the 6.5 magnitude Seattle-Tacoma Earthquake of 1965, and the 6.8 magnitude Nisqually earthquake in 2001. These three earthquakes ranged from 32 to 36 miles below the ground surface and caused considerable damage to roadways and structures.

Subduction zone earthquakes are caused by rupture between the subducting oceanic plate and the overlying continental plate. These earthquakes typically have a magnitude of up to 9 and a recurrence interval estimated at 500 years. The last large subduction zone earthquake in Washington is believed to have occurred about 300 years ago.

The King County Geographic Information Systems website (iMAP) indicates the site is located within a Seismic Hazard area. Hazard designations are described and defined in the King County Critical Area Ordinances (CAO) and regulated by King County Zoning Code 21A.24. Seismic Hazard areas are defined as sites being subject to severe risk of earthquake damage as a result of seismically induced settlement, soil liquefaction, and lateral spread.

Liquefaction occurs when loose, saturated granular soils such as fine sand and coarser silts lose their ability to support a load during a seismic event. The soils will actually flow like fluid, resulting in ground settlement and deformation. Factors controlling the development of liquefaction include seismic intensity and duration, soil characteristics, in situ stress conditions, and the depth to the groundwater. Some soil zones above the bedrock at this site may be at risk for liquefaction during the design earthquake event. Based on mapping provided in the Washington State Department of Natural Resources online geologic portal, the site is considered to have a low risk for liquefaction during the design earthquake event.

USGS has identified a number of active fault lines, or cracks, in the earth's crust in the central Puget Sound area. However, faults that could produce surface rupture are not mapped within the subject site. The two closest major mapped faults are the Seattle and Tacoma faults. Mapped lines associated with these faults are at least 20 miles from the site. In our opinion, the relative risk of fault rupture at the surface of the subject site are low.

3.2 Scour

Bridge scour is the removal of stream sediment from around bridge abutments or piers due to flowing water. Erosion of material from scour may compromise the structural integrity of a bridge founded on shallow foundations. Deep foundation systems such as driven piles or shafts are often utilized in bridge construction to lessen the risk potential from scour.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Seismic Site and Soil Parameters

The site and soil criteria used for foundation design recommendations provided in this report are in general conformance with the American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications, 8th Edition, November 2017, and the current Washington State Department of Transportation (WSDOT) Bridge Design Manual (BDM), M23-50. The seismic provisions of the AASHTO Manual are based on a design earthquake having a seven percent probability of exceedance within a 75-year period. An earthquake event with this probability of exceedance has a return period of about 975 years.

Spectra, developed by the WSDOT Bridge and Structures office, was used to generate the site specific design response spectrum, utilizing the USGS regional probabilistic ground motion seismic hazard maps, with updated site coefficients provided in the WSDOT BDM. The seismic hazard maps were developed for AASHTO Site Class B. Based on the underlying soil profile, we determined the site is characterized most closely with AASHTO Site Class D. WSDOT BDM site coefficients for Site Class D have been utilized to adjust the mapped peak ground acceleration (PGA), and spectral acceleration coefficients S_s and S_1, as shown below in Table 2.

Table 2: Seismic Design Parameters

Seismic Item	Symbol	Value	Reference
Site Coordinates	N/A	Latitude = 47.268° N Longitude = 121.915° W	USGS Earthquake Hazards Website (USGS EHW)
Site Class	SC	D	AASHTO Table 3.10.3.1-1
Peak Ground Acceleration	PGA	0.340 g (Site Class B)	Spectra
Spectral Acceleration Coefficient (Short Period-0.2 sec)	S_s	0.769 g (Site Class B)	Spectra
Spectral Acceleration Coefficient (Long Period-1.0 sec)	S_1	0.223 g (Site Class B)	Spectra
Zero Period Site Factor	F_{pga}	1.260 (Site Class D)	Spectra
Short Period Site Factor (Short Period-0.2 sec)	F_a	1.192 (Site Class D)	Spectra
Long Period Site Factor (Long Period-1.0 sec)	F_v	2.154 (Site Class D)	Spectra
Zero Period Spectral Response Acceleration	A_s	0.428 g (Site Class D)	Spectra/AASHTO Equation 3.10.4.2-2
Short Period Spectral Response Acceleration (Short Period-0.2 sec)	S_{DS}	0.917 g (Site Class D)	Spectra/AASHTO Equation 3.10.4.2-3
Long Period Spectral Response Acceleration (Long Period-1.0 sec)	S_{D1}	0.480 g (Site Class D)	Spectra/AASHTO Equation 3.10.4.2-6
Seismic Design Category	SDC	C	AASHTO Table 3.5-1

4.2 Liquefaction and Settlement Potential

Using the results of our subsurface exploration, limited laboratory testing, and site specific ground response, we have estimated the impacts of liquefaction and liquefaction induced settlement of the proposed bridge approaches and structure foundations. We evaluated the liquefaction potential at all three boring locations utilizing the computer program Liquefy Pro, developed by Civiltech, Inc. Liquefy Pro calculates the soil susceptibility to liquefaction based on the simplified empirical procedure of Seed and Idriss (1971) with modifications described in NCEER Technical Report 97-0022.

The liquefaction and seismically induced settlement potential was estimated for ground motions with return periods of approximately 975 years. Modeling indicates the loose to medium dense silty sand soils found between about 35 to 44 feet below the ground surface may liquefy if subject to ground shaking associated with a 975-year earthquake design event. Total settlement is estimated to range from 0.5 to 1.1 inches with anticipated differential settlements of 0.5 to 1.1 inches. Due to the depth and minimal extent of the liquefiable soils, we do not anticipate lateral spreading or flow will be an issue for foundation design. The results of the liquefaction analyses are shown on Plates B-1 and B-2 in Appendix B, as plots of safety factor against liquefaction versus depth for the design event.

4.3 Bridge Foundation Alternatives

Based on our subsurface investigation, soils at the subject site generally consists of medium dense to dense cohesionless soils that range in depth from 38 to 47 feet below the ground surface. Bedrock underlies the soils. We understand scour is not an issue and liquefaction induced total settlement is estimated to range from 0.5 to 1.1 inches. Based on the soil and site conditions, a shallow foundation system utilizing Geosynthetic Reinforced Soil (GRS) abutment or spread footings may be feasible. If the noted liquefaction settlement is considered unacceptable for a shallow foundation, a deep foundation such as driven piles may need to be utilized. Based on our evaluation of the site conditions, geotechnical design parameters for GRS abutments, spread footings, and driven piles are provided in Sections 4.4, 4.5, and 4.6 respectively.

4.4 Geosynthetic Reinforced Soil Abutment

The Geosynthetic Reinforced Soil (GRS) bridge abutment consists of alternating layers of compacted granular fill and geosynthetic reinforcement. In our opinion, due to the flexibility of the system, the GRS abutment would better accomadate liquefaction induced settlement than a shallow concrete foundation. The primary reinforcement spacing in GRS systems is less than or equal to12 inches. For bridge abutments, facing elements can be frictionally connected to the reinforcement layers to form the abutment face and wing walls. The method and material for construction are generally non-proprietary with the most common block consisting of split face concrete masonry units.

4.4.1 Design

We utilized the June 2018 Federal Highway Administration *Design and Construction Guidelines for Geosynthetic Reinforced Soil Abutments and Integrated Bridge Systems* (NO. FHWA-HRT-17-080) for guidance in the preliminary GRS bridge abutment design. AASHTO LRFD Bridge Design Specifications defines the various load factors and combinations that need to be considered in the design of the bridge. Resistance factors for mechanically stabilized earth structures provided by AASHTO are also adopted and utilized for the GRS design. The preliminary design is based on a proposed single span bridge that is 70 feet in length and 30 feet in width. Preliminary dead and live loads provided for the Service 1 State superstructure are 600 kips/abutment and 220 kips/abutment respectively. Our preliminary design utilized the minimum geotextile ultimate tensile strength of 4800 lb/ft allowed for design of bridge abutments, based on ASTM D4595 "Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method." For your reference, a plan of the Preliminary GRS Abutment Design (Figure C-1) is provided in Appendix C.

4.4.2 GRS Foundation and Backfill

The initial excavation for the GRS bridge foundation is anticipated to be below the water table. In cases where the excavation is below the water table, the contractor should have readily available sump pumps, well points, or other appropriate equipment to adequately dewater the excavation. To help provide bearing width and prevent stream water from scouring the GRS abutment and wing walls, a reinforced soil foundation (RSF) will be placed at the bottom of the excavation. The RSF is composed of granular fill material that is compacted and encapsulated within a geotextile fabric.

Once the RSF has been completed, placement of soil, geotextile and block facing for the GRS abutment can take place. For backfill of the GRS abutment, FHWA-HRT-11-026 recommends utilizing clean crushed backfill for the reinforced zone. Therefore, we recommend using "Crushed Surfacing Base Course" as specified in Section 9-03.9(3) of the current WSDOT Standard Specifications. The backfill is to be placed in loose lifts not exceeding six inches and compacted as specified in Section 2-03.3(14)1 of the current WSDOT Standard Specifications. Other clean angular structural backfill for the GRS abutment may be acceptable and can be evaluated if requested as the design progresses.

The long-term stability of the GRS abutment depends on the proper foundation preparation, correct placement and embedment of the geotextile, and suitable compaction of the backfill material. We recommend having a representative of the Materials Laboratory onsite during construction to provide quality control testing and inspection of the foundation preparation, geotextile placement, and material backfill. This includes field density testing of soil and aggregate backfill compaction.

4.4.3 Scour

Consideration and analysis of potential scour is critical to long term stability of the GRS Bridge abutment. If scour is determined to be a potential issue, countermeasures must be designed for the system to prevent scour of the bridge abutments and river channel. After construction, scour countermeasure condition and channel instability should be assessed during each regular bridge inspection and after extreme flood events. Any countermeasure failure or significant change in channel condition should be noted and scheduled for repair or stabilization. Without proper inspection and maintenance, a scour countermeasure may fail or a channel may become unstable, which can lead to undermining of the abutment and bridge failure.

4.5 Bridge Abutment and Wing Wall Design

4.5.1 Bearing Capacity

Based on the results of the subsurface investigation, spread footing foundations may be utilized for the bridge abutments and wing walls as long as they are founded in at least medium dense native sand and gravel or structural fill overlying the medium dense to dense native sand and gravel. The estimated depth to these bearing soils will be approximately 10 feet below the road surface. Unfactored strength and extreme limit nominal bearing capacities, and service limit state bearing capacity at 0.5 inch settlement, are provided in Table 3 for a spread footing foundation with a minimum footing width of 4 feet. As the design progresses, we can provide bearing capacities for dimensions of individual footings when needed.

Table 3: Shallow Foundation Design Recommendations

Parameter	Value
Unfactored Strength and Extreme Limit Nominal Bearing Capacities	10,500 psf
Strength Limit State Bearing Capacity Resistance Factor	0.45
Extreme Limit State Bearing Capacity Resistance Factor	1.0
Service Limit State Bearing Capacity at 0.5-inch Settlement	4,000 psf
Service Limit State Bearing Capacity Resistance Factor	1.0
Strength Limit Precast Concrete Placed on Sand Sliding Resistance Factor	0.9
Strength Limit Cast-in-Place Concrete on Sand Sliding Resistance Factor	0.8
Minimum Footing Embedment Depth	2.0 feet

4.5.2 Active and At-Rest Lateral Earth Pressure: Static Condition

Bridge abutment back walls and wing walls may be needed on this project to support roadway embankment fills. Based on an active earth pressure coefficient (K_a) of 0.27, we recommend using an active lateral earth pressure of 35H pounds per square foot (psf) for the design of walls, if the top of the structure is free to rotate outward a minimum of 0.001 H, where H is the height of the structure in feet. If the top of the structure is restrained from lateral movement, we recommend utilizing an at-rest lateral earth pressure of 55H psf derived from an at-rest earth pressure coefficient (K_o) of 0.43.

The above lateral earth pressures are based on level backslope conditions. In addition, the backfill is assumed to be a well drained granular soil that is placed and compacted in accordance with Section 2-09.3(1)E of the current WSDOT Standards. Any additional fill placed above the structure and traffic surcharge loading should be included in the design.

4.5.3 Lateral Passive Earth Pressure: Static Condition

Lateral loads for wall design can be offset by passive resistance from buried structural elements bearing against competent native soils or compacted structural fill. However, soil resistance from scour or erosion susceptible soils must not be included in the design. Based on a passive earth pressure coefficient (K_p) of 3.69, static passive resistance may be evaluated using a lateral passive earth pressure of 460D psf, where D is the depth of wall embedment for sidewalls cast neat against undisturbed native soil or structural fill.

At the strength limit state, a passive earth pressure component of sliding resistance factor of 0.45 can be applied to the above noted passive earth pressure. For the service and extreme event limit conditions, a resistance factor of 1.0 should be applied. The noted passive resistance is based on the assumption that competent native soil or compacted structural fill extends laterally beyond the structural element a distance equal to at least twice the height of the structure. If the soils do not extend the required lateral distance, the passive resistance should be ignored when evaluating the lateral resistance to movement.

Passive resistance develops from lateral displacement of the structural element. The movement required to generate ultimate passive resistance is a function of the type of soil bearing against the buried sections of the structural elements. Structural elements bearing against undisturbed native soils or well compacted structural fill must move a minimum of 0.02H, to generate 100 percent of the passive pressure, where H is the height in feet of the buried structural member.

4.5.4 Active and At-Rest Lateral Earth Pressure: Seismic Condition

In addition to inertia forces from the structure, earthquake ground shaking will induce dynamic earth pressures on all walls. Based on an active seismic earth pressure coefficient (K_{ae}) of 0.407, for walls supporting granular structural fill, we recommend using a dynamic active earth pressure increment (K_{ae}-K_a) of 17H psf, where H is the wall height in feet. This pressure will act uniformly over the height of the wall. It should be noted that this incremental pressure is in addition to the static earth pressure discussed previously. If, however, the walls are not free to rotate outward, based on an at-rest seismic earth pressure coefficient (K_{ae}) of 0.619, the dynamic earth pressure increment (K_{ae}-K_o) will be about 24H psf. These values are based on the assumption that level ground conditions are present at the top and base of the walls.

4.5.5 Lateral Passive Earth Pressure: Seismic Condition

Earthquake lateral loading will be partially resisted by soil friction along the base of footings and by passive earth pressures acting against buried sidewalls. Provided the resisting soils are not susceptible to erosion or river scour, the resistance of the passive soil pressures in an earthquake, based on a seismic passive earth pressure coefficient (K_{pe}) of 2.8, may be calculated assuming a seismic passive earth pressure of 350D psf. This full passive resistance will only be mobilized if the wall moves laterally a sufficient distance as described previously for the static lateral earth pressure conditions. The noted value is based on the assumption that level ground conditions are present at the top and base of the walls.

4.5.6 Dynamic Shear Modulus and Poisson's Ratio

The dynamic response of the bridge abutment footings can be modeled using the stiffness matrix method. Typically, the solution for a rigid circular footing placed on the surface of an elastic half space provides the basic stiffness coefficients for the various modes of foundation displacement (translation, rotation, and rocking). In order to complete the analysis, the dynamic shear modulus and Poisson's Ratio of the foundation soil must be estimated.

For this site, the abutment footings will bear on generally dense poorly graded gravel and sand. For preliminary design purposes, we recommend a maximum (low stain) shear modulus (G_o) of 20 kips per square inch (ksi) and associated Poisson Ratio of 0.35.

Table 6-3 of the Washington State Department of Transportation Geotechnical Design Manual provides high strain reduction values for shear Modulus (G) based on site class and effective peak ground acceleration (PGA x Fpga). For Site Class D and effective Peak Ground Acceleration of 0.428 g, a high strain shear modulus value (G) of 10 ksi can be used for design.

4.5.7 Scour

Consideration and analysis of potential scour is critical to long term stability of the spread footing bridge abutments. If scour is determined to be a potential issue, countermeasures must be designed for the system to prevent scour of the bridge abutments and river channel. After construction, scour countermeasure condition and channel instability should be assessed during each regular bridge inspection and after extreme flood events. Any countermeasure failure or significant change in channel condition should be noted and scheduled for repair or stabilization. Without proper inspection and maintenance, a scour countermeasure may fail or a channel may become unstable, which can lead to undermining of the abutments and bridge failure.

4.6 Driven H-pile

If the anticipated level of settlement appears excessive for a shallow foundation, driven H-piles could be utilized as a deep foundation system for support of the bridge. H-pile foundations are adaptable for staged construction, install relatively quickly, and are easily spliced for increased driving length if unanticipated soil conditions are encountered. At this site, the piles would be driven to the depth of bedrock, anticipated to range from 24 to 30 feet below the estimated bottom of pile cap elevation. Given the soils overlying the bedrock consist of alluvial soils and debris flow deposits, obstructions are a major concern during driving. Large boulders several feet in diameter were encountered in borings B-1 and B-3 at 5 ft bgs and 2.5 ft bgs respectively.

Typical H-pile types recommended for this bridge foundation would be minimum HP12X74 or HP14X89, dependent on the factored axial load requirements, including downdrag load. The piles will be driven through dense gravel zones with cobbles to reach the bedrock surface. Obstructions such as boulders may be encountered at any time during pile driving. The contractor should be prepared to remove shallow obstructions or penetrate through deeper obstructions, if encountered. In addition, it may be necessary to shift the location of certain piles to reach the design depth. Consequently, provisions to alter the size of the pile cap to accommodate shifted pile locations may be necessary at time of construction. All piles must equipped with driving shoes/tips to reduce the potential for damage to the piles during installation.

Given the limited depth to bedrock, lateral stability for the bridge foundation may be an issue. In addition, though we were able to drill into the bedrock with the sonic drill, we were unable to fully characterize the competency and compressive strength of the bedrock. Therefore, if driven H-piles are chosen as the preferred alternative, additional coring and testing of the bedrock will be required in order to finalize the design and construction requirements.

4.6.1 Nominal Pile Capacity

In accordance with AASHTO LRFD Article 10.7.3.2.3, nominal axial compressive resistance of piles driven to hard rock is typically controlled by the structural pile resistance. A geotechnical resistance factor of 0.50 is applied as specified in AASHTO Article 6.5.4.2 for axial resistance of piles subject to damage due to severe driving conditions. All piles should be spaced no closer than three pile diameters, center to center.

Pile axial capacity estimates, including downdrag load, for two different 50 ksi H-pile sections are provided in Table 4. Separate estimates are provided for both abutments due to the differing soil conditions between KCB-1 and KCB-2. The actual bridge location, length, and alignment have not been completed to date. The values provided are for preliminary design purposes only.

Table 4: Pile Axial Capacity Estimates

Boring No.	Pile Type	Pile Length (ft)	Structural Compression Resistance (kips)		Liquefaction Induced Down-Drag (kips)
			Nominal	Factored	
KCB-1	HP12X74	24	1090	545	64
	HP14X89	24	1305	652	80
KCB-2	HP12X74	30	1090	545	92
	HP14X89	30	1305	652	115

Notes:
1) Pile length estimates assume the bottom of pile cap is 14 feet below the current road grade.
2) Pile length is embedment below pile cap to top of bedrock surface.
3) Factored Resistance = Area pile tip x Fy x ϕ

4.6.2 Ground Vibrations from Pile Driving

Private residences all located in proximity to the bridge project. If pile foundations are selected for final design, pre-construction surveys should be completed to identify and document the condition and signs of existing distress to nearby structures. Typically, surveys would be completed for structures within a 500 foot radius of pile installation locations. In addition, wells and septic systems within a 500 foot radius should be identified and inspected prior to and following pile driving operations.

4.6.3 L-Pile Parameters for Piles Subjected to Lateral Loads

The L-Pile (Reese, Wang, et.al, 2004) computer program is commonly used to analyze the behavior of driven piles subjected to lateral loads. Table 5 on the following page, provides geotechnical design parameters for use with the L-Pile program under static and simulated earthquake loading conditions. For preliminary design estimates, we are assuming piles will be driven to refusal at the top of the bedrock.

Table 5: Coal Creek Bridge #3035A Bridge L-Pile Parameters											
Boring No.	Top Layer Elevation (ft)	Bottom Layer Elevation (ft)	Soil Type	Effective Unit Weight (pcf)	Cohesion (psf)		Friction Angle (degrees)		Modulus of Subgrade Reaction (pci)		E_{50}
					Static	Seismic	Static	Seismic	Static	Seismic	
KCB-1	883	875	Sand	68	0	0	38	38	125	125	---
	875	867	Sand	68	0	0	35	35	110	110	0
	867	862	Sand	63	0	400	32	0	60	30	0.02
	862	859	Sand	63	0	0	32	32	60	60	0
KCB-2	885	859	Sand	68	0	0	38	38	125	125	---
	859	855	Sand	58	0	200	30	0	40	20	0.02

Notes:

1) *The profile provided is referenced from the assumed bottom of the pile cap, 14 feet below the existing road grade.*
2) *Piles are assumed to terminate at the bedrock contact, values not provided*
3) *pcf = pounds per cubic foot*
4) *psf = pounds per square foot*
5) *pci = pounds per cubic inch*
6) *Values provided are for single piles only. Reduction factors for group effects may apply.*

4.7 Bridge Approach Slabs

We recommend bridge approach slabs be required for this project in order to reduce local and long term settlement associated with the underlying approach road fills and the bridge deck. The bridge approach slabs shall be designed in accordance with Section 10.6 of the current WSDOT Bridge Design Manual.

4.8 Construction Considerations

4.8.1 Earthwork/Temporary Excavation Slopes

Based on our subsurface borings and understanding of the project, in our opinion, the contractor should be able to complete site earthwork with standard construction equipment. Prior to beginning of earthwork activities, appropriate erosion and sedimentation control measures should be implemented in accordance with the local best management practices (BMPs). Uncontrolled fill soils and possible boulders may be encountered during excavation for the GRS foundation or pile cap. Therefore, the contractor will need to plan for boulder mitigation if encountered.

Excavations can be cut back to temporary slopes no steeper than 1.5(H):1(V) as described for Type C soils by WAC 296-155-66503, Appendix B. Further flattening or possible shoring may be required based on the soils conditions observed during construction. Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. All temporary cuts in excess of 4 feet should be sloped in accordance with WAC 296-155. The stability of temporary cuts can be reduced over time by the presence of moisture or vibration. Therefore, the contractor will need to perform ongoing monitoring of temporary slopes and take the necessary steps to ensure their stability throughout the life of the project. Additional care should be exercised when operating heavy equipment within 5 feet from the top of temporary cut slopes. The slope toe for any stockpiled materials should be a minimum of 2 feet away from the top of the excavation.

4.8.2 Construction Dewatering

Dewatering of the site will be the responsibility of the contractor. Even with successful diversion of surface water flows, groundwater levels may be above the depth of excavation required for the placement of the GRS foundations or pile caps. In order to facilitate construction, minimize disturbance to exposed foundation subgrades, and maintain stability of the excavation, additional dewatering may be necessary. The bid documents should indicate that installation of sheet piling, well points, sumps or other methods of controlling water may be required. The contractor should be required to submit a dewatering plan detailing their proposed methods for collection, management, storage and disposal of surface water and groundwater.

4.8.3 Subsurface Drainage and Backfill for Walls

We generally recommend providing positive drainage behind conventional structural walls to control potential hydrostatic pressure. The drain system is typically placed near the base of the wall. In a stream environment, drainage systems placed at or below the median stream elevation are generally not needed as the hydrostatic pressures are considered to be in equilibrium. We recommend, however, that a drainage system or weep holes be installed behind exposed walls above the median stream elevation. If the exposed wall height is minimal, the drainage system may prove to be ineffective and could be eliminated. We recommend that this issue be addressed when the configuration of wall heights and their relationship to stream elevation are more defined.

After the bridge abutments are installed, the excavation should be backfilled for a minimum distance of 5 feet behind the abutments with “Gravel Backfill for Walls”. The backfill is to be placed and compacted in accordance with Section 2-09.3(1)E of the WSDOT Standards. Care should be exercised with respect to construction coordination/scheduling to protect the new structure from displacement or undue stresses resulting from backfill operations. Additionally, when opposite sides of structural elements are to receive backfill, the materials should be placed simultaneously and maintained at approximately the same elevation on all sides as the work progresses.

4.8.4 Roadway Embankment Construction

We recommend all permanent embankments be graded at 2H:1V or flatter. Where permanent slopes of embankments cannot be practically graded at 2H:1V or flatter, reinforced slopes or retaining walls will be required. Depending on the final alignment of the bridge and associated roadway, retaining walls may also be needed due to right-of-way restrictions or to limit possible encroachment into sensitive areas.

Gravel Borrow meeting the requirements of WSDOT 9-03.14(1) should be used to construct bridge approach embankments. The Gravel Borrow fill shall be placed by terracing into the excavation slopes. Maximum lift thickness, minimum compaction levels and soil moisture content should be as specified by WSDOT 2-03.3(14)C – Method C.

4.9 Hot Mix Asphalt (HMA) Pavement Section

Prior to paving, the completed roadway subgrade shall be in a firm and unyielding condition as demonstrated by proof-rolling with heavy equipment and verified by a representative from our office. All materials used for the HMA pavement section shall meet current WSDOT Standard Specifications.

Placement and compaction of HMA should be in accordance with Section 5-04 of the WSDOT Standard Specifications. However, HMA should be compacted to a minimum of 92 percent of the maximum theoretical density as determined by King County Materials Laboratory (KCML) Test Method N-1. Properties of the HMA mix design should be in accordance with WSDOT 9-03.8(2) for Equivalent Single Axle Load (ESAL) value of 300,000.

After the subgrade has been approved, proper placement of the following pavement design section will provide for long-term pavement performance and support of future traffic loads:

- 0.25' minimum compacted depth HMA, Class ½", PG 64-22 (Wearing Course)
- 0.25' minimum compacted depth HMA, Class ½", PG 64-22 (Leveling Course)
- 0.50' minimum compacted depth Crushed Surfacing Base Course (CSBC)

5.0 CONTINUING GEOTECHNICAL SERVICES

As the design develops, when needed, we are available to provide additional geotechnical design and construction recommendations for specific aspects of the project.

We appreciate the opportunity to have been of service on this project and trust this report addresses your current needs. Should you have question, require clarification, or desire additional information, please contact Doug Walters (206-477-2112), Casey Wagner (206-477-1910), or Alan Corwin (206-477-1853) at your convenience.

Sincerely,
King County Materials Laboratory

Alan D. Corwin, P.E.
King County Materials Engineer

<u>Attachments</u>
Figure 1 – Vicinity Map
Figure 2 – Boring Location Map

<u>Appendices</u>
Appendix A – Boring Logs and Laboratory Test Results
Appendix B – Liquefaction Analysis

6.0 REFERENCES

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Washington State Department of Natural Resources. *Washington Interactive Geologic Map*. Available on the web at https://fortress.wa.gov/dnr/protectiongis/geology/?Theme=wigm.

Washington State Department of Transportation, 1996, Bridge Design Manual, M23-50, 2018.

Washington State Department of Transportation, *Geotechnical Design Manual M46-03.11,* 2015.

Washington State Department of Transportation, *Standard Specifications for Road, Bridge, and Municipal Construction, M41-10,* 2018

Washington State Department of Transportation, Richard Brice, P.E., BridgeLink, Version 1.1.8.0(x64), *Spectra*

Figure 1: Vicinity Map

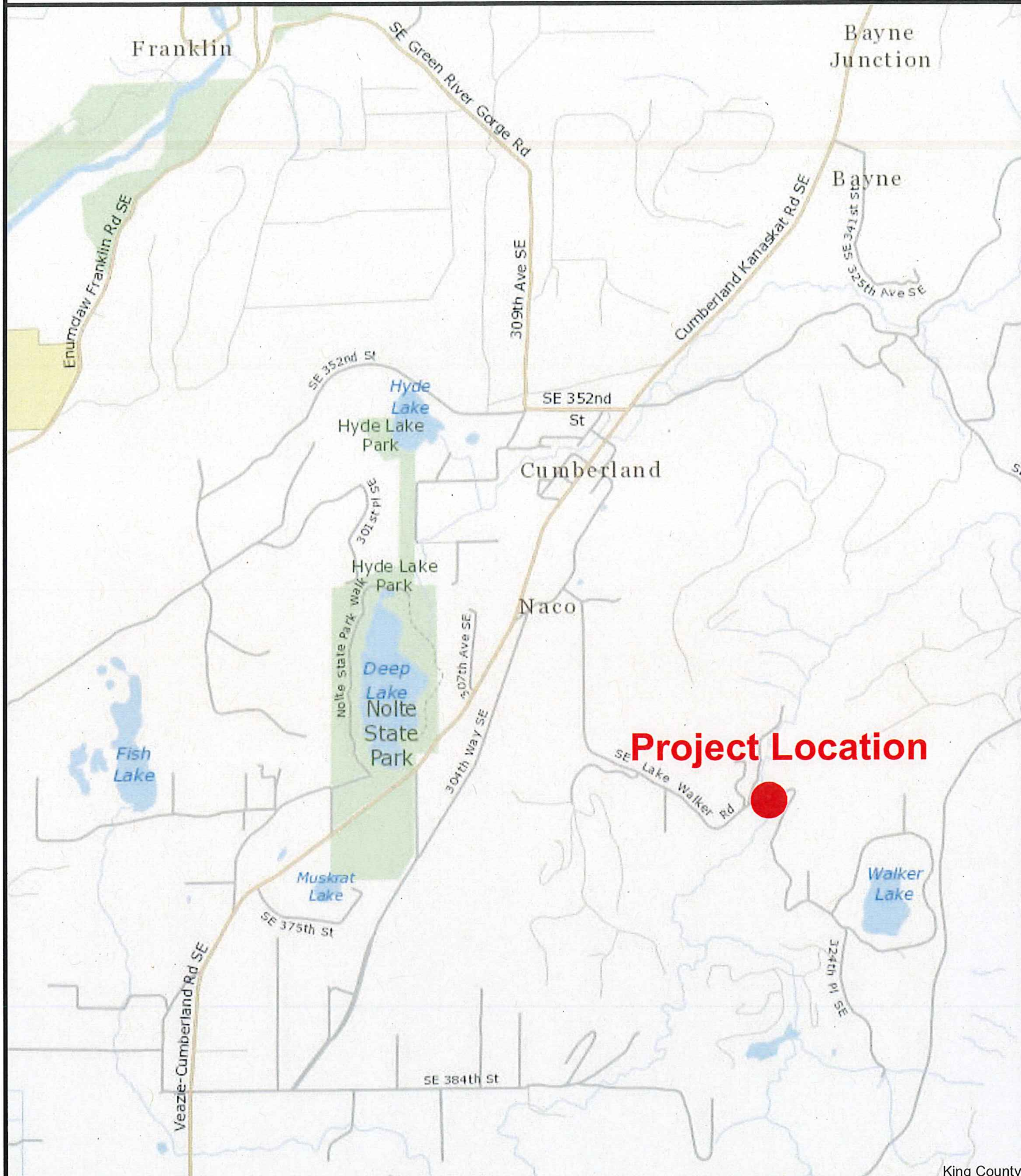

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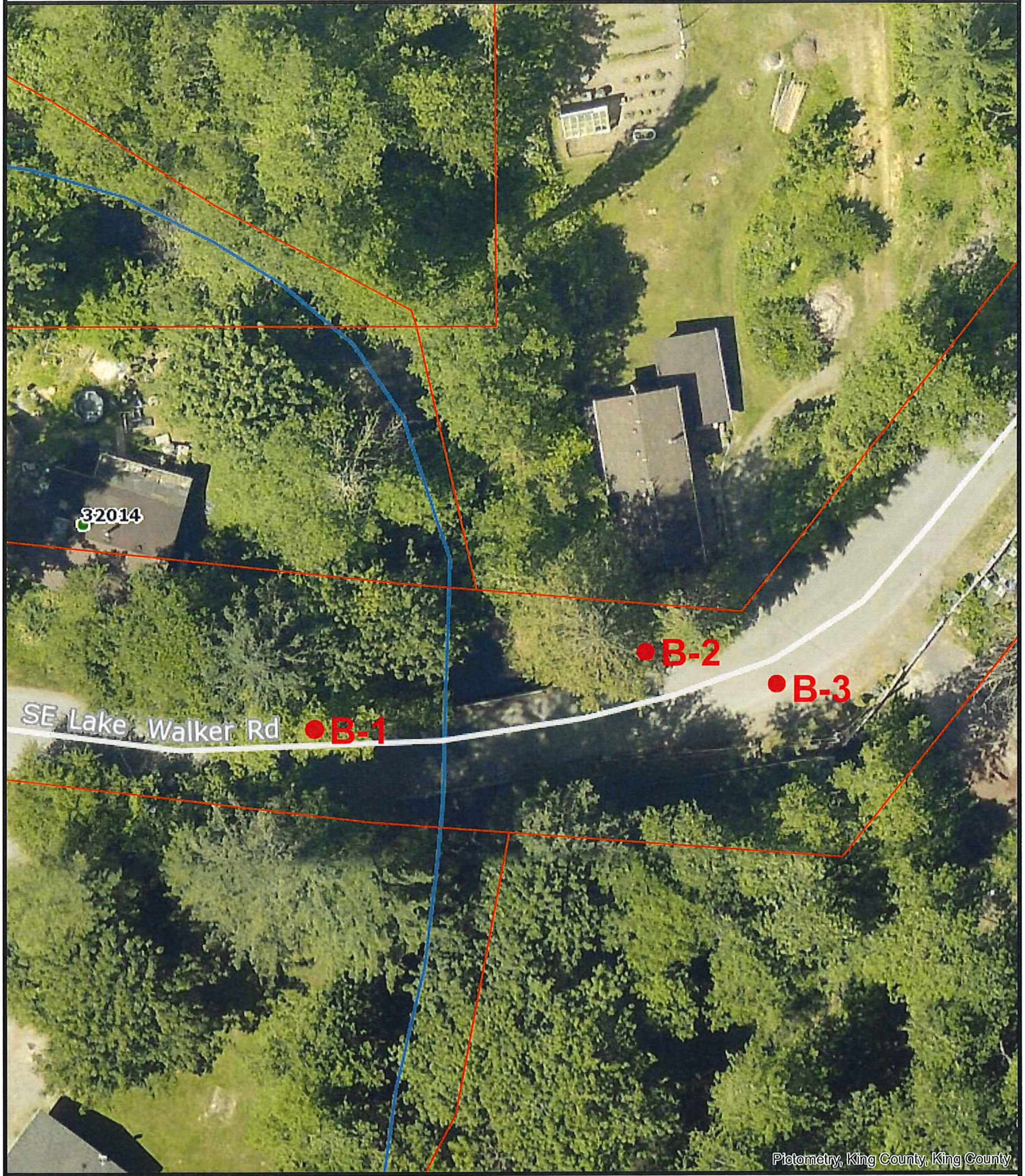
Figure 2: Boring Locations



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APPENDIX A
GEOTECHNICAL ENGINEERING REPORT
COAL CREEK BRIDGE #3035A REPLACEMENT

BORING LOGS
FIGURE A-1: B-1
FIGURE A-2: B-2
FIGURE A-3: B-3
FIGURE A-4: LEGEND

LABORATORY TESTS
FIGURE A-5 & A-6: TEST RESULTS B-1
FIGURES A-7 & A-8: TEST RESULTS B-2
FIGURES A-9 & A-10: TEST RESULTS B-3

LOG OF BORING

BORING B-1

PROJECT: **Coal Creek Bridge Replacement**
BORING LOCATION: **See Attached Location Map**
DRILL METHOD: **Sonic Drill**
DRILLER: **Holocene**
DEPTH TO - Water: **13'** Caving: **N/A**

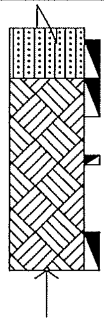
DATE: **7/11/18**
START: **N/A**
FINISH: **N/A**
LOGGER: **Casey Wagner**
DATE CHECKED: **7/11/18**

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
0		SM	Asphalt 2" Dark brown silty sand with gravel, intermittent iron staining and cobbles, moist, loose to medium dense (fill).			
5 / 895	50/6"	ROCK	Boulder			
890		SM	Brown silty sand with gravel, 2" seam of red rock/brick, trace iron staining and charcoal/coal, moist, medium dense (fill).			
10 / 885	8,12,13	GP-GM	Brown silty gravel with sand, trace iron staining, wet, medium dense.			
15 / 880	25,17,18	GM	Brown to gray silty gravel with sand, intermittent intermixed coal debris, highly disturbed, saturated, medium dense.	10.7	15.1	
20	14,13,32					10" Recovery
875 / 25	10,19,23	SM	Brown to gray silty sand with gravel, intermittent intermixed coal debris, occasional boulders, highly disturbed, wet, dense.	19.2	20.8	
						16" Recovery
870				12.0	29.2	
30 / 865	10,8,13	GM	Gray silty gravel with sand, scattered coal, wet, medium dense.	11.0	14.3	
35	10,9,11	SM	Gray silty sand with scattered gravel, wet,			13" Recovery

Boring B-1 was drilled in the eastbound travel lane, 6' west of the existing bridge deck, and 6' north of the road centerline. Groundwater was observed during drilling at approximately 13' below the ground surface.

Figure A-1

LOG OF BORING
BORING B-1
(continued)

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
860			medium dense.			
40	50/1"	ROCK	Dark gray extrusive igneous bedrock, fine grained crystalline structure chiefly composed of pyroxene, fresh, hard.			No Recovery
855						
			Boring Terminated			
45						
850						
50						
845						
55						
840						
60						
835						
65						
830						
70						
825						
75						
820						
80						

LOG OF MONITOR WELL INSTALLATION

WELL NO. B-2

PROJECT: **Coal Creek Bridge Replacement**
BORING LOCATION: **See Attached Location Map**
DRILL METHOD: **Sonic Drill**
DRILLER: **Holocene**
DEPTH TO - Water: **14'**

DATE: **7/9/18**
START: **N/A**
FINISH: **N/A**
LOGGER: **Casey Wagner**
DATE CHECKED: **7/11/18**

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks	Monitor Well Construction Schematic
0		SM	Brown silty sand with gravel, intermittent iron staining and cobbles, moist, medium dense (fill)..				
895 / 5	11,23,14					11" Recpvery	
890 / 10	11,8,34					15" Recovery	
885		GM	Brown to gray silty gravel with sand, intermittent intermixed coal debris, trace organics, slight iron staining, highly disturbed, wet, medium dense.	9.0	25.3		
15	16,18,21					9" Recovery	
880 / 20	8,10,13					14" Recovery	
				14.1	16.2		
875 / 25	9,11,9					8" Recovery	
870		GP-GM	Gray poorly graded gravel with silt and sand, trace coal, wet, medium dense.				
30	12,13,14					7" Recovery	
				11.3	10.6		
865 / 35	7,9,12					10" Recovery	

Boring B-2 was drilled in the shoulder of the eastbound lane, 21' east of the existing bridge deck, and 11' north of the centerline. Groundwater was observed during drilling at approximately 14' below the ground surface. A 2" diameter monitoring well was installed in the boring and is identified by the Washington State Department of Ecology discrete well tag number ACB-345.

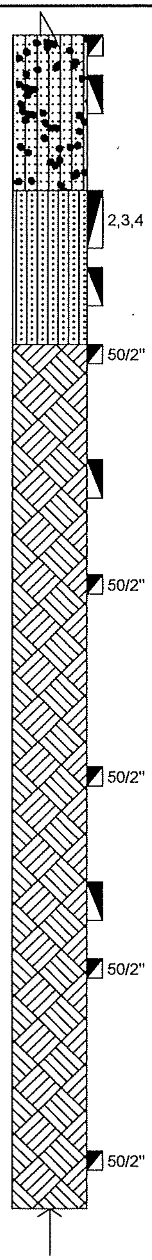
Figure A-2

KING COUNTY MATERIALS LABORATORY

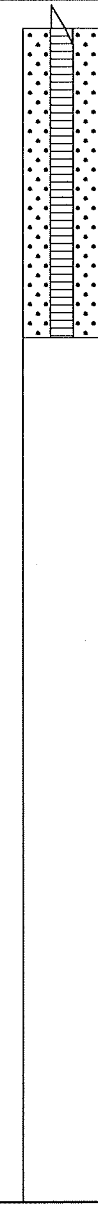
LOG OF MONITOR WELL INSTALLATION
WELL NO. B-2

PROJECT: **Coal Creek Bridge Replacement**
BORING LOCATION: **See Attached Location Map**
DRILL METHOD: **Sonic Drill**
DRILLER: **Holocene**
DEPTH TO - Water: **14'**

DATE: **7/9/18**
START: **N/A**
FINISH: **N/A**
LOGGER: **Casey Wagner**
DATE CHECKED: **7/11/18**



ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks	Monitor Well Construction Schematic
860 / 40		GM	Gray, silty gravel with sand, trace coal, wet, medium dense.	13.0	16.8		
	2,3,4	SM	Gray silty sand with gravel, wet, loose.	21.2	39.9	8" recovery	
855 / 45	50/2"	ROCK	Dark gray extrusive igneous bedrock, fine grained crystalline structure chiefly composed of pyroxene, fresh, hard.			No Recovery	
850 / 50	50/2"					No Recovery	
845 / 55	50/2"					No Recovery	
840			Compressive Strength: 3740 PSI.				
60	50/2"					No Revoery	
835 / 65	50/2"					No Recovery	
830 / 70			Boring Terminated				



Boring B-2 was drilled in the shoulder of the eastbound lane, 21' east of the existing bridge deck, and 11' north of the centerline. Groundwater was observed during drilling at approximately 14' below the ground surface. A 2" diameter monitoring well was installed in the boring and is identified by the Washington State Department of Ecology discrete well tag number ACB-345.

Figure A-2

KING COUNTY MATERIALS LABORATORY

LOG OF BORING
BORING B-3

PROJECT: **Coal Creek Bridge Replacement**
BORING LOCATION: **See Attached Location Map**
DRILL METHOD: **Sonic Drilling**
DRILLER: **Holocene**
DEPTH TO - Water: **14'** Caving: **no**

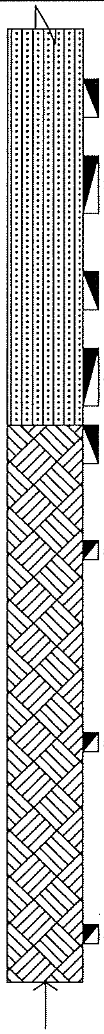
DATE: **7/10/18**
START: **N/A**
FINISH: **N/A**
LOGGER: **Casey Wagner**
DATE CHECKED: **7/11/18**

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
0 / 900		SM	2" Asphalt Dark brown silty sand with gravel, intermittent iron staining and cobbles, moist, medium dense, (fill).			
		ROCK	Boulder.			
5 / 895	50/3"					No Recovery
		SM	Brown silty sand with gravel, intermittent iron staining, trace coal, moist, medium dense, (fill).			
10 / 890	20,16,39					16" Recovery
		GM	Brown to gray silty gravel with sand, scattered cobbles, intermittent intermixed coal debris, slight iron staining, highly disturbed, saturated, medium dense.	10.5	25.1	
15 / 885	22,14,12					7" Recovery
20 / 880	15,15,23	SM	Brown to gray silty sand with gravel, slight iron staining, intermittent intermixed coal debris, scattered cobbles, highly disturbed, wet, medium dense.			11" Recovery
				11.1	36.4	
25 / 875	17,22,26					11" Recovery
				10.8	30.3	
30 / 870	8,13,18	SM	Gray silty sand with gravel, scattered coal, wet, medium dense.			10" Recovery
35 / 865	8,12,12					15" Recovery

Boring B-3 was drilled in the westbound travel lane, 44' east of the existing bridge deck, and 7' south of the road centerline. Groundwater was observed during drilling at approximately 14' below the ground surface.

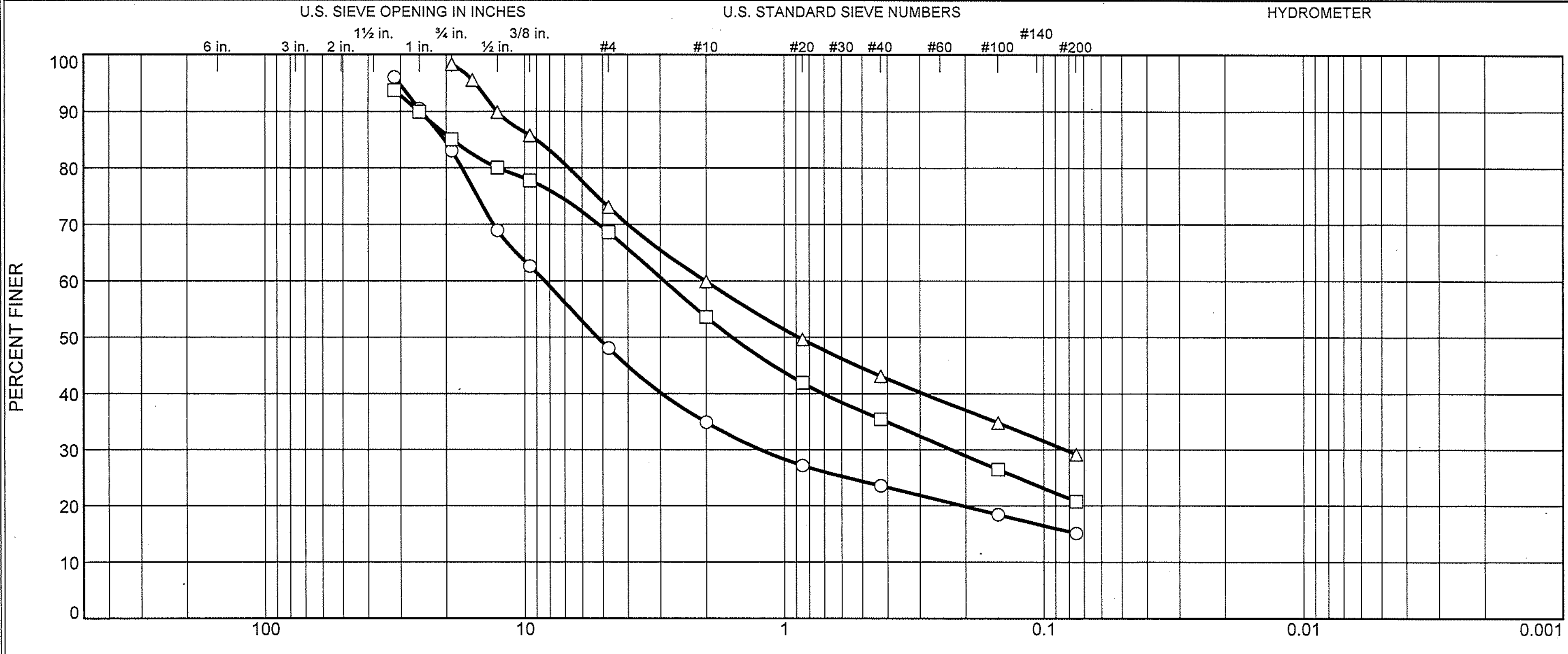
Figure A-3

LOG OF BORING
BORING B-3
(continued)



ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
				13.5	27.3	
40						
860	3,4,6					18" Recovery
45				23.3	41.6	18" Recovery
855	4,6,5					
		ROCK	Dark gray extrusive igneous bedrock, fine grained crystalline structure chiefly composed of pyroxene, fresh, hard.			
50	50/2"					
850						
55	50/1"					
845						
60	50/1"					
840						
			Boring Terminated at 61.5'			
65						
835						
70						
830						
75						
825						
80						
820						

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○			35.0	13.1	11.3	8.5	15.1	
□			16.4	15.0	18.2	14.6	20.8	
△			25.2	13.2	16.8	13.9	29.2	

	Source	Sample #	Depth/Elev.	Date Sampled	USCS	Material Description	NM %	LL	PL
○	B-1		18	7/11/18	GM	Silty Gravel with Sand	10.7		
□	B-1		22	7/11/18	SM	Silty Sand with Gravel	19.2		
△	B-1		27	7/11/18	SM	Silty Sand with Gravel	12.0		

Client King County

Project Coal Creek Bridge Replacement

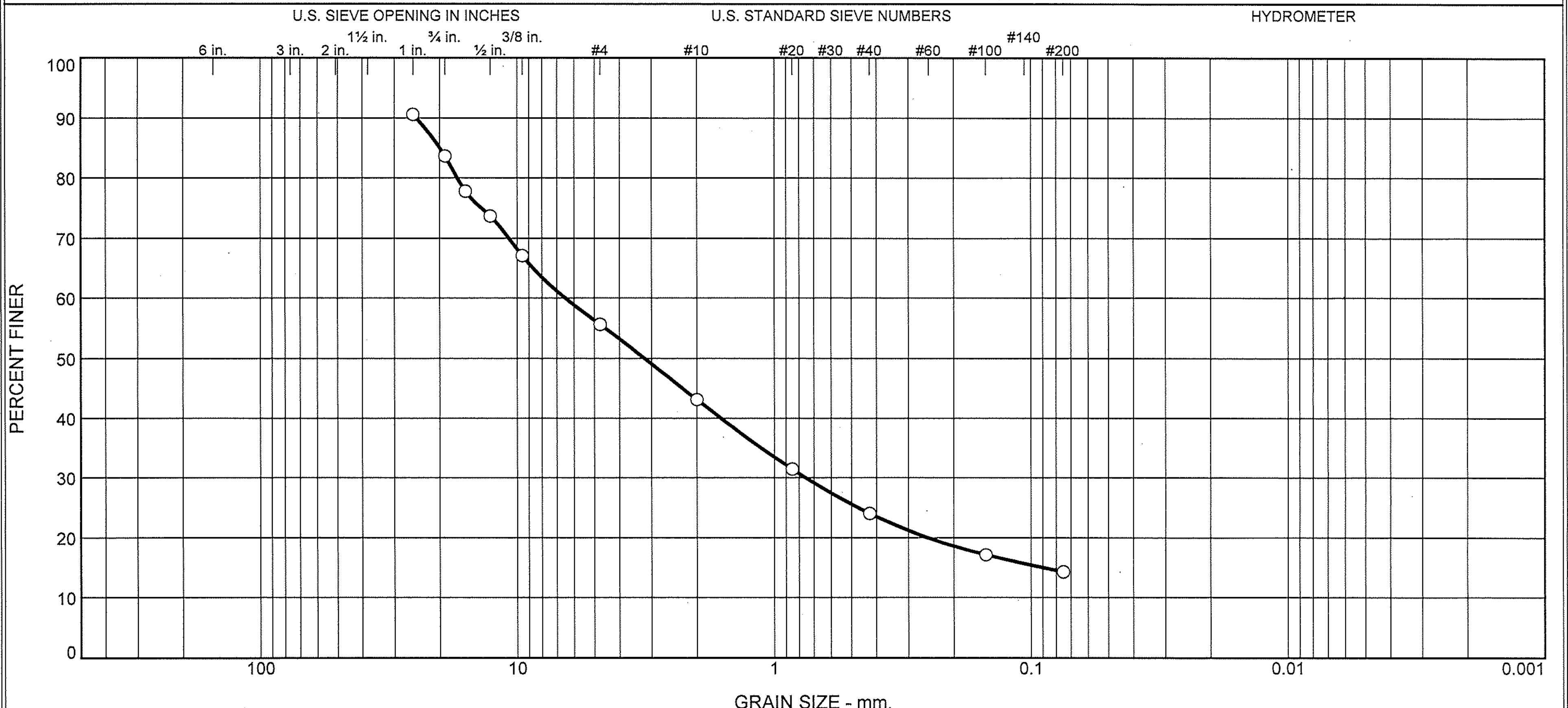
Project No. 1134751 Figure A-5

KING COUNTY

MATERIALS LABORATORY

Tested By: CW

Particle Size Distribution Report



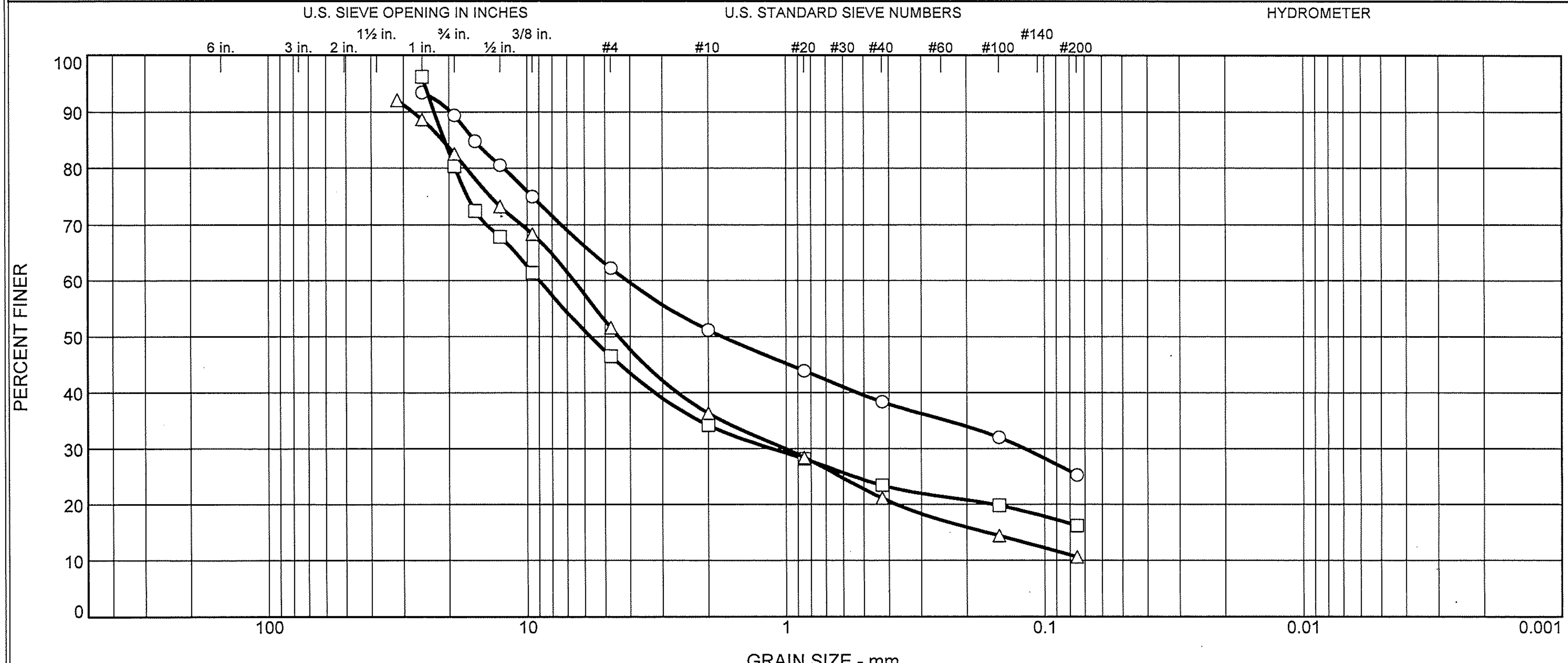
	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○			28.1	12.5	19.1	9.7	14.3	

	Source	Sample #	Depth/Elev.	Date Sampled	USCS	Material Description	NM %	LL	PL
○	B-1		32	7/11/18	GM	Silty Gravel with Sand	11.0		

Client King County
Project Coal Creek Bridge Replacement
Project No. 1134751
Figure A-6

KING COUNTY
MATERIALS LABORATORY

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○			27.2	11.0	12.8	13.1	25.3	
□			33.8	12.3	10.8	7.2	16.2	
△			30.9	15.3	15.2	10.5	10.6	

	Source	Sample #	Depth/Elev.	Date Sampled	USCS	Material Description	NM %	LL	PL
○	B-2		13	7/9/18	GM	Silty Gravel with Sand	9.0		
□	B-2		22	7/9/18	GM	Silty Gravel with Sand	14.1		
△	B-2		32	7/9/18	GP-GM	Poorly Graded Gravel with Silt and Sand	11.3		

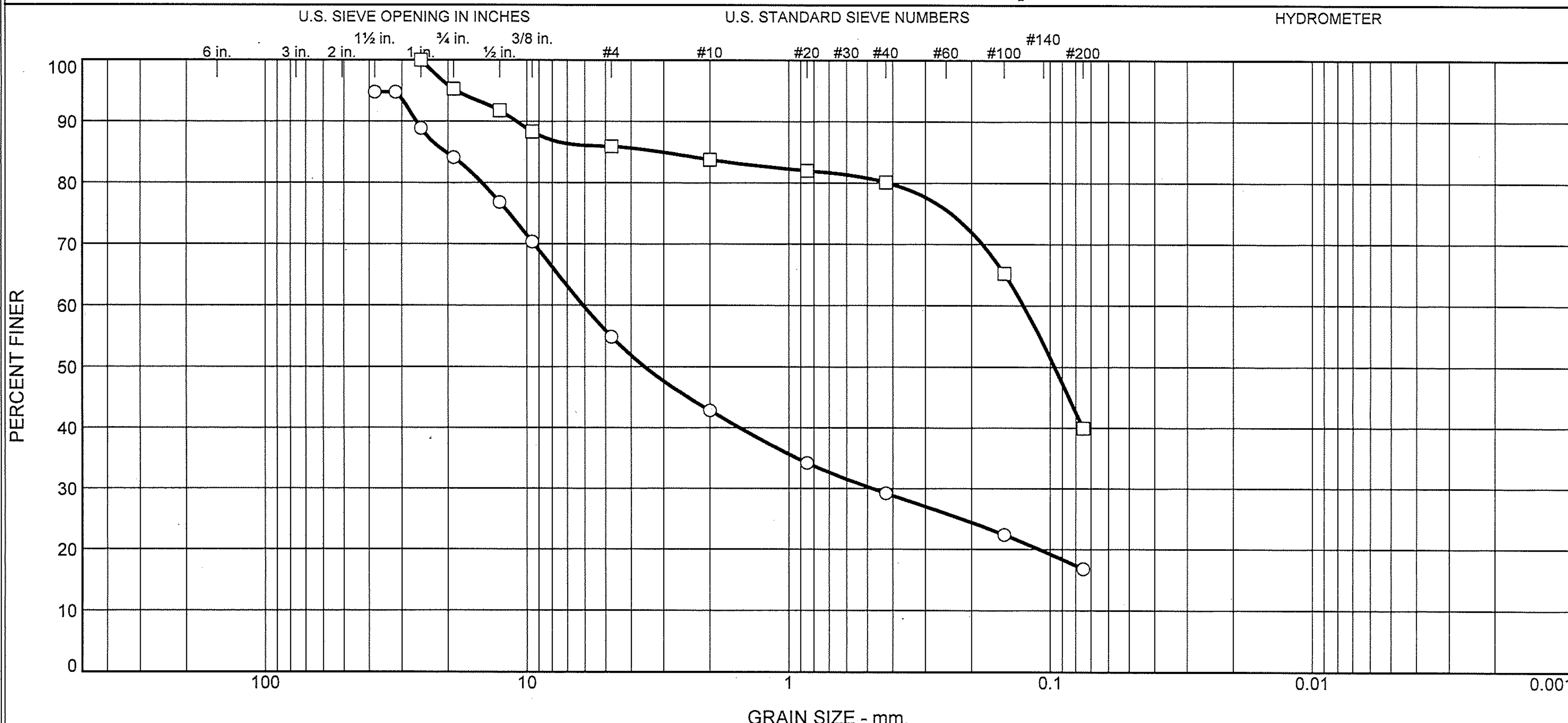
Client King County
Project Coal Creek Bridge Replacement
Project No. 1134751 Figure A-7

KING COUNTY

MATERIALS LABORATORY

Tested By: CW

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○			29.3	12.0	13.6	12.4	16.8	
□	0.0	4.8	9.3	2.1	3.7	40.2	39.9	

	Source	Sample #	Depth/Elev.	Date Sampled	USCS	Material Description	NM %	LL	PL
○	B-2		37	7/9/18	GM	Silty Gravel with Sand	13.0		
□	B-2		42	7/9/18	SM	Silty Sand	21.2		

Client King County

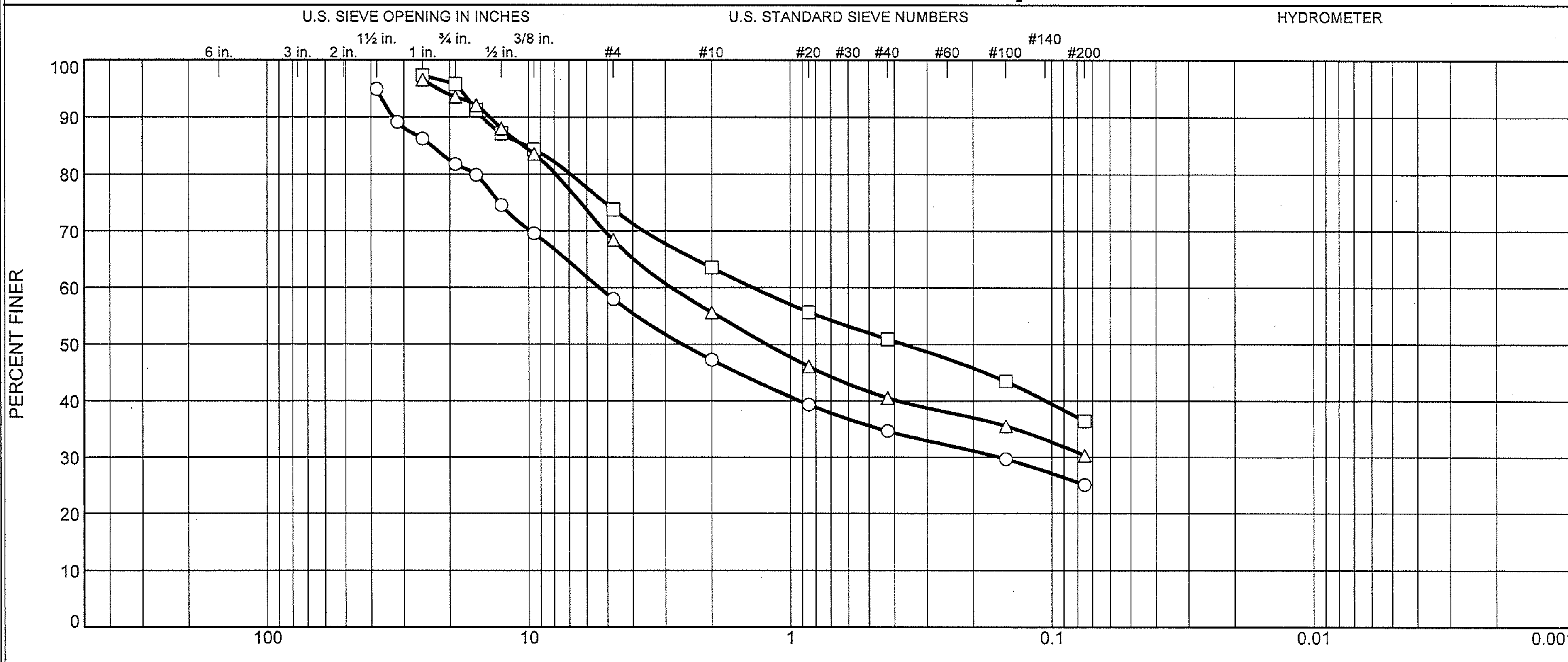
Project Coal Creek Bridge Replacement

Project No. 1134751 Figure A-8

KING COUNTY

MATERIALS LABORATORY

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○			23.8	10.7	12.6	9.5	25.1	
□			21.9	10.3	12.6	14.5	36.4	
△			25.1	12.8	15.1	10.2	30.3	

	Source	Sample #	Depth/Elev.	Date Sampled	USCS	Material Description	NM %	LL	PL
○	B-3		13	7/10/18	GM	Silty Gravel with Sand	10.5		
□	B-3		23	7/10/18	SM	Silty Sand with Gravel	11.1		
△	B-3		28	7/10/18	SM	Silty Sand with Gravel	10.8		

Client King County

Project Coal Creek Bridge Replacement

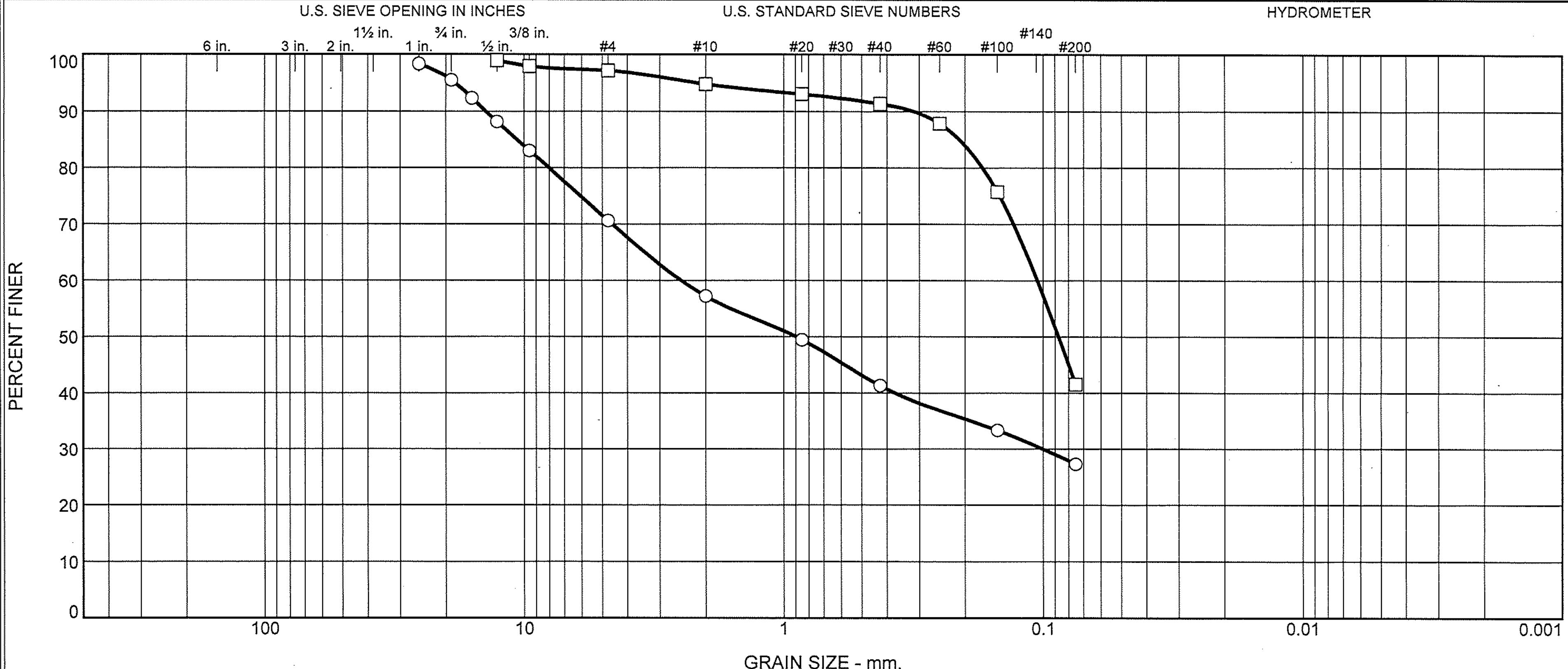
Project No. 1134751 Figure A-9

KING COUNTY

MATERIALS LABORATORY

Tested By: CW

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○			24.9	13.4	15.9	14.0	27.3	
□				2.3	3.5	49.7	41.6	

	Source	Sample #	Depth/Elev.	Date Sampled	USCS	Material Description	NM %	LL	PL
○	B-3		38	7/10/18	SM	Silty Sand with Gravel	13.5		
□	B-3		45	7/10/18	SM	Silty Sand	23.3		

Client King County

Project Coal Creek Bridge Replacement

Project No. 1134751 Figure A-10

KING COUNTY

MATERIALS LABORATORY

Tested By: CW

APPENDIX B
GEOTECHNICAL ENGINEERING REPORT
COAL CREEK BRIDGE #3035A REPLACEMENT

LIQUEFACTION ANALYSIS

FIGURE B-1: B-1

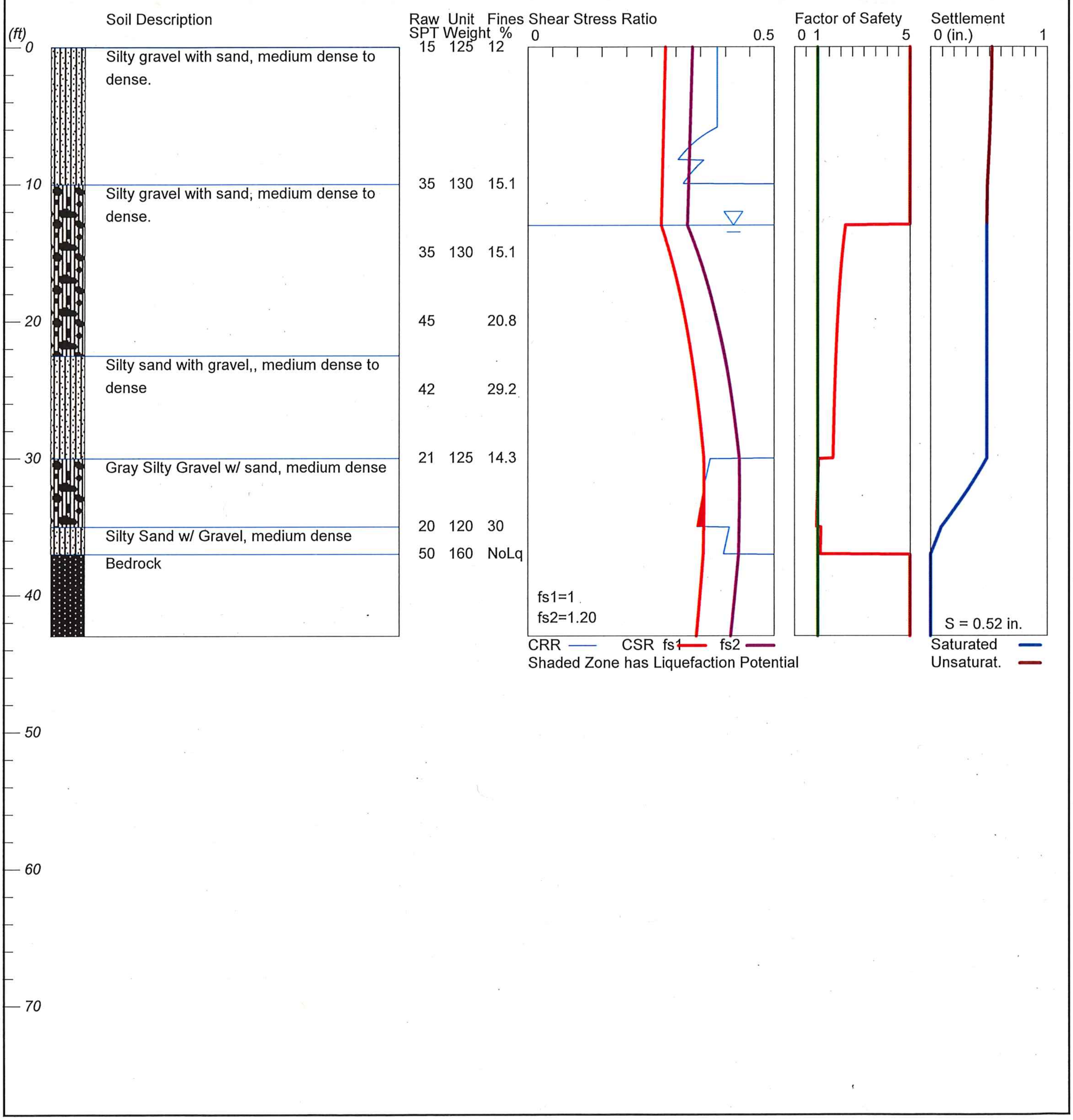
FIGURE B-2: B-2

LIQUEFACTION ANALYSIS

Coal Creek Bridge #3035A B-1

Hole No.=B-1 Water Depth=13 ft Surface Elev.=100

Magnitude=7
Acceleration=.428g



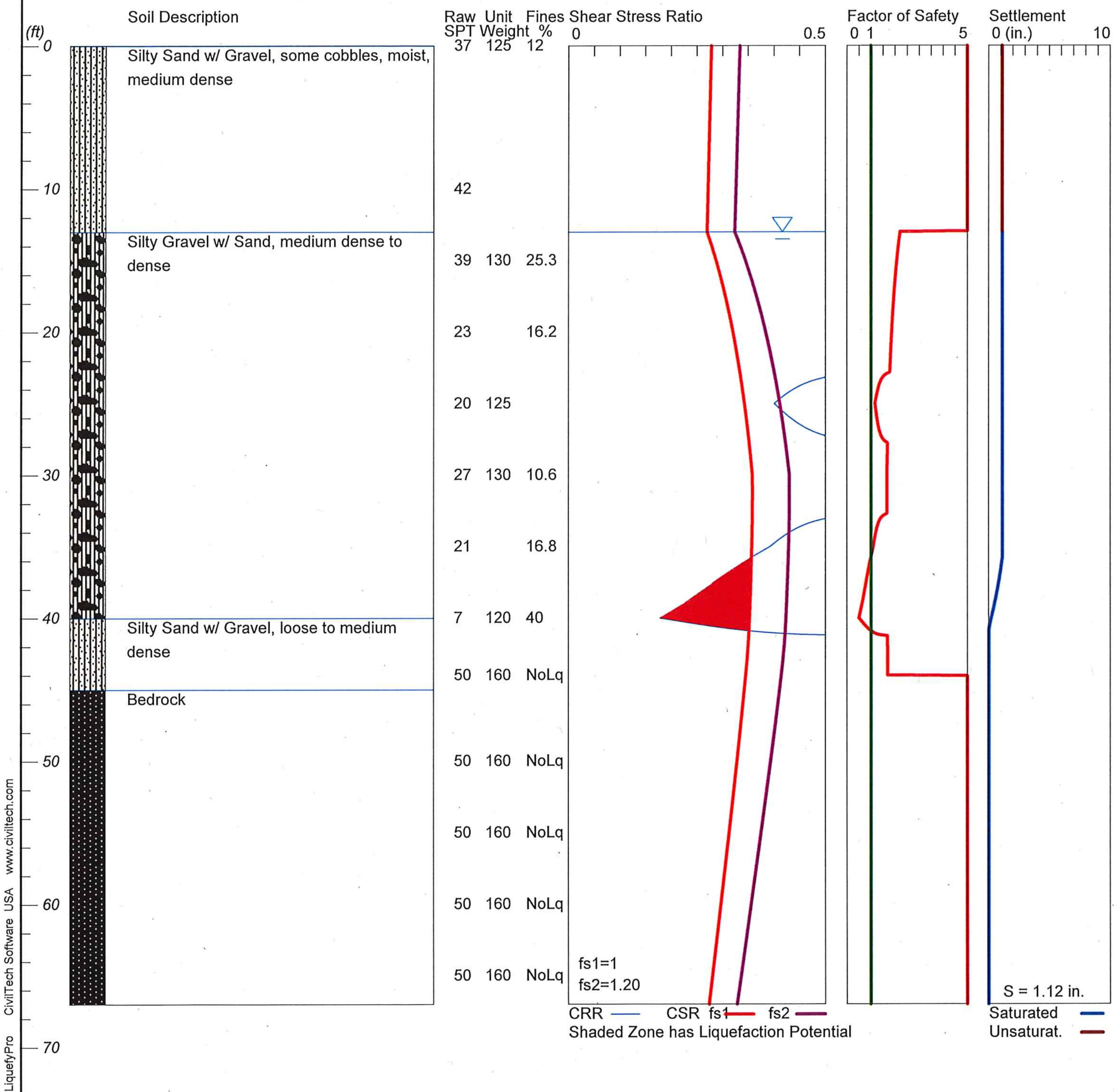
King County Materials Laboratory **Liquefaction and Settlement** **Plate B-1**

LIQUEFACTION ANALYSIS

Coal Creek Bridge #3035A B-2

Hole No.=B-2 Water Depth=13 ft Surface Elev.=100

Magnitude=7
Acceleration=.428g



APPENDIX C
GEOTECHNICAL ENGINEERING REPORT
COAL CREEK BRIDGE #3035A REPLACEMENT

GRS ABUTMENT PRELIMINARY DESIGN

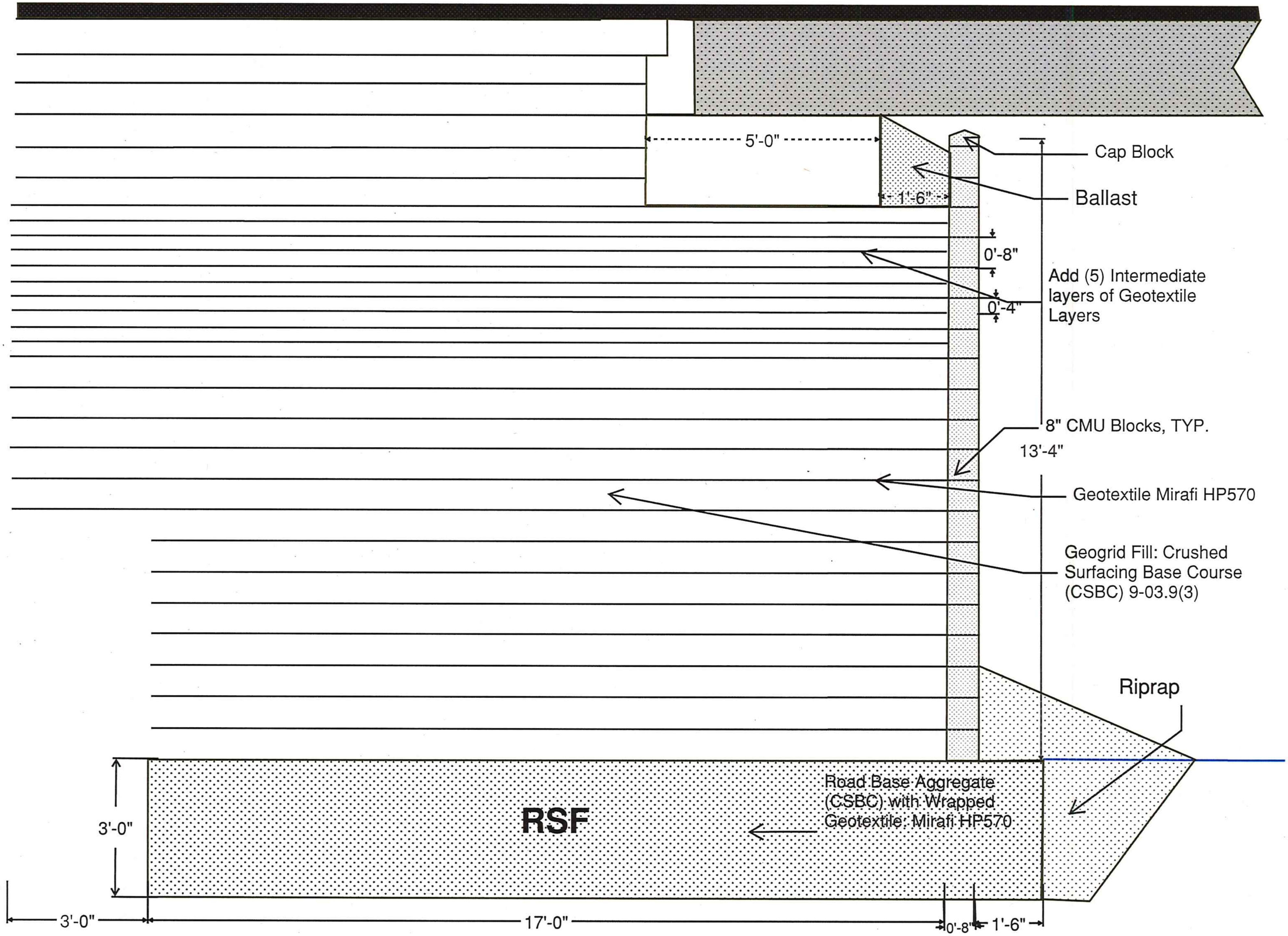


Figure C-1: GRS Abutment

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Appendix E

Draft Hydraulics Report

Indicator Engineering PLLC
7511 Greenwood Ave N #605
Seattle, WA, 98103
Tel 206-651-5103
www.indicatoreng.com

INDICATOR ENGINEERING

MAY 20, 2019

TECHNICAL MEMO

TO:
Aaron Olson, PE (KPFF)
Rachel Liberty, PE (KPFF)
CC:
Via: Email

FROM:
Pat Flanagan, PE
Russell Bair, EIT
PROJECT: 10055

RE: Coal Creek Bridge #3035A Replacement – Hydraulic Design Memo (PRE-FINAL)

This document summarizes the hydrologic, hydraulic and scour analysis of the proposed Coal Creek Bridge #3035A Replacement for King County. The document is presented in the following sections:

1 EXISTING BRIDGE

The project site is located where SE Lake Walker Road crosses Coal Creek at Bridge #3035A about 1.5 miles southeast of Cumberland in southeastern King County (Figure 1). The existing bridge has a treated timber substructure built in 1958 that supports a steel plate girder and floor beam superstructure. The original plate girders of the structure came from Bridge #164E, built by King County in 1912. This bridge originally spanned Bear Creek on NE Union Hill Road. Bridge #164E was widened in 1955; the plate girder-floor beam system was removed and replaced with girders supporting a steel deck pan. The girders and floor beam system was later transported to SE Lake Walker Road and used to span Coal Creek. Thus, the bridge built at Coal Creek has the same substructure design as Bridge #164E prior to the widening in 1955 and is 107 years old as of 2019 (King County). The existing bridge crossing is 41 feet long, 18 feet wide and is supported by timber pile bents within the waterway at each end (Figure 2).

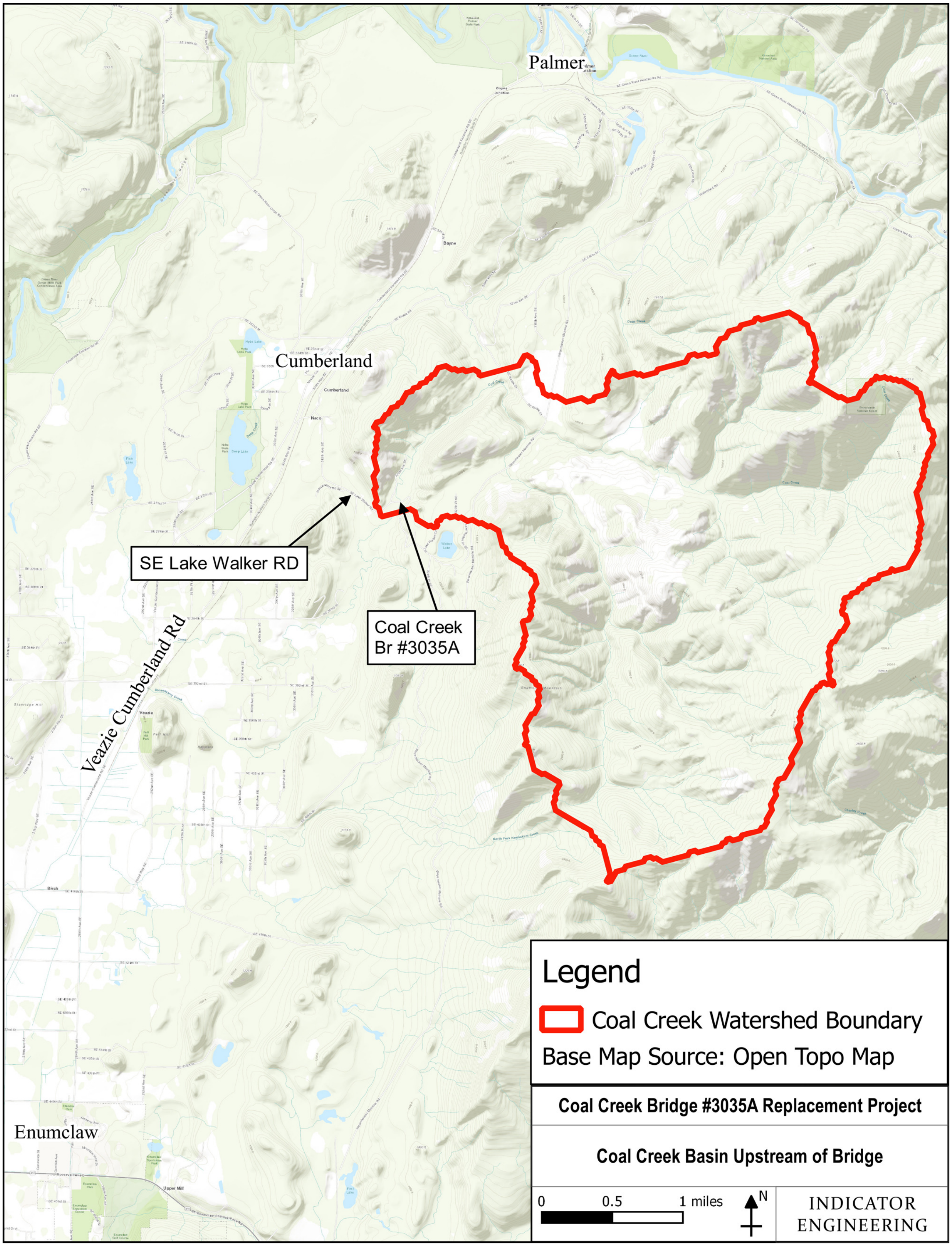

Figure 1 Location of Bridge #3035A and Coal Creek Basin Map.

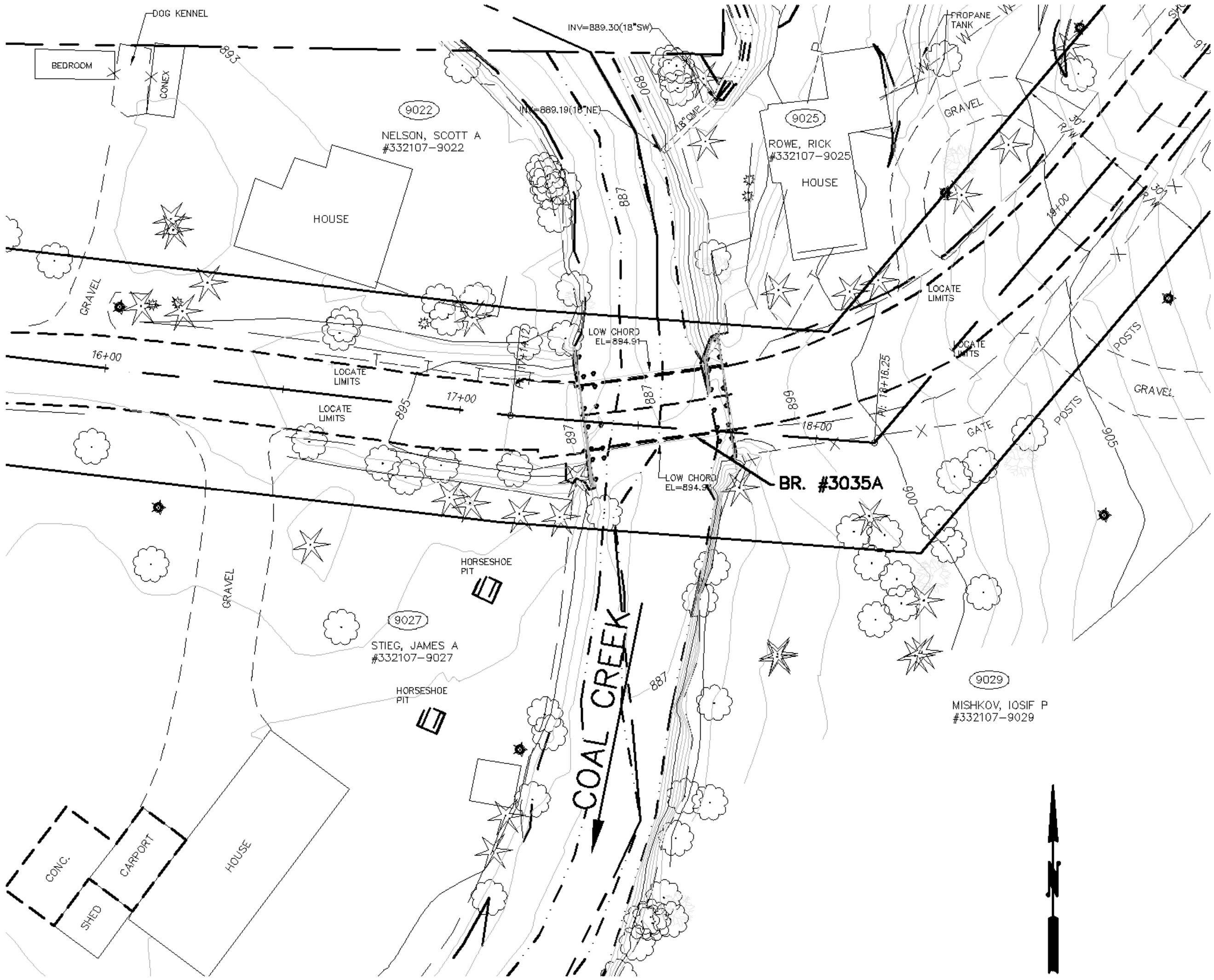

Figure 2 Survey basemap of SE Lake Walker Road at existing bridge #3035A. Coal Creek flows from North to South (top to bottom) through the bridge.

INSPECTION HISTORY

The available King County bridge inspections reports dating back to 1983 were reviewed and the following are selected excerpts pertaining to the hydraulic and geomorphic condition of the crossing. Notes are provided in parenthesis.

- 9/15/1983: Waterway: adequate
- 9/13/1984: Waterway: stone channel with riprap banks-ok
- 8/29/1985: Waterway: large adequate channel with riprap banks
- 5/8/1986: Waterway: riprap banks, slight potential for scour
- 4/9/1987: Waterway: some potential for scour. Pier Protection: heavy rip rap
- 1/25/1990: Waterway: high potential for flood and scour
- 12/13/1990: Scour: (6) scour calc/eval has not been made
- 5/10/1995: Scour: no evidence of scour
- 5/2/1996: Scour: Left bank scour about 6" below bottom backwall planks, right bank scour just below bottom backwall plank. Channel and channel Protection: Downstream of bridge on left bank, about 15-20' away from bridge, a tree has root scour-about 25% of roots are exposed. The tree is ~35' high-there

is potential for tree to hit overhead utility lines and the bridge. Downstream right corner- quarry spalls are in place, but insufficient quantity. Upstream left bank is well protected with rock. Repair Order: Downstream right corner (SW) of bridge needs quarry spalls. Approximate volume needed is 15'x4'x4'.

- 5/8/1997: Both timber backwalls undermined up to 12" vertically, undermining is worse on right bank, but rock soil combined with height of backwall seems to hold backfill in place. Monitor. Other Notes: Channel sounding cross-section at upstream and downstream face.
- 5/28/1998: Approximately 6" vertical of scour under left bank bottom backwall plank and 12" vertical scour under right bank. Repair per work order (see 1996 notes) Erosion at downstream right bank leading to roadway shoulder erosion. Repairs: Add to the 1996 work order: Restore (SW corner) with quarry spalls and add a couple 1-man rock at toe to stabilize. Add quarry spalls on left bank, add 12'x4'x37' long backwall plank along right bank.
- 5/11/1999: Entire length of right abutment backwall is undermined 12" horizontally and vertically, and entire length of left backwall is undermined 12" horizontally and 8" vertically. No major loss of backfill material yet, being held in place with large rocks.
- 4/4/2000: Undermining the same as previous inspection, additional backwall plank will be added and void filled with CDF in late summer 2000, see work order.
- 8/19/2010: Downstream left bank has 5' high undercut bank with leaning trees and exposed roots. Riprap in place upstream left bank. Gravel bar forming along upstream right bank.

Regarding crossing stability, the bridge inspection history informs us that the approach fill lag walls have been previously undermined by as much as 12 inches. The channel sounding from 1997 was compared to the 2018 survey revealing that the bed has aggraded 1 to 1.5 feet (increase in bed elevation). Repairs were ordered in the bridge inspections of 1996, 2000, and 2002, however no further information was provided on the extent of the repair or date constructed.

2 GEOMORPHIC SITE CHARACTERISTICS

The geomorphic conditions of Coal Creek in the SE Lake Walker Road crossing reach have been investigated and are summarized below for purposes of designing the proposed bridge crossing. The geomorphic observations are based on a site inspection and a review of site history, 2018 survey data collected by the County, LiDAR flown in 2003 (King County) and 2016 (QSI 2017), aerial photos and soil borings (King County 2018). Indicator Engineering visited the site on January 22, 2019 to observe channel and bank conditions and walked Coal Creek channel for 300 feet upstream and 650 feet downstream of the bridge. Photographs of the channel and bank conditions observed in the bridge reach are provided in Appendix A.

CHANNEL AND FLOODPLAIN

The bankfull channel width at the bridge ranges from 34 to 41 feet based on the topography. Downstream of the bridge 100 feet, the channel widens slightly with bankfull widths in the range of 36 to 51 feet.

At the bridge reach, Coal Creek appears to be somewhat incised with a broad floodplain terrace that is generally 2.5 to 5 vertical feet above the thalweg based on the available topography. The floodplain terrace is about 500 to 650 feet wide, and bridge #3035A crosses the creek at the far east end of the floodplain near the valley wall. Flows that exceed channel capacity would spread out across the broad floodplain, with a portion of the flow bypassing the bridge and overtopping SE Lake Walker Road to the west before returning back to the channel.

The floodplain's relative elevation to water levels in Coal Creek suggest that either fill has been placed or the channel has degraded and incised over time, relative to a more typical floodplain that conveys flow during 1.5 to 3-year events (Castro and Jackson 2001). The hydraulic analysis indicates the floodplain begins to convey flow at the 10 to 25-year recurrence interval event. Berms appear to have been placed along the right bank upstream of the bridge, based on the LiDAR and site investigation.

A comparison of the channel cross section at the bridge from 1997 to 2018 shows the bed has aggraded (increased) about 1 to 1.5 feet. The LiDAR and site investigation show a slightly steeper longitudinal channel profile about 400 feet downstream of the bridge. The steeper reach may correspond to the lower 1997 bed elevation. No significant headcuts or drops were observed in the creek downstream of the crossing.

BED AND BANK MATERIAL

The native soil surrounding the creek generally consists of gravels and cobbles mixed with sands. The geotechnical report also noted the presence of silts and coal in layers that may interact with the creek. A pebble count was performed in a riffle section 320 feet upstream of the bridge (Figure 3) and represents the bed material observed in the reach. The bed material was generally cobble-gravel as listed in Table 1.

Vegetation can increase bank stability and reduce erodibility given the banks transportable soils. The banks were generally steep and not well vegetated upstream and downstream of the bridge. Where trees, woody debris and dense root structures (willows, alders, etc.) were observed in the bank, they were generally higher, allowing the roots to be undermined and only provide temporary erosion resistance.

Table 1. Coal Creek channel bed surface material from pebble count.

% Finer than	Particle Size (mm)
95	151
85	108
50	50
30	29
15	18

CHANNEL ALIGNMENT

The channel alignment is shown in Figure 3. Riprap has been placed on the banks at several locations in the reach to protect from lateral channel migration.

The channel is a gradual right-hand bend through the bridge reach with the channel located near the left (east) side of the floodplain valley. This creates an asymmetric channel section upstream with deeper flow along the left bank. The channel bend begins about 50-70 feet upstream of the bridge. The outside bank (left/east) has been heavily armored with riprap, which is moss-covered and, based on tree size, may be at least 15 to 25 years old. The toe is undermined in a few spots, and isolated stones have fallen down the slope, however in general the riprap appears stable. That riprap is aligning the channel through bridge #3035A and should be monitored during routine inspections, as failure of the upstream left bank riprap would allow the channel to migrate east at the proposed bridge.

A cursory comparison of LiDAR datasets at unprotected bends further upstream shows migration rates of up to 5 to 10 ft/yr (Figure 4). This reinforces that the upstream riprap is necessary for channel alignment through the bridge #3035A crossing.

Downstream the left (east) bank is undermined, beyond vertical in places, and appears to be slowly eroding. Trees along the left bank are providing temporary resistance to migration, however erosion rates may temporarily increase when the trees do fail.

The right (west) bank both upstream and downstream of the bridge is sparsely vegetated with a few trees along the bank top. The current channel conditions have allowed a small gravel bar to form along this bank, suggesting lower erosive energy; however, the bridge inspection reports indicate this bank is subject to erosion and the thalweg may shift at times to the right (west) bank at the bridge.

lower erosive energy; however, the bridge inspection reports indicate this bank is subject to erosion and the thalweg may shift at times to the right (west) bank at the bridge.

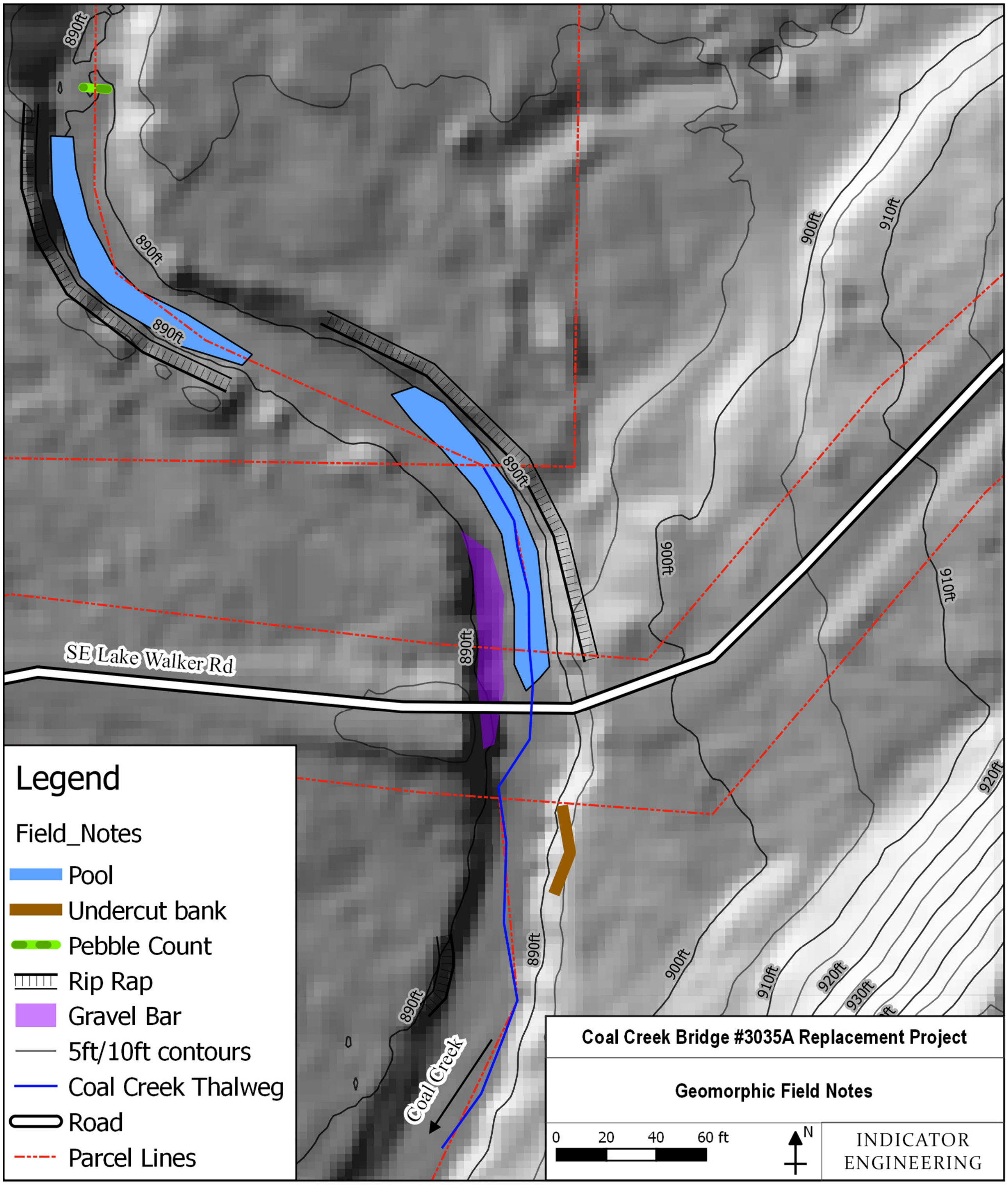

Figure 3 Channel bed and bank observations in the bridge #3035A reach of Coal Creek.

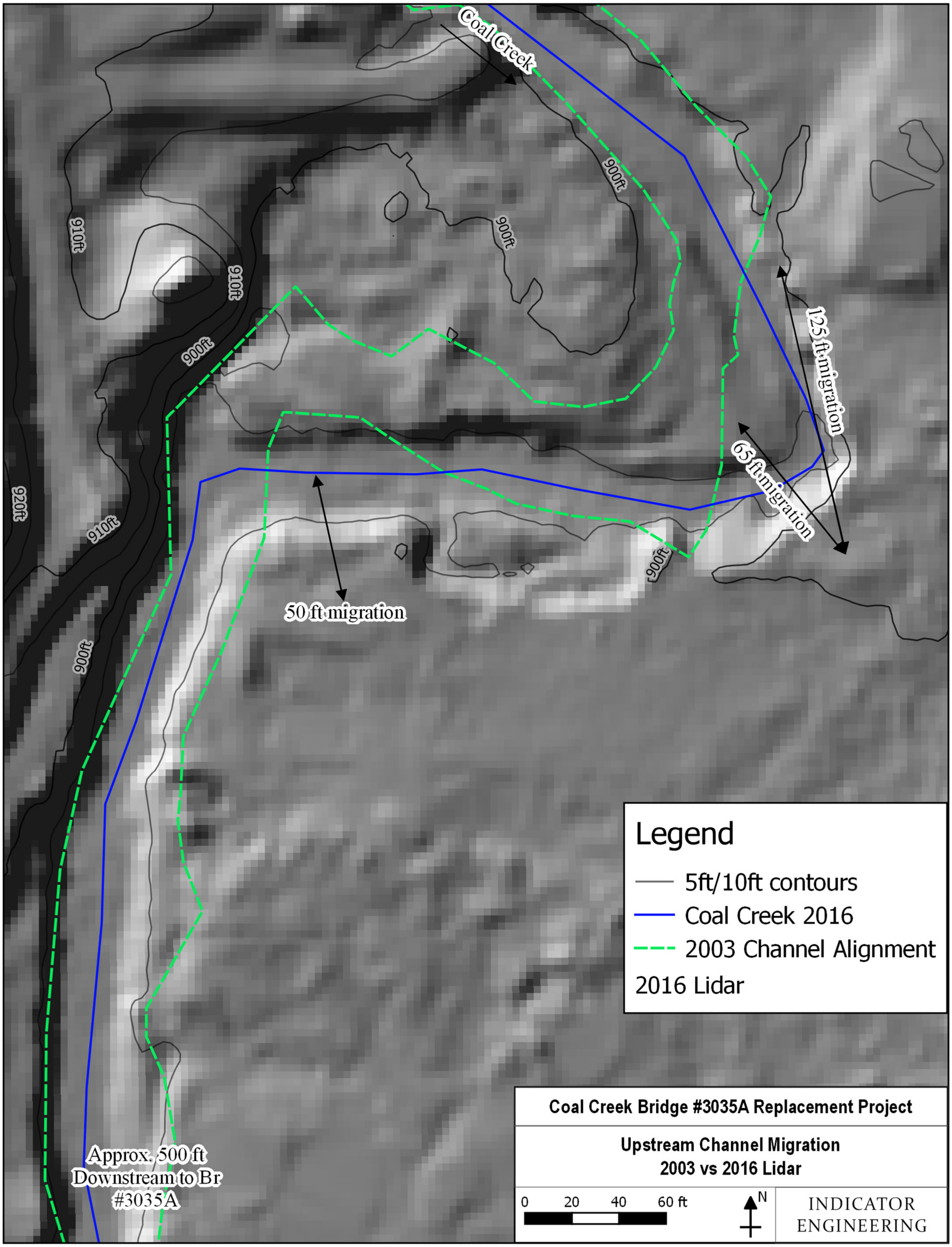

Figure 4 Channel migration of Coal Creek from 2003 to 2016 based on Lidar datasets. Migration reach appears to be unarmored and is located about 850 ft upstream of bridge #3035A crossing.

WOODY DEBRIS

Coal Creek is a largely forested basin, with the potential to deliver woody debris to the stream. However, very little woody debris was observed in the channel through the bridge reach. Local landowners may have removed any larger debris to increase channel capacity, or the debris may get collected at sharp bends upstream. The Coal Creek channel has capacity to transport fallen trees in the range of 30 to 40 feet, and many of the trees in the reach that could fail are 12 to 24 inch diameter. Longer or larger diameter trees would likely become embedded and are less likely to be carried through the bridge.

OBSERVED LOCAL SCOUR

Numerous pools at bends, around trees and at woody debris were observed throughout the bridge reach. Maximum pool depths during mid-winter base flow were up to 4.0 feet deep, with several pools about 3.0 feet in depth. The bend pool upstream of the bridge was observed to be 2.5 to 3.0 feet deep, and max depth at the upstream bridge face was 2.2 feet. For comparison water depths in the riffles were typically 0.4 to 0.6 feet deep on the day of the inspection.

3 HYDROLOGIC ANALYSIS

Regional regression equations developed by the USGS (2016) for region 3 of Washington were used to estimate the peak instantaneous flows in Coal Creek at the bridge. The flows are reported in Table 2. There are no stream gages or available high flow measurements for Coal Creek.

Table 2. Peak discharge in Coal Creek at Bridge #3035A

Annual Exceedance Probability (%)	Recurrence Interval (years)	Discharge (cfs)
50%	2-yr	593
20%	5-yr	901
10%	10-yr	1110
4.0%	25-yr	1360
2.0%	50-yr	1550
1.0%	100-yr	1750
0.5%	200-yr	1940
0.2%	500-yr	2210

4 PROPOSED BRIDGE DESCRIPTION

This section may be revised after the 30% design of the bridge #3035A replacement.

The proposed replacement bridge evaluated is a single span with a 50-feet long hydraulic opening and 38-feet wide crossing, at approximately the same location as the existing crossing. The bridge piers would be set back outside of the channel banks to provide a less constrictive hydraulic opening. The proposed bridge is anticipated to be supported by spread footing foundations placed below scour depth.

5 HYDRAULIC ANALYSIS

A HEC-RAS hydraulic model was developed for Coal Creek from 200 feet downstream to 400 feet upstream of the bridge. A digital elevation model (DEM) was built for the site using the 2018 survey surface and extended with LiDAR data (QSI 2017) into the floodplain and for the upstream channel. Manning's roughness values were set to 0.040 for the channel (Limerinos 1970) and 0.070 for the lightly vegetated floodplain. The downstream boundary condition was set to normal depth using a slope of 0.010 ft/ft based on downstream channel and simulated energy grade slope. The HEC-RAS hydraulic model geometry and channel cross section locations are shown in Figure 5. Cross section plots are included in Appendix B. All elevations are referenced to the survey which is reported to be in the vertical datum of NAVD-88 feet.

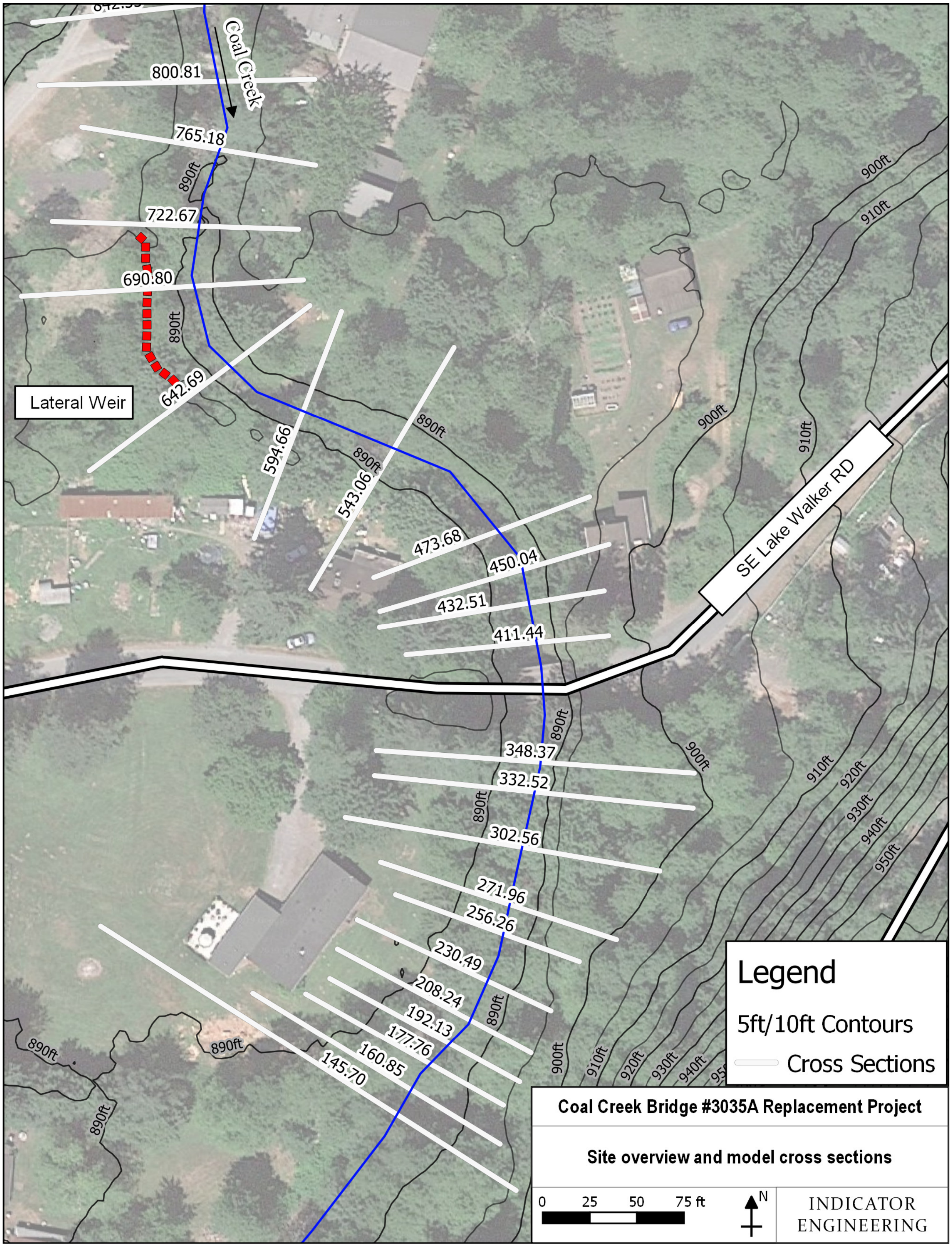

Figure 5 Coal Creek HEC-RAS hydraulic model geometry.

HYDRAULIC RESULTS

The steady state water surface profiles up to the 500-year recurrence interval were simulated through the project reach for both the existing and proposed bridge conditions. The simulated 100-year water surface elevation for the existing bridge is 893.3 feet. The proposed bridge would remove the piers and open the span, which produce the same **100-year water surface for the proposed bridge of 893.3 feet**. The proposed bridge replacement project would not increase 100-year water levels in Coal Creek upstream or downstream of the bridge, as shown in Figure 6; however a slight rise would occur under the bridge within the right-of-way due to the wider opening reducing the velocity head. The 100-year water surface profiles are tabulated in Appendix B. For purposes of design, the 100-year average channel velocity through the proposed bridge is 8.5 to 10.0 feet per second, which corresponds to a design velocity of 12 to 15 feet per second (using a multiplier of 1.5).

During large floods above a 10-year event, the model simulates flow would overtop the right bank upstream near river station 642-722 and be conveyed overland across the road. At the 100-year event this overflow is simulated as 170 cfs, or about 10% of the 1750 cfs peak in Coal Creek. This overflow is expected to bypass the bridge and cross SE Lake Walker Road about 150 to 300 feet west of the existing bridge. The model shows the proposed bridge would not affect this overflow.

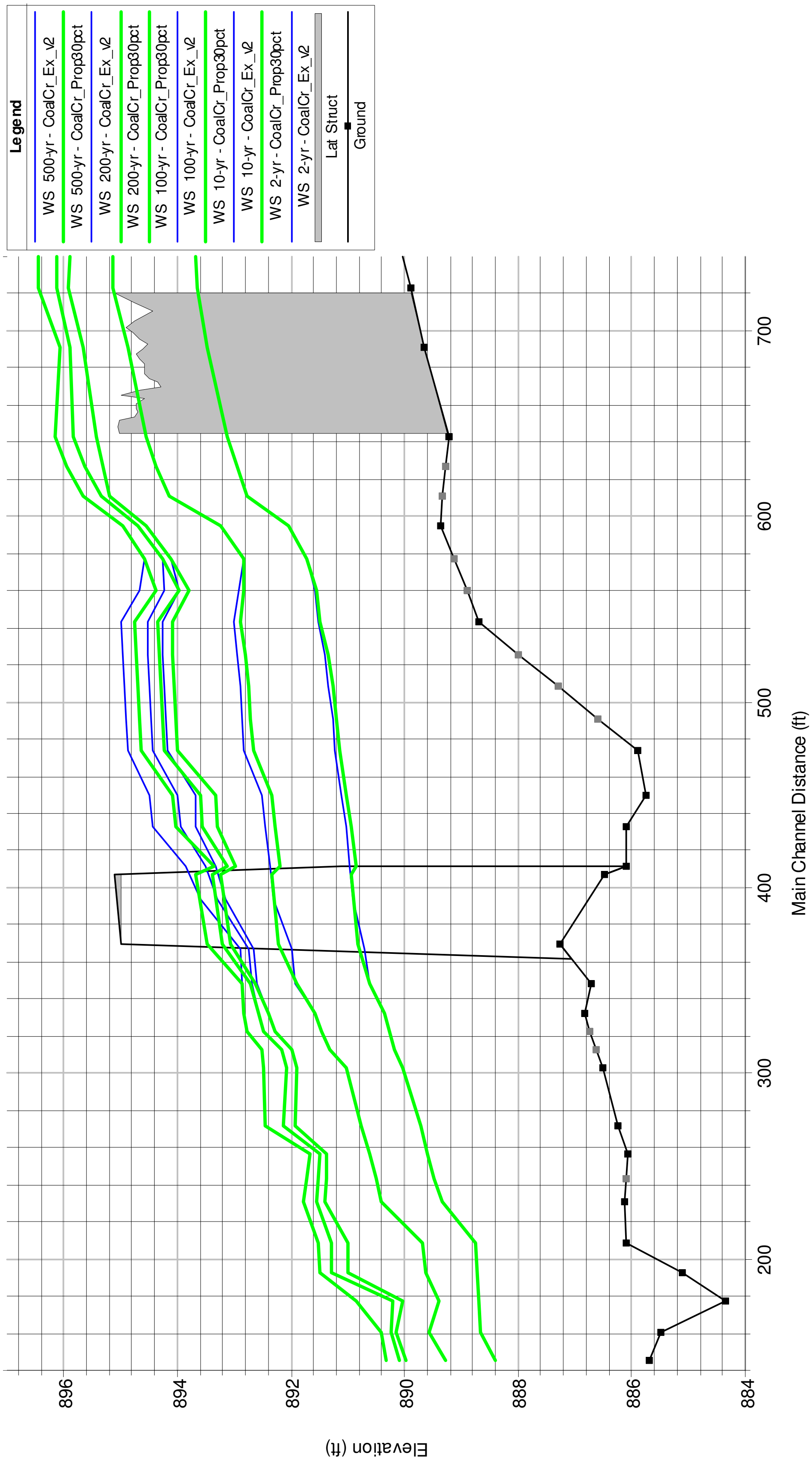

Figure 6 Coal Creek HEC-RAS hydraulic model simulated water surface profiles. Existing (Ex_v2) is blue and proposed (Prop30pct) is green.

6 SCOUR AND EROSION ANALYSIS

Lateral migration and associated bend scour are the primary concern for the long-term stability of the proposed bridge. There is potential for contraction scour at the crossing as the west approach fill constricts the floodplain. Also, the stability of the longitudinal stream profile has the potential to be an issue over the bridge's lifespan. The scour mechanisms at the proposed bridge #3035A are summarized below, and scour depths are reported in Table 3.

- Bend Scour: Yes. The bridge is located downstream of a 60-degree right hand bend with a radius to channel width ratio of about 2.3. The outside of the bend has been armored with riprap, preventing lateral migration and aligning the flow through the bridge, while the hardened bank exacerbates bend scour. The deepest bend scour was observed 50 to 80 feet upstream of the bridge, and would be expected to remain upstream of the bridge during a flood; however the bend hydraulics effect flow patterns and bed levels through the bridge as evidenced in both the survey and bend scour analysis.
- Contraction Scour: Yes. The SE Lake Walker Road fill and proposed bridge forms a slight constriction of the floodplain, mostly on the west approach based on the hydraulic modeling and topography. Both upstream and downstream of the road, the natural floodplain appears to be 200-300 feet wider than the 43-foot proposed bridge opening. However, the hydraulic model shows that the channel is incised, and the incised condition combined with berms upstream results in less than 30% of the total flow conveyed in the floodplain during the 200-year event. A significant portion of the flow that is conveyed in the floodplain would overflow to the west and bypass the bridge, thus not contributing to contraction scour.
- Local Pier Scour: No. The proposed bridge would be a single span with no intermediate piers.
- Abutment Scour: No. Not a significant scour mechanism at this site. The flow patterns at the bridge do not include significant contraction of flowlines at the abutment that is typical of this form of scour.
- Longitudinal Profile Stability: Maybe. The Coal Creek channel profile shows conflicting patterns for the bridge reach. Survey data indicate that the channel has aggraded 1 to 1.5 feet at the bridge in the last 21 years. However, a few hundred feet downstream the channel steepens, and this may gradually translate upstream to the bridge, resulting in 1 to 2 feet of degradation. The aggradation may correspond to a temporary sediment pulse related to the significant logging in the basin. The majority (50-70%) of the upper watershed appears to have been logged in the 1980's, while a large portion (10-25%) in the middle watershed was logged in the 1990's. The basin is generally reforested, with significant logging roads, and this may have contributed sediment pulses at the bridge crossing.
    - In either the degradation or aggradation case, we expect the transition to be gradual. A small amount of additional degradation has been assumed for the scour design elevation. Freeboard is recommended to maintain conveyance in the case of continued long-term aggradation.
- Armoring: Possible. The largest cobbles observed in the bed and bank are up to 12 inches and the d85 was measured at over 4 inches. The presence of this size of cobble material is likely to provide a reduction in the maximum scour. This has been incorporated into the total scour estimate.

The 100, 200, and 500-year scour elevations at the bridge are shown in Table 3. The calculations were made considering HEC-18 (FHWA 2012) that recommends the 200-year design event be used for evaluating scour at new bridges, and foundations be designed for potential exposure to full scour depth. The scour calculations are summarized in Appendix C.

Table 3. Scour summary table.

Event	Bend Scour (ft)	Contraction Scour (ft)	Longitudinal Profile Stability (ft)	Armoring (ft)	Total Scour Depth (ft)	Existing Bed Elevation (ft)	Scour Design Elevation (ft)
100-year	-1.5	-0.8	-2.0	0.8	-3.5	886.1	882.6
200-year	-1.6	-1.0	-2.0	1.0	-3.6	886.1	882.5
500-year	-2.2	-1.5	-2.0	1.5	-4.2	886.1	881.9

7 DESIGN RECOMMENDATIONS

The following recommendations are provided for the design of the Coal Creek Bridge #3035A Replacement at SE Lake Walker Road. Key hydraulic design parameters are provided in Table 4. The recommended design features would result in a replacement bridge with an initial scour code of 8, due to: bridge foundations determined to be stable for calculated scour conditions as scour is above top of footing or by installation of properly designed countermeasures.

Table 4. Recommended Bridge #3035A Replacement Hydraulic Design Parameters.

Design Parameter	Bridge #3035A Replacement
Water Elevation, 100-year	893.3 feet
Freeboard	3.0 feet (min)
Low Chord Elevation	896.3 feet (min)
Scour Elevation, 200-year	882.5 feet

- 100-year Water Surface Elevation: 893.3 feet (NAVD88)
- Freeboard: 3.0 feet above the 100-year = 896.3 feet (NAVD88). The bridge low chord should be designed to provide the recommended freeboard above the 100-year water surface. The three feet of freeboard is standard per King County 2016 Road Design Standards. We recommend the standard freeboard be provided given the observed aggradation and potential for debris. Additional freeboard above the standard is not recommended as necessary, as no debris accumulation has been noted in the past and the aggradation rate appears gradual.
- Scour Design Elevation: 882.5 feet (NAVD88). Foundations for both the east and west abutment/piers should be designed for potential exposure to this depth. If foundations are designed above this elevation, then scour countermeasures should be included in the design. The scour design elevation corresponds to the calculated scour for the 200-year peak flow, following FHWA HEC-18.
- Approach Fill/Bank Protection: The existing channel riprap revetment upstream on the left (east) bank aligns the channel through the proposed bridge crossing. This revetment should be maintained to prevent lateral channel migration upstream of the proposed crossing. The banks at the proposed bridge should be tied smoothly into the surrounding upstream and downstream banks, and surface protection of the road fill should be installed at the bridge. Depending on the specific bridge design, bank protection should be placed in areas that may experience increased erosion.
- Monitoring: In addition to routine monitoring of the abutments and foundations, the channel alignment upstream and downstream of the bridge should be observed and noted during routine inspections. The upstream left (east) bank riprap should also be inspected. The channel bed levels at the bridge should be monitored occasionally, about every 5 years, to determine rates of channel aggradation or degradation. Bank protection may become necessary upstream or downstream of the crossing in the future, depending on actual flows, debris, and sediment rates.

8 REFERENCES

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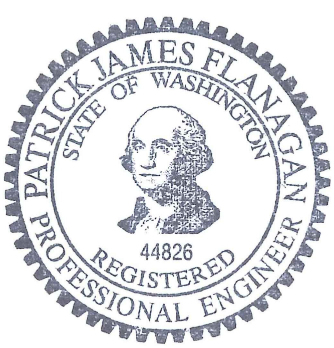
9 CLOSING

Thank you for allowing Indicator Engineering to provide hydraulic engineering support for the Coal Creek Bridge #3035A Replacement Project. Please contact Pat Flanagan at (206) 651-5103 if you have any questions or would like to discuss the analysis described above.

Respectfully Submitted,

Indicator Engineering PLLC

Prepared by:



Patrick Flanagan, PE

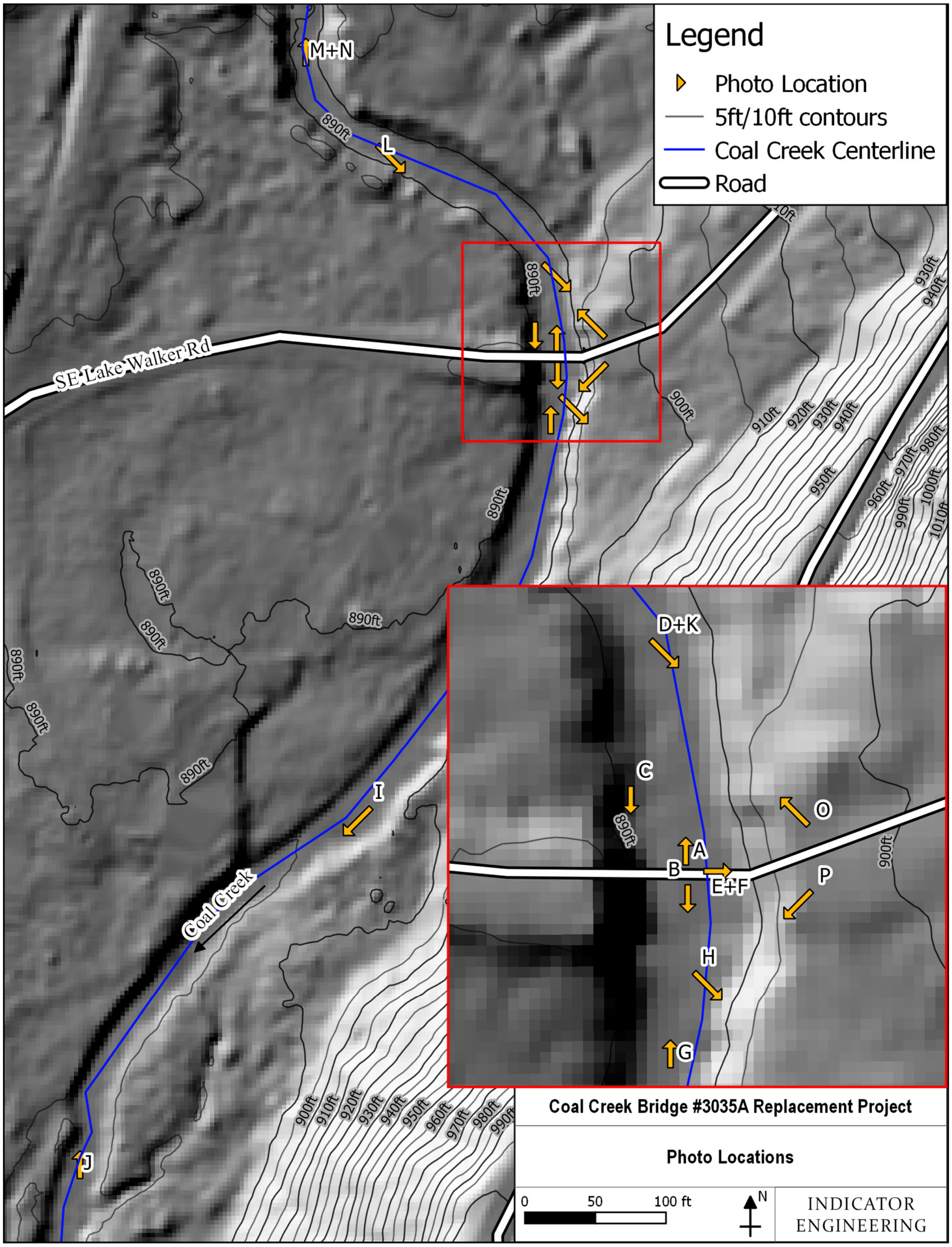
ENCLOSURE:

Appendix A Site Photographs

Appendix B Hydrologic and Hydraulic Analysis

Appendix C Calculations Summary – Scour

APPENDIX A SITE PHOTOGRAPHS



Locations of selected photographs from the site visit in January 2019.

LB = left bank, RB = right bank.

Looking Upstream from bridge (Photo A)

Looking downstream from bridge (Photo B)

Looking downstream on RB (Photo C)

Looking downstream (Photo D)

Gauge under bridge: 11:00am 1/22/2019 (Photo E)

Looking towards RB under bridge (Photo F)

Looking upstream (Photo G)

Looking downstream at undercut LB just downstream of bridge (Photo H)

Looking downstream, approx. 350’ downstream of bridge, barrel is located at chokepoint where stream gradient increases going downstream and substrate transitions from gravels to cobbles (Photo I)

Looking upstream at 4’ deep hole ~650’ downstream from bridge. End of steeper plain bed section. (Photo J)

Looking downstream, thalweg between LB culvert and bridge. Rip Rap on LB. Max depth about 2 feet. (Photo K)

Looking downstream at bend upstream of bridge. The riprap is on the LB in distance, and on the RB at the section where photo is taken. (Photo L)

Looking upstream at location of pebble count. Private bridge crossing upstream. (Photo M)

Gravelometer on LB point bar at location of pebble count. (Photo N)

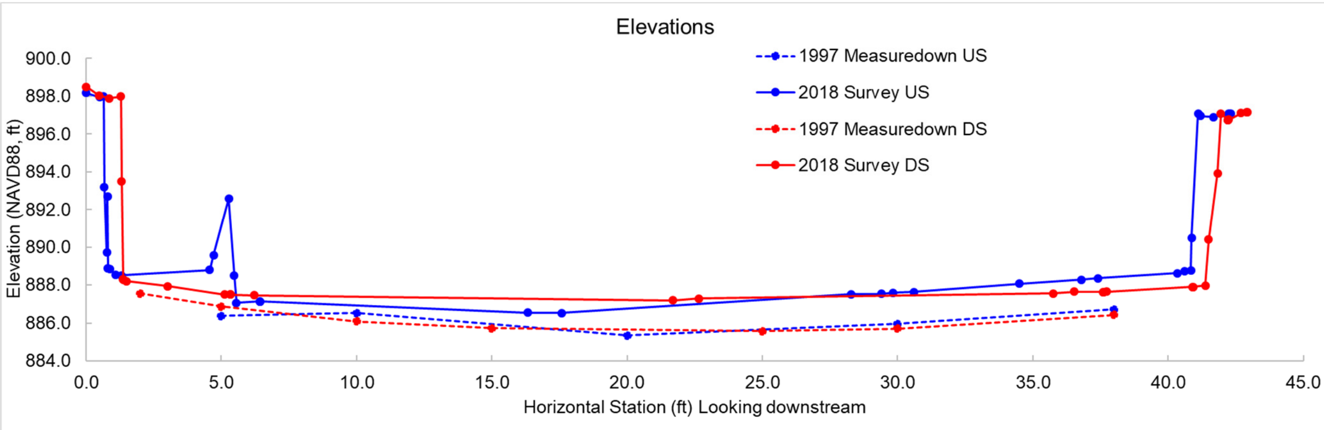
Looking upstream from LB end of bridge at rip rap bend (Photo O)

Looking downstream from LB end of bridge at undercut LB. (Photo P)

APPENDIX B HYDROLOGIC AND HYDRAULIC ANALYSIS

Channel soundings are shown in the figure below, followed by the hydraulic results in the table and HEC-RAS cross section plots. Hydrologic report from streamstats is also attached.

Figure B1. Channel section plot at bridge #3035A from 1997 soundings and 2018 survey.



Hydraulic Results

Table B1. Simulated water surface elevations for 100-year peak flow in Coal Creek. Listed from downstream to upstream.

HEC-RAS River Station (ft)	Existing Conditions (ft)	Proposed Bridge (ft)	Difference (ft)
145.7	889.96	889.96	0.00
160.85	890.15	890.15	0.00
177.76	890.03	890.03	0.00
192.13	891.00	891.00	0.00
208.24	890.99	890.99	0.00
230.49	891.40	891.40	0.00
256.26	891.37	891.37	0.00
271.96	891.92	891.92	0.00
302.56	891.89	891.89	0.00
332.52	892.39	892.39	0.00
348.37	892.61	892.65	0.05
385 BR D	892.65	893.09	0.44
385 BR U	893.14	893.28	0.14
411.44	893.33	893.04	-0.28
432.51	893.66	893.22	-0.45
450.04	893.69	893.25	-0.44
473.68	894.17	893.97	-0.20
543.06	894.26	894.07	-0.19
594.66	894.55	894.55	0.00
642.69	895.44	895.44	0.00
690.8	895.65	895.65	0.00
722.67	895.91	895.91	0.00
765.18	895.89	895.89	0.00
800.81	895.67	895.67	0.00
842.33	897.50	897.50	0.00

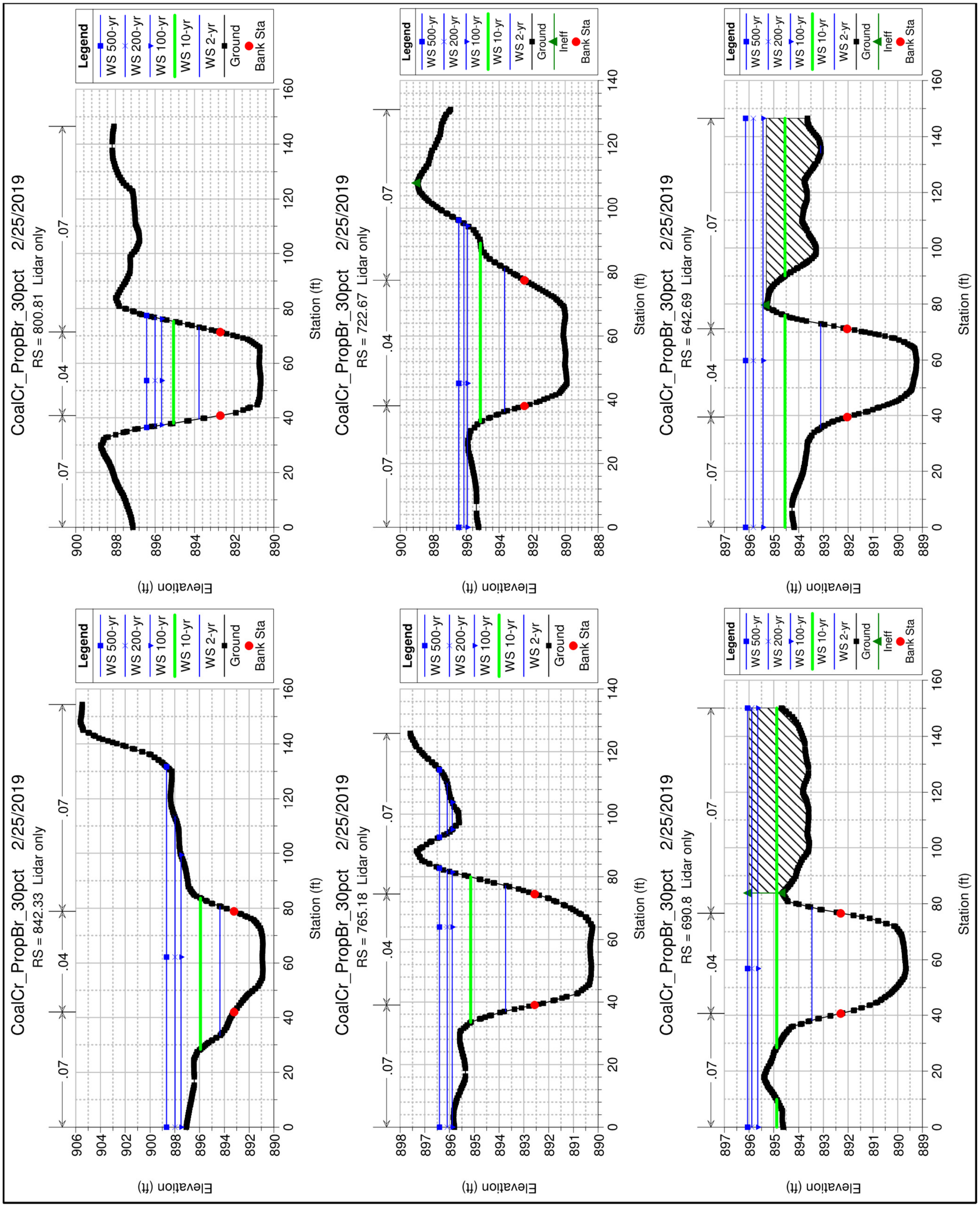


Figure B2. HEC-RAS Coal Creek hydraulic model cross sections for proposed bridge #3035A.

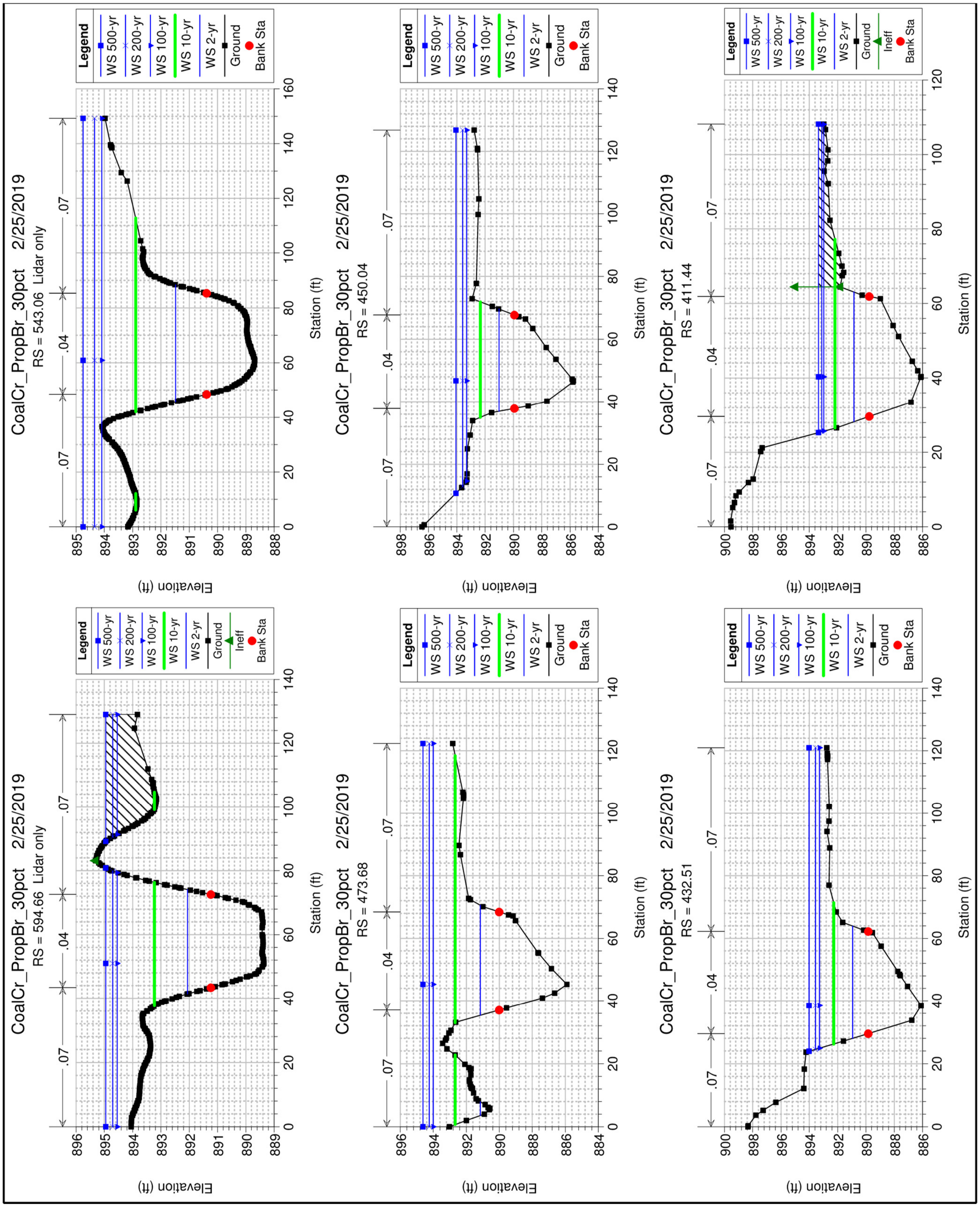


Figure B2 (continued). HEC-RAS Coal Creek hydraulic model cross sections for proposed bridge #3035A.

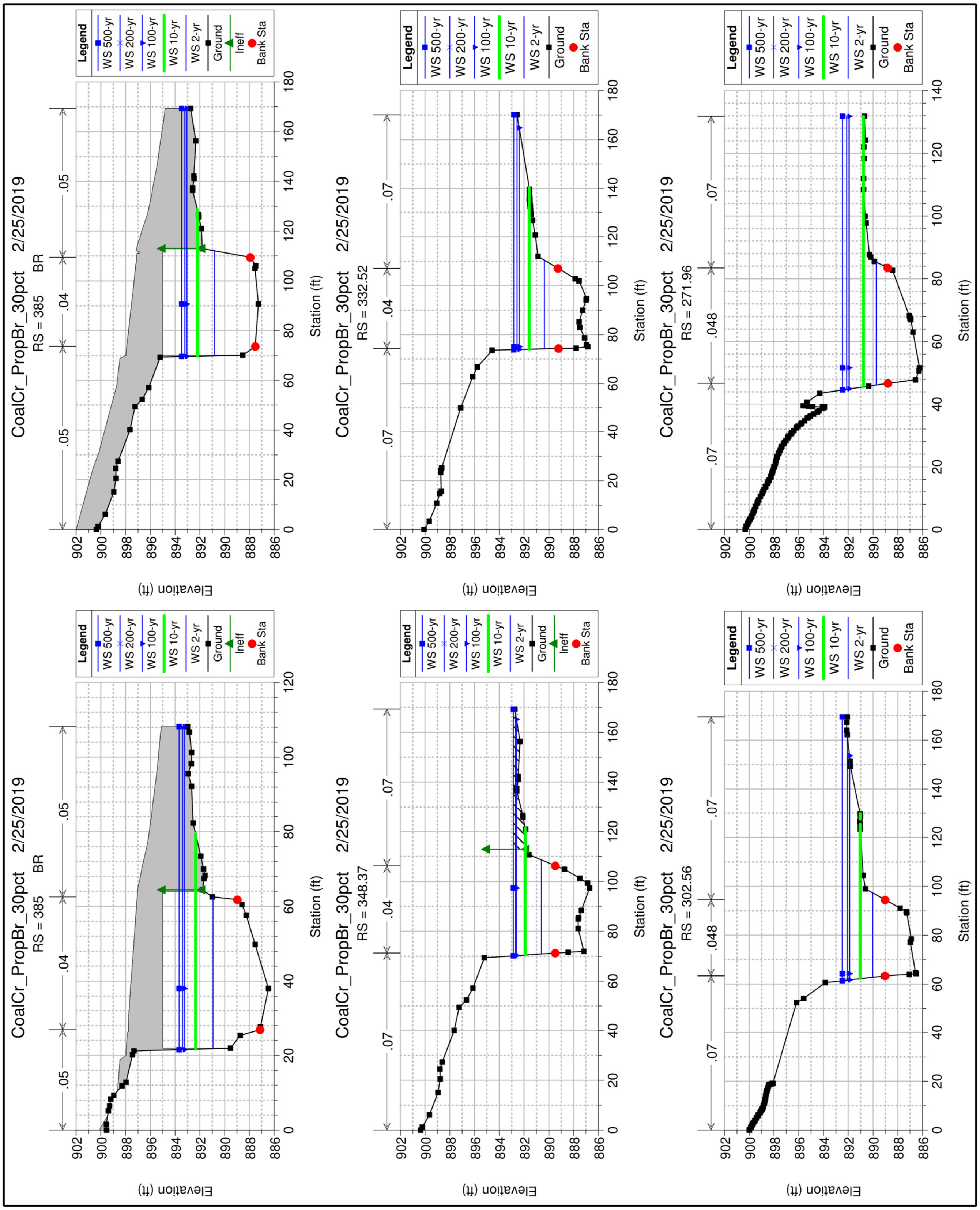


Figure B2 (continued). HEC-RAS Coal Creek hydraulic model cross sections for proposed bridge #3035A.

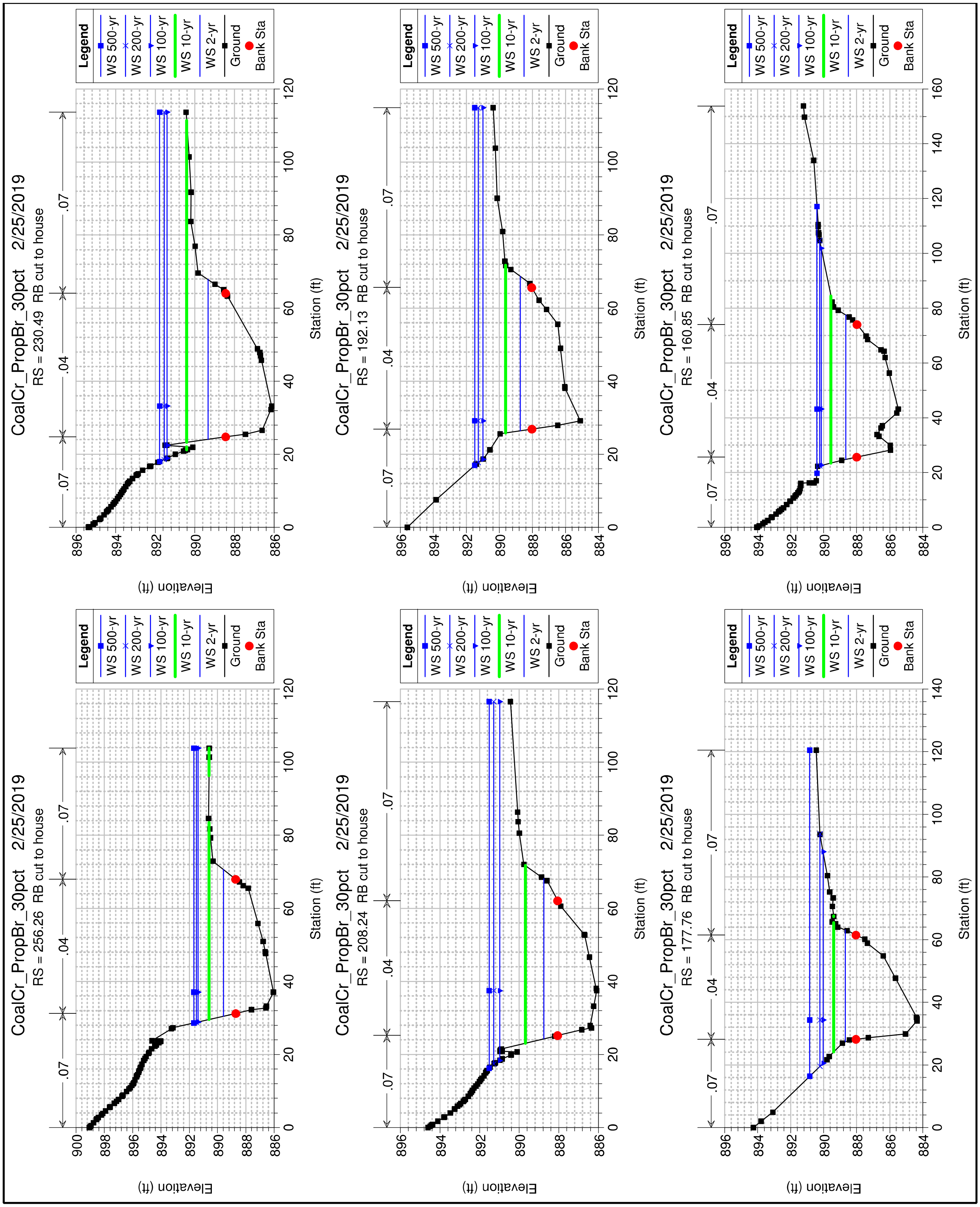


Figure B2 (continued). HEC-RAS Coal Creek hydraulic model cross sections for proposed bridge #3035A.

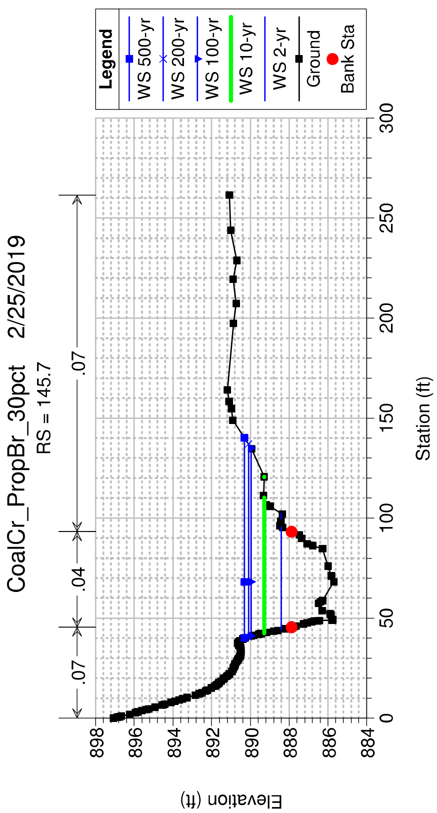
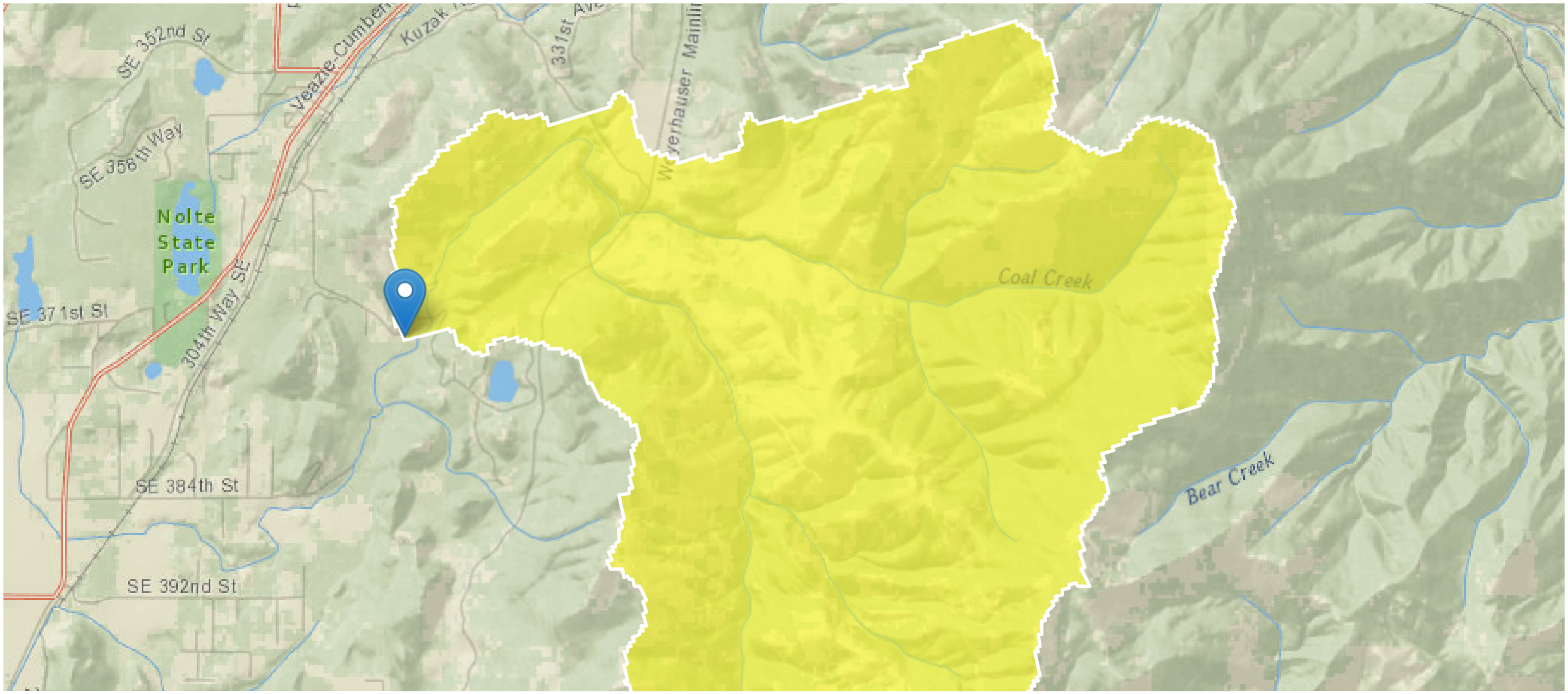


Figure B2 (continued). HEC-RAS Coal Creek hydraulic model cross sections for proposed bridge #3035A.

StreamStats Report - Coal Cr Bridge 3035A

Region ID:	WA
Workspace ID:	WA20190116013951596000
Clicked Point (Latitude, Longitude):	47.26728, -121.91831
Time:	2019-01-15 17:40:05 -0800



King County Bridge 3035A over Coal Creek

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM30M	Mean basin slope computed from 30 m DEM	39.2	percent
CANOPY_PCT	Percentage of drainage area covered by canopy as described in OK SIR 2009_5267	56.7	percent
DRNAREA	Area that drains to a point on a stream	8.96	square miles
ELEV	Mean Basin Elevation	2160	feet
ELEVMAX	Maximum basin elevation	3870	feet
MINBELEV	Minimum basin elevation	889	feet
NFSL30	North-Facing Slopes Greater Than 30 Percent	19.3	percent
PRECIP	Mean Annual Precipitation	82.5	inches
PRECPRIS10	Basin average mean annual precipitation for 1981 to 2010 from PRISM	93.5	inches
RELIEF	Maximum - minimum elevation	2980	feet
SLOP30_30M	Percent area with slopes greater than 30 percent from 30-meter DEM.	71.3	percent

Peak-Flow Statistics Parameters [Peak Region 3 2016 5118]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	8.96	square miles	0.08	2610
PRECPRIS10	Mean Annual Precip PRISM 1981 2010	93.5	inches	33.2	168

Peak-Flow Statistics Flow Report [Peak Region 3 2016 5118]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
2 Year Peak Flood	593	ft^3/s	301	1170	43.2
5 Year Peak Flood	901	ft^3/s	448	1810	44.4
10 Year Peak Flood	1110	ft^3/s	543	2250	45.6
25 Year Peak Flood	1360	ft^3/s	643	2890	48.1
50 Year Peak Flood	1550	ft^3/s	709	3380	50.5
100 Year Peak Flood	1750	ft^3/s	786	3890	51.8
200 Year Peak Flood	1940	ft^3/s	842	4490	54.2
500 Year Peak Flood	2210	ft^3/s	918	5330	57.7

Peak-Flow Statistics Citations

Mastin, M.C., Konrad, C.P., Veilleux, A.G., and Tecca, A.E.,2016, Magnitude, frequency, and trends of floods at gaged and ungaged sites in Washington, based on data through water year 2014 (ver 1.1, October 2016): U.S. Geological Survey Scientific Investigations Report 2016–5118, 70 p. (http://dx.doi.org/10.3133/sir20165118)

APPENDIX C CALCULATIONS SUMMARY – SCOUR

Contraction scour and bend scour were calculated for the proposed Coal Creek bridge #3035A at SE Lake Walker Road. The contraction scour was calculated by applying Laursen's Live-Bed methodology as described in HEC-18 (FHWA 2012). Armoring for was estimated to eliminate the contraction scour using HEC-18 methods. Armoring has been assumed to be equal to contraction scour for calculation purposes.

Table C1. Contraction scour calculation results for the Proposed Bridge.

Peak Flow	Y1 (ft)	Q1 (cfs)	Q2 (cfs)	W1 (ft)	W2 (ft)	K1	Y2 (ft)	Y0 (ft)	Scour (ft)
100yr	6.3	1,294	1,498	31.4	34.9	0.59	6.7	5.9	0.8
200yr	6.5	1,350	1,603	31.4	34.9	0.59	7.1	6.1	1.0
500yr	6.9	1,444	1,781	31.4	34.9	0.59	7.8	6.3	1.5

The Thorne and Abt (1992) equation for bend scour was applied after reviewing several methods. The HEC-RAS hydraulic model results for the proposed bridge geometry were used to determine a Y1 depth upstream between bends at section 543. The Y1 depth was calculated as the hydraulic depth in the channel. The bend scour equation was used to estimate a maximum depth of scour at the bend and compare that to the existing depths from the model. The resulting depth of scour was assumed to be the same at the bridge, though total depth would be less as the bridge is downstream of the bend. The bend scour depth is most likely to occur at the left (east) bank side; however bridge inspection reports suggest that historically the thalweg may have migrated to the center or right (west) bank under the bridge. The calculations are shown in the table below.

Table C2. Bend scour calculation results for the Proposed Bridge.

				Upstream (Y1)		**at Br**	**at Bend**		**Thorne&Abt(1992)/Rozovskii(1957)**			
Peak Flow	Radius of Bend	Width	R/W	Y1	Y1 FG	Ymax EG	Ymax EG		Ymax	Scour		X, Distance to end of currents
	(FT)	(FT)		(FT)	(FT)	(FT)	(FT)		(FT)	(FT)		(FT)
100yr	80	35	2.29	5.0	5.7	6.8	8.1		9.6	1.5		173.4
200yr	80	35	2.29	5.2	5.7	6.9	8.3		9.9	1.6		178.4
500yr	80	35	2.29	5.7	5.7	7.2	8.7		10.9	2.2		188.5

Appendix F

Preliminary Critical Areas Memo

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King County
Department of Local Services
Road Services Division

February 20, 2019

TO: File

FM: Katie Merrell, Environmental Engineer III, Environmental Unit

RE: Coal Creek Bridge #3035A Replacement Project #1135997
Preliminary Critical Areas Memorandum

This preliminary critical areas memorandum (memo) includes the project description, environmental baseline of the project area, a synopsis of applicable regulations, and anticipated actions needed to mitigate project impacts. More specific critical area and regulatory information will be provided after the preferred bridge replacement alternative is identified. If needed, wetland delineations and ratings will be completed preferably in the spring. Aquatic area/stream investigations will be completed preferably in the low-flow conditions of summer.

Project Location

The Coal Creek Bridge #3035A is located in unincorporated King County on SE Lake Walker Road, at the Coal Creek crossing near the intersection with 320th Avenue SE, and near the community of Cumberland. The project site is approximately four miles east of the City of Black Diamond, within the NE Quarter of Section 33, Township 21N, Range 07E, and can be found on page 779 (Row 4, Column C) of the Thomas Brothers Guide. The site is located at N47.26867 and W-121.91551.

Project Background

King County is studying design alternatives to replace Coal Creek Bridge #3035A. The bridge replacement will be funded by the Federal Highway Administration (FHWA). The existing bridge's superstructure is a two-lane single span that is 41 feet long and 18 feet wide. The bridge is founded on creosote-treated timber piles driven to an unknown depth. The bridge abutments consist of treated timber piles and lagging. The bridge is presently load-limited and has an Average Daily Traffic (ADT) count of 310 (2017). SE Lake Walker Road is a designated county snow/ice route, school bus, and lifeline route. The bridge provides sole access to 118 parcels, which includes approximately 70 residences and a Department of Fish and Wildlife boat launch for public recreational access to Lake Walker. Adjacent land use includes single-family rural residences, mobile homes, and commercial forest areas.

The original plate girders of the structure came from Bridge 164E, built by King County in 1912. This bridge originally spanned Bear Creek on NE Union Hill Road. Bridge 164E was widened in 1955; the plate girder-floor beam system were removed and replaced with girders supporting a steel deck pan. The girders and floor beam system was later transported to SE Lake Walker Road and used to span Coal Creek. Thus, the bridge built at Coal Creek has the same substructure design as bridge 164E prior to the widening in 1955 and is 107 years old as of 2019.

The bridge has a sufficiency rating of 9.68 out of 100 and was identified in the King County 2017 Annual Bridge Report as a priority for replacement. The roadway at the bridge location has a substandard horizontal curve, the timber back wall planks and timber piles are deteriorated, there is widespread rust corrosion on the steel floor beams, and peeling paint throughout the structure. The bridge abutments restrict the ability to convey flood flows in Coal Creek.

Project Description

The Coal Creek Bridge #3035A Replacement Project is presently in the Preliminary Design Phase. The following information reflects known information as of February 2019.

The bridge replacement will probably be constructed with a wider clear span over the creek. The existing bridge piles will be removed to the extent possible; if full removal of in-water piles is not possible, the piles will be cut below the mudline of the creek and capped with streambed gravel substrate.

The currently unmapped floodplain of the creek will be delineated to determine if the bridge supports can be placed outside of the stream's localized floodplain. Deep foundations will probably be needed at this location because the bridge is in a seismically vulnerable area.

Anticipated Project Impacts

The project will require riparian area disturbance and over-water and in-water work to complete the following:

- Deconstruct the bridge: temporary erosion and sediment control (TESC) installation, tree removal, vegetation clearing, fish relocation and stream dewatering/diversion, pile removal, excavation
- May require a temporary bridge, or work trestle which may require pile driving or drilled shafts
- Conduct fill/riprap removal and streambank stabilization
- Construct the new bridge which may require pile driving or drilled shafts
- Placement of fill, new streambed material, erosion control, and native planting
- Installation of large wood structures in the stream channel

The work for the project will impact the streambed and the vegetated riparian areas. The potential for changes to stormwater quality and quantity from changes in impervious surfaces are being evaluated. The project will require that at least one traffic lane be available at all times because this is a sole-access route.

The bridge replacement may require private property instruments, including permanent acquisitions, temporary construction easements, permanent easements, and private driveway reconstructions. Survey of the stream channel characteristics will be conducted approximately 500 feet up and downstream from the bridge. Presently, Right-of-Entry (ROE) to the study parcels is incomplete.

Anticipated Project Benefits:

The project will provide the following benefits:

- Accommodate natural stream processes including improved sediment and wood transport
- Less debris accumulation at the bridge, minimizing the potential for scour
- Elimination of the load limit on the bridge
- Improved safety for the traveling public

Construction Timing and Duration

Construction is anticipated to begin in 2021. The duration of construction activities will be based on the preferred design.

Environmental Baseline and Regulations

Desktop Resources

The environmental baseline for the project site was analyzed using existing literature and resources. The following desktop resources were reviewed:

- Washington Department of Fish and Wildlife (WDFW)

  - Priority Habitat and Species (PHS) on the Web – Interactive Mapping Tool
  - Salmonscape – Interactive Mapping Tool
- United States Fish and Wildlife Service (USFWS) information for Planning and Consultation – Interactive Mapping Tool
- National Marine Fisheries Service species list for Puget Sound
- King County iMap
  - Environmentally Critical Areas (Critical Areas Layer 2018)
  - Flooding Information
  - Hydrography and Hydrology
  - Groundwater
  - Planning/Miscellaneous Designations/Shoreline Management Designations

King County Critical Areas

King County defines critical areas under King County Code (KCC) 21A.24 and KCC 21A.06 as land with natural hazards or land that supports certain unique, fragile, or valuable resource areas. Critical areas and their buffers designated by King County include areas at high risk of erosion, landslides, earthquakes or flooding; coal mines; fish and wildlife habitat conservation areas, streams, lakes, wetlands or lands adjoining streams, rivers, and other water bodies. The following subsections describe critical areas present at the project site and a summary of applicable federal, state and local regulations.

Aquatic Areas/Streams

Aquatic Areas are streams regulated under KCC 21A.24.355, Chapter 75.20 of the Revised Code of Washington (RCW), Chapter 173-225 Washington Administrative Code (WAC), Chapter 220-110 WAC, Section 401 and 404 of the Clean Water Act (CWA). Coal Creek is a fish-bearing Type S (Shorelines of the State) perennial water body that has a minimum of a 165-foot-wide critical area buffer under KCC 21A.24. Shoreline jurisdiction extends 200 feet landward of the ordinary high water mark (OHWM).

Coal Creek is approximately 9.2 miles long and is within the upper sub-basin of Water Resource Inventory Area 08 (Duwamish/Green River Watershed), which outfalls eventually to Puget Sound. The main stem of Coal Creek empties into Fish Lake. This lake has no surface outflow and so is not directly linked by surface connection to the main stem of the Green River; however, it is likely that water from Fish Lake flows underground and surfaces as perched springs and/or riverbed springs in the Green River streambed in the vicinity of River Miles 48 – 50.

The channel width is approximately 40.5 feet wide at the bridge crossing. The OHWM and bankfull channel indicators will be identified in the field and the 100-year flood elevation will be estimated as the project design is developed. After the preferred alternative is selected, additional stream investigations will likely occur in support of federal regulatory compliance under the CWA, Endangered Species Act (ESA), and Magnuson-Stevens Act (MSA), and local, state and federal permits. See the enclosed permit matrix for additional regulatory triggers.

Wetlands

Wetlands are regulated under KCC 21A.24.318 - 21A.24.345 and Section 404 of the Clean Water Act. According to the King County iMap, WDFW PHS data, and the USFWS National Wetland Inventory, there are no mapped wetlands within the anticipated project limits. However, smaller wetlands are not well represented in these inventories. County environmental staff observations during a limited preliminary site visit in January 2019 did not identify any suspected wetlands. Once the project footprint is known, additional site visits by county environmental staff will confirm if wetlands are indeed absent.

Groundwater
The project is within a Critical Aquifer Recharge Area that is highly susceptible to groundwater contamination. Groundwater was encountered at a depth of approximately 13 feet below road grade during geotechnical boring, which is about the same level as the approximate stream elevation.

Geological Critical Areas
The project's *Geotechnical Report* (September 2018), prepared by King County, characterizes the soil and groundwater conditions for the project. The project is in a mapped Seismic Hazard area, which is an area that is at risk for severe earthquake damage due to seismically induced settlement, soil liquefaction, or lateral spread.

Flood Hazard Areas – FEMA Floodplain/Floodway
Floodplains and floodways are regulated under KCC 21A.24.230 - 21A.24.271. The FEMA floodway and 100-year floodplain are not mapped within the project area. However, streams typically have unmapped floodplains the extent of which will be modelled according to methods prescribed by the latest version of the King County Surface Water Design Manual.

Wildlife Habitat
Wildlife habitat conservation areas and wildlife habitat networks are regulated under KCC 21A.24.382 - 21A.24.386. According to King County iMap, there are no fish and wildlife habitat conservation areas mapped within the project area. Presence of cutthroat trout in Coal Creek has been documented by several sources. Wildlife habitat within the project area has been impacted by anthropogenic influences.

Additional Regulations

National Environmental Policy Act
The lead federal agency for the project is the FHWA. The project will require a Documented Categorical Exclusion.

Endangered Species Act and Magnuson-Stevens Act
Federal ESA-listed threatened or endangered species are listed as potentially occurring within the project limits. The project area will be further analyzed in this respect as the design develops. The entire Coal Creek watershed is inaccessible to salmon and so the project will not result in adverse modification of Essential Fish Habitat.

Section 106 of the National Historic Preservation Act (Cultural Resources)
The King County Road Services Division (RSD) Archaeologist screened the project on February 14, 2017. The general setting of the project on a freshwater stream in the vicinity of a historically mapped trail suggests a high likelihood for unknown buried intact prehistoric archaeological deposits. In addition, the project area was historically mined for coal, as the name of the creek suggests. Unrecorded historic mining features and artifacts may be present in the project area. The project location includes a previously installed bridge and existing road prism. These factors reduce the likelihood of intact prehistoric archaeological deposits somewhat. However, federal funding is anticipated and a federal permit may be required for this project. Section 106 procedures, beginning with the formal definition of an Area of Potential Effects (APE) and consultation with the state and Tribes will be required. The APE will include the footprint of the new bridge, footprint of the existing bridge, any temporary by pass roads, staging areas, and mitigation areas. The existing bridge will be evaluated for historical significance.

Preliminary soil investigations received a Section 106 exemption from Washington Department of Transportation on June 13, 2018. An archaeological survey will be completed for the project with screened shovel probes as soon as the APE and corresponding private property Rights-of-Entry are available. As for all RSD projects, if cultural resources or human remains are encountered during construction all work will cease and RSD policies will be followed.

Shoreline Management Act

Shoreline Management Areas are regulated under KCC 20.20.100, KCC Title 25, RCW 90.58; WAC 173-27-050; WAC 173-14, 16, 17, 18.210, 19, & 22. According to iMap, the project is within both Aquatic and Conservancy shoreline designations.

Green Building Ordinance #17709 (2005)

The preferred alternative will be reviewed in accordance with the King County Green Building Ordinance upon development of 30-percent plans. This review will identify opportunities for design and construction measures to support sustainability goals in King County, including a project-level goal of reaching platinum-level performance to reduce greenhouse gas emissions. Measures will also focus on sustainable materials, construction demolition and diversion, preservation of natural site amenities, stormwater management, and social and equity issues.

Anticipated Permits and Approvals

Federal:

- National Environmental Policy Act Documented Categorical Exclusion
- United States Fish and Wildlife Service and National Marine Fisheries Service Endangered Species Act Review
- United States Army Corps of Engineers Section 404 of the Clean Water Act Permit

Federal/State: National Historic Preservation Act Section 106 Concurrence by the Washington State Department of Historic Preservation

State:

- State Environmental Policy Act (SEPA) Determination of Non-significance and Notice of Action Taken
- Washington State Department of Fish and Wildlife Hydraulic Project Approval

Local:

- King County Department of Local Services Permitting Division
  - Shoreline Substantial Development Permit
  - Clearing and Grading Permit
  - Flood Hazard Certification
- King County Green Building Ordinance Green Building Assessment

Mitigation

The project follows requirements for mitigation sequencing as outlined in the SEPA Rules under Washington Administrative Code Chapter 197-11-768, which includes avoiding, minimizing, rectifying and compensating for impacts to critical areas. Temporary and permanent impacts are anticipated to the stream and stream buffer. The stream buffer is defined by KCC as extending for 165 feet from the OHWM. Permanent impacts include the footprint of the proposed bridge and bridge approaches, and temporary impacts include the detour/construction trestle, associates piles, and piles needed for the construction of the bridge.

The project will avoid impacts by:

- Designing the proposed bridge and piers to be located above/landward of the OHWM
- Limiting the project footprint to the smallest area possible
- Protecting riparian habitat to the extent possible
- Protecting large trees to the extent possible

The project will minimize impacts by:

- Limiting the footprint of permanent piers and temporary support piles to the extent possible
- Limiting on site riparian and in-stream disturbance using fencing or flagging prior to construction
- Performing in-water work within the designated low-flow work window to minimize impacts to fish
- Installing TESC and implementing best management practices (BMPs) prior to and during construction
- Implementing a Stormwater Pollution Prevention Plan (SWPPP) and Spill Prevention Control and Countermeasures Plan (SPCC) to protect water quality
- If feasible, using vibratory pile driving to install and remove piles instead of impact pile driving
- Reducing Greenhouse Gas Emissions during construction
- Removing fish from the work area prior to construction
- Removing creosote-treated timber from the riparian area, buffer, and floodplain.

Rectification and compensatory mitigation will be required for the following impacts:

- Riparian habitat temporarily impacted by the project will be replanted with native vegetation upon completion of the project. Permanent impacts to riparian habitat may result in the need for mitigation in an off site location. Installation of large wood structures within the stream channel will compensate for loss of wood recruitment.
- Significant trees with a diameter at breast height greater than four inches removed for bridge replacement may require on site or off site mitigation to achieve a minimum planting ratio of 3:1; the final ratio will be determined by permit and approval requirements.
- Stormwater mitigation measures, if required, will be determined as the design for the project progresses.
- Other mitigation measures for fish and wildlife may include implementation of nest-protection buffers and/or bird exclusion BMPs for any active nests observed near the project site, particularly for sensitive species during the breeding season.

Please contact me at Katie.Merrell@kingcounty.gov or 206-477-3548 if there are any questions related to this memo.

Enclosures

KM:mr

cc: Trinh Truong, Project Manager/Engineer IV, Engineering Services Section (ESS), Road Services Division (RSD), Department of Local Services (DLS)
Stephen Conroy, Environmental Scientist III, Environmental Unit, Maintenance Section, RSD, DLS

Coal Creek Bridge #3035A Replacement Project #1135997 Vicinity Map 1

February 19, 2019

N

2 1 0 2 Miles

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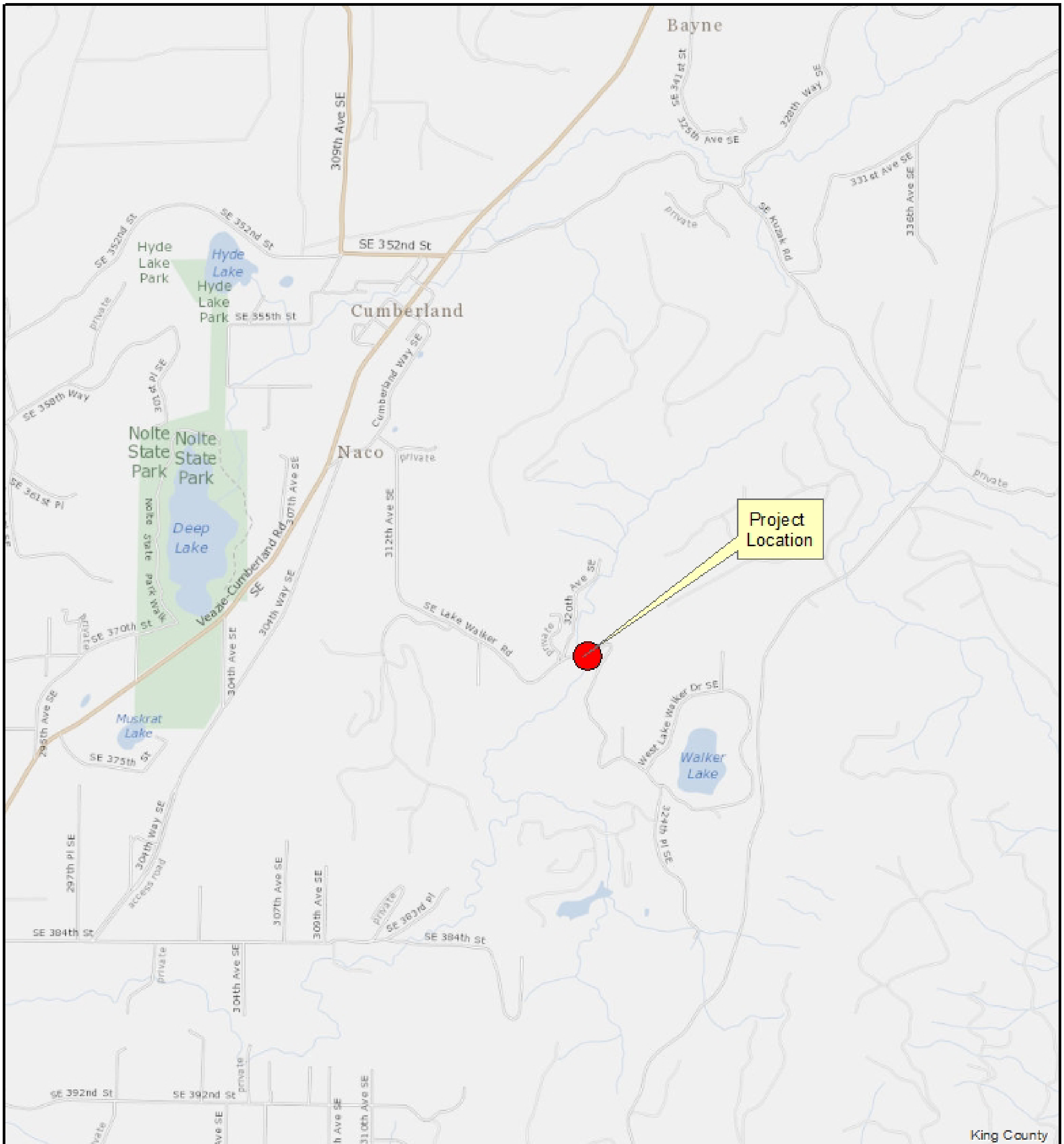

Coal Creek Bridge #3035A Replacement Project #1135997 Vicinity Map 2

N

1,500 750 0 1,500 Feet

February 19, 2019

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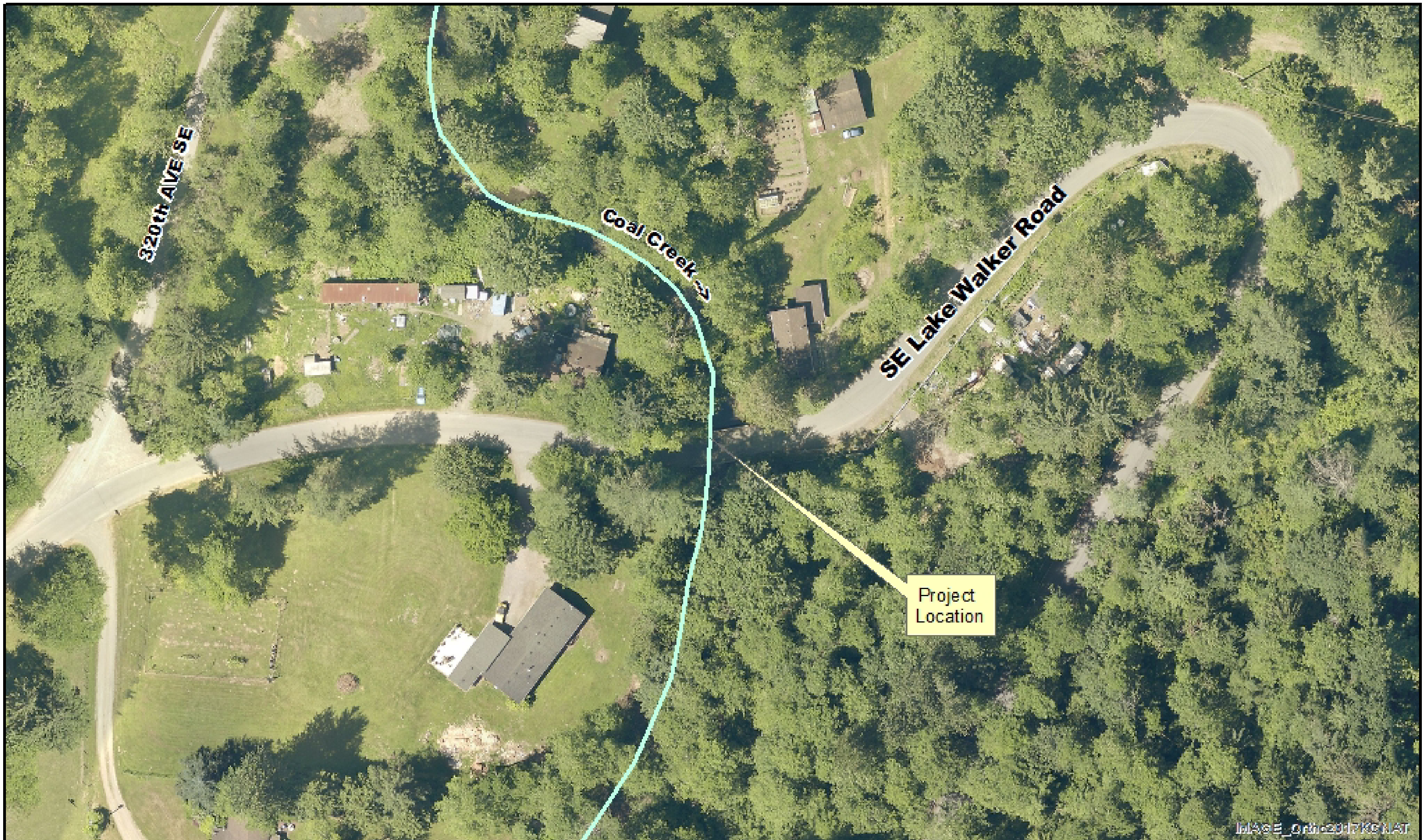
King County



Coal Creek Bridge #3035A
Replacement Project #1135997
Vicinity Map 3

February 20, 2019

N

100 50 0 100 Feet

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Looking southwest/downstream at the bridge profile


Looking southwest at the bridge deck

Looking east at the bridge deck


Looking east at the upstream bridge profile

Looking west at the bridge approach/horizontal curve

Looking south/downstream from the bridge deck

Looking north/upstream from the bridge deck

Looking east at the upstream/right bank vegetation


Looking west on SE Lake Walker Road at the bridge deck and surrounding tree canopy vegetation

Appendix G

Public Outreach Summary and Comment Log

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King County Department of Local Services, Road Services Division
Coal Creek Bridge Replacement Project
March 26, 2019 Open House Report

Introduction

The King County Road Services Division is evaluating alternatives for replacing the Coal Creek Bridge #3035A on SE Lake Walker Road in unincorporated King County. The bridge provides sole access to a community of approximately 70 single-family homes and a Department of Fish and Wildlife boat launch to Lake Walker.

King County hosted an open house on Tuesday, March 26 from 6 to 7:30 p.m. at the Enumclaw Fire Department Cumberland Station. Residents and other stakeholders were invited to attend to learn about and provide comment on the alternatives.

Open House Promotions

The open house was promoted through a variety of methods:

- **Website:** Information about the open house was posted on the project webpage.
- **Media:** Information about the open house was sent to the Enumclaw Courier-Herald.
- **Signage:** Information about the project and the open house was posted near the Coal Creek Bridge.
- **Door-to-door notification:** Brent Champaco, Community Relations Planner, conducted door-to-door outreach and delivered flyers to the properties to the east of the Coal Creek bridge.

Open House Details

Approximately 32 people attended the open house at the Cumberland Fire District. As people arrived, they were greeted, asked to sign-in, informed of the format and oriented about the set-up of the room. Participants were encouraged to view the boards, fill out a comment form and to share comments and questions with project staff.

There were eight boards on display which provided information on:

- Welcome
- Project location
- Project schedule
- Why replace the existing bridge?
- Bridge type
- Alternative 1

- Alternative 2
- Alternative 3

Open house participants were also encouraged to take a project handout, FAQ and Road Alert information.

Comment Summary

The comments below are a high-level summary of what the public shared with study staff during the open house and on the comment forms that were submitted.

Comments on bridge alternatives

- Overall, open house attendees agreed that the bridge needs to be replaced.
- Open house participants were glad to see that the road approach and the new bridge will both be wider than the existing conditions. Some people suggested that this will help keep traffic moving in two directions even during a snow event.
- A few open house participants mentioned that during high water events, the river overtops the road approach on the west side of the existing bridge. They said the creek needs to be fixed and/or a higher bridge should be put in.

Comments on bridge construction

- Open house participants agreed that the one-lane temporary bridge width is enough for the volume of traffic that uses this route.
- They were also glad to hear that the temporary bridge will be signalized.

Other comments

- Most people at the open house mentioned that the road leading to and from the bridge is in terrible condition and needs to be replaced/repaved.
    - Road has been bad for at least 2 years.
    - The condition of the road is dangerous to all modes, particularly motorcycles and school busses.
- Some people requested that additional traffic control features be added on the road. Some examples mentioned included:
    - Widen the road at the top of the hill
    - Add a speed limit sign (25 mph) at the top of hill
    - Add a stop sign at West Lake Walker Drive SE
    - Stripe the centerline along SE Lake Walker Road
    - Examine the height of the guardrail just before the downhill hairpin turn.
    - Add a stop sign for traffic leaving Lake Walker boat launch area

	King County Department of Local Services, Road Services Division Coal Creek Bridge Replacement Project Public Comment Register							
No.	**Name**	**Affiliation/ organization**	**Email**	**Phone**	**Comment**	**Comment date**	**Who is responsible for drafing a response?**	**Response**
1	Bill				Please fix roads leading to/from bridge and other bridges in vicinity, including the railroad crossing. Lived in the area since 1992 and have observed one flood that flooded mobile home. I want 25 mph signs at top of hill. We want a traffic study stop sign at West Lake Walker Drive SE. Strip the centerline along SE Lake Walker Road.	3/26/2019	KC	The comment has been forwarded to our Traffic Operations Unit for reivew. Further investigation of this subject is needed.
2	Steve			206-504-0446	I want to see a traffic study. Widen road at top of hill and post a speed limit of 25 MPH. School bus issues: road is too narrow for busses to turn. Top of road/hill, can we have a traffic calming device? We heard work for traffic would happen by last October. Can the road be striped at least? How about the centerline. Just before the downhill hairpin turn, please look at guardrail height.	3/26/2019	KC	The comment has been forwarded to our Traffic Operations Unit for reivew. Further investigation of this subject is needed.
3					Before the bridge work there are a few other issues that concern the neighborhood, up the hill! Since it's getting more congested, the hill itself seems to be sluffing off. New pavement? There should be lines down the middle. At the top there should be proper signage showing directions better and also a stop sign from the boat launch area. Thank you for your time. Just a reminder, quite a few years back, the water (by the bridge) took the path of least resistance across the two yards (over six feet across the road) before the bridge so having a higher bridge would be a waste until the creek is fixed.	3/26/2019	KC	The comment has been forwarded to our Traffic Operations Unit for reivew. Further investigation of this subject is needed.
4	Verbal comment made at open house				Will there be a weight restriction (lower than existing bridge) on the temporary bridge?	3/26/2019	KPFF	There will no weight restrictions on the temporary detour bridge.
5	Verbal comment made at open house				Will the road also be repaved when the bridge is constructed?	3/26/2019	KPFF	The roadway will be repaved within the anticipated project limits required to construct the bridge. Due to the limited funds and resouces, County Roads Divsion is not able to overlay SE Lake Walker Road at this time. Please report any unincorporated King County road issues, including those on SE Lake Walker Road, to King County 24/7 Road Helpline at 206-477-8100 or toll-free at 800 527-6237. For non-urgent issues, please email King County Roads Division at maint.roads@kingcounty.gov
6	Verbal comment made at open house				Instead of building a temporary bridge, why doesn't the County use other existing roads?	3/26/2019	KPFF	There are no existing County owned roads that are available for a temporary detour. SE Lake Walker Road is the only means of access for residents that live in and around Lake Walker

	King County Department of Local Services, Road Services Division Coal Creek Bridge Replacement Project Public Comment Register							
No.	**Name**	**Affiliation/ organization**	**Email**	**Phone**	**Comment**	**Comment date**	**Who is responsible for drafing a response?**	**Response**
7	Verbal comment made at open house				The road leading to and from the bridge is in terrible condition and needs to be replaced/repaved. It's been bad for at least 2 years. It is dangerous to all modes, particularly motorcycles and school busses.	3/26/2019	KC	The roadway will be repaved within the anticipated project limits required to construct the bridge. Due to the limited funds and resouces, County Roads Divsion is not able to overlay SE Lake Walker Road at this time. Please report any unincorporated King County road issues, including those on SE Lake Walker Road, to King County 24/7 Road Helpline at 206-477-8100 or toll-free at 800 527-6237. For non-urgent issues, please email King County Roads Division at maint.roads@kingcounty.gov
8	Verbal comment made at open house				Glad to see that the road approach to the bridge will be widened	3/26/2019	KPFF	Comment noted.
9	Verbal comment made at open house				Glad to hear that the temporary bridge will be signalized	3/26/2019	KPFF	Comment noted.
10	Verbal comment made at open house				Glad to hear that the new bridge will be wider than existing bridge	3/26/2019	KPFF	Comment noted.
11	Verbal comment made at open house				During high water events, the river overtops the road approach on the west side of the existing bridge. They said the creek needs to be fixed and/or a higher bridge should be put in.	3/26/2019	KPFF	The proposed bridge will be approximately 3 feet higher than the existing birdge.
12	Verbal comment made at open house				As you go up the hill east of the existing bridge around the hairpin turn, the property owner that owns the large parcel of land SE of the bridge has put up a fence which now blocks some of the sight distance that the public used to have prior to the fence being placed.	3/26/2019	KC	The comment has been forwarded to our Traffic Operations Unit for reivew. Further investigation of this subject is needed.
13	Verbal comment made at open house				The new 26' wide bridge deck width should keep 2 lanes moving even during the snow. People said that KC did plow the road during the snow storm. The plow got up around the hairpin turn to the east but wasn't able to get all the way to the lake.	3/26/2019	KPFF	Comment noted.
14	Verbal comment made at open house				The structure immediately northeast of the bridge was supposedly an old coal weigh station. He wasn't sure about the structure northwest of the bridge if it had any relation to the coal industry.	3/26/2019	KPFF	Comment noted.
15	Verbal comment made at open house				General agreement that the one lane temporary bridge width will be sufficient enough for the volume of traffic that uses this route.	3/26/2019	KPFF	Comment noted.
16	Verbal comment made at open house				Has King County spoken with the property owner southwest of the existing bridge yet? Since the primary right-of-way need is either a strip of permanent right-of-way take or temporary construction easement they were curious if we have spoken with them.	3/26/2019	KC	King County will communicate with the property owner after the preferred alternative of bridge type and location is selected.