DRAFT Alternatives Analysis Report for George Davis Creek Fish Passage Project

Sammamish, Washington

Prepared for:

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PBS Project 45015.001

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1 INTRODUCTION

George Davis Creek (or Creek) presents an opportunity to create a project that provides access to habitat for fish in Lake Sammamish, including the severely endangered Kokanee salmon. Unfortunately, the lower reaches of the Creek are chocked full of barriers which include culverts, an overflow system, and manmade dams. A further complication is that most of the barriers exist on private property.

This feasibility study analyzed possible project alternatives within the lower reaches of George Davis Creek. Multiple alternatives were considered early on by the design team (PBS Engineering and Environmental Inc., Northwest Hydraulic Consultants, 48 North Solutions, and City of Sammamish Public Works), then eventually narrowed to four alternatives that were determined to be the most feasible and representative of a wide range of project scope and cost. These alternatives were then weighed against a common set of scoring criteria from which a preferred alternative will be chosen. All alternatives include some level of improvements upstream of East Lake Sammamish Parkway (ELSP), including the removal of the concrete dam upstream. The four alternatives are listed below:

1. Installing a culvert at ELSP that will tie into a planned culvert that will be located at the adjacent East Lake Sammamish Trail (ELST).
2. Routing the Creek to the north along the east side of the ELST to where the existing overflow discharges.
3. Rebuilding the Creek from the current outlet, constructing a series of fish passable culverts and bridges up to the east side of ELSP.
4. Rebuilding the Creek within the property adjacent to the existing outlet and constructing a similar series of fish passable culverts and bridges up to the east side of ELSP. This option includes acquiring the lower parcel at the water.

The four alternatives are presented in Figure 1.

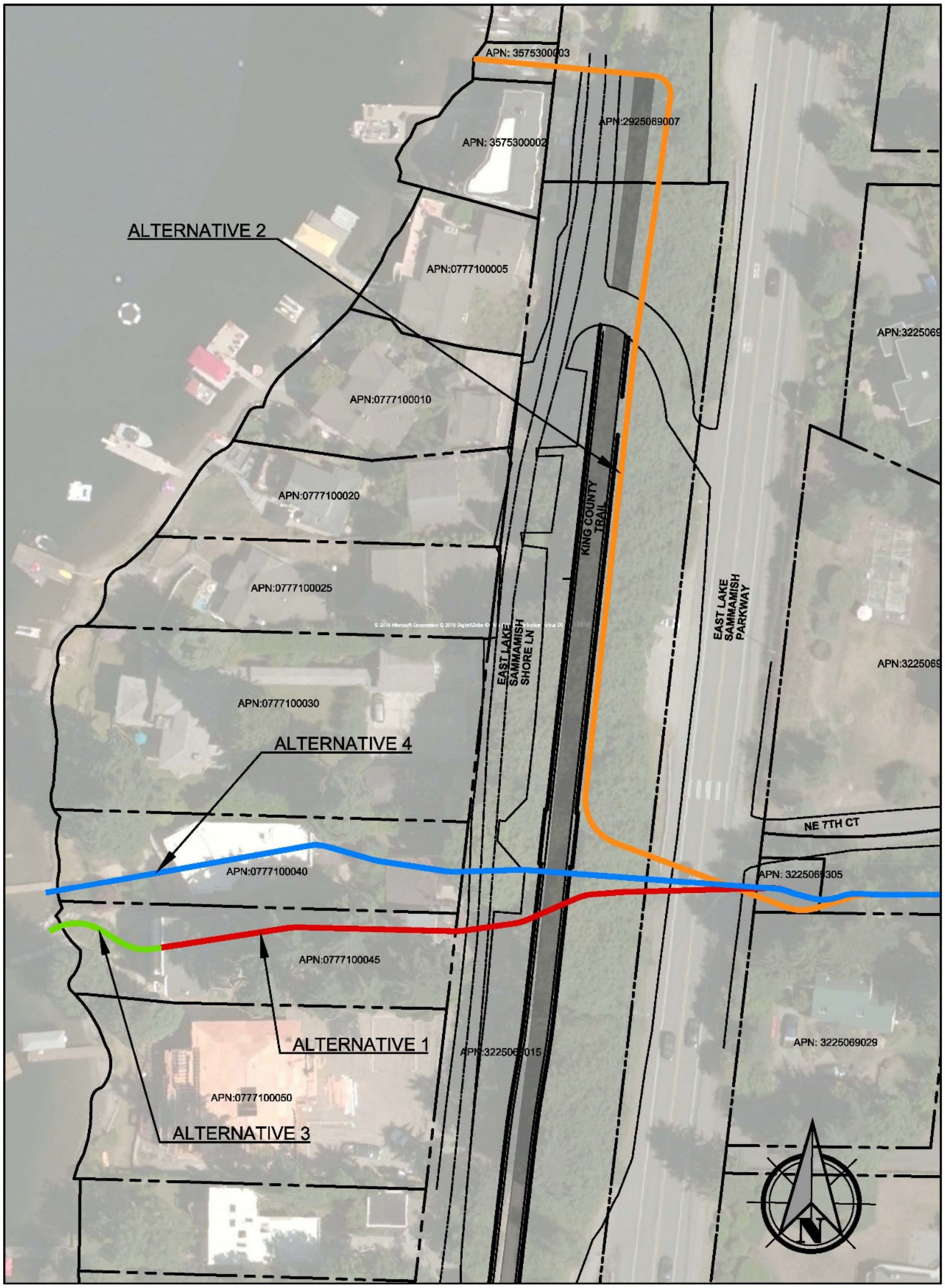

Figure 1. Four alternatives for the George Davis Creek Fish Passage Project.

2 EXISTING CONDITIONS

George Davis Creek is of great importance to the City of Sammamish (City), draining the Inglewood Basin to Lake Sammamish. The Creek flows through the heart of the City, roughly south and parallel to Inglewood Hill Road in the upper reaches, and flows into Lake Sammamish near NE 7th Court. The Creek flows east to west from the Sammamish Plateau into Lake Sammamish.

Northwest Hydraulic Consultants (NHC) and 48th North Solutions (48th NORTH) conducted a reach assessment of George Davis Creek extending from the mouth, at Lake Sammamish, to the NE 6th Street crossing approximately 1 mile upstream on August 14, 2018. Observations made during this site visit, as well as available data and information from previous studies, were evaluated to develop an understanding of existing conditions on the Creek with respect to anthropogenic changes, stream morphology, and aquatic habitat. Findings are presented in the following sections.

2.1 Physical Characteristics and Morphology

The lower mile of George Davis Creek, downstream of NE 6th Street, can be divided into four segments defined by longitudinal slope, degree of manipulation, and, to some extent, underlying geology.
Table 1 defines the stream segments and Figure 2 shows their locations.

Table 1. George Davis Creek Stream Segments

Segment	Station (feet)	Description	Average Slope (%)
1	0 – 500	Mouth to debris basin upstream of ELSP	5 to 16
2	500 – 1,200	Lower Ravine	4
3	1,200 – 2,100	Middle Ravine	8
4	2,100 – 5,000	Upper Ravine	4

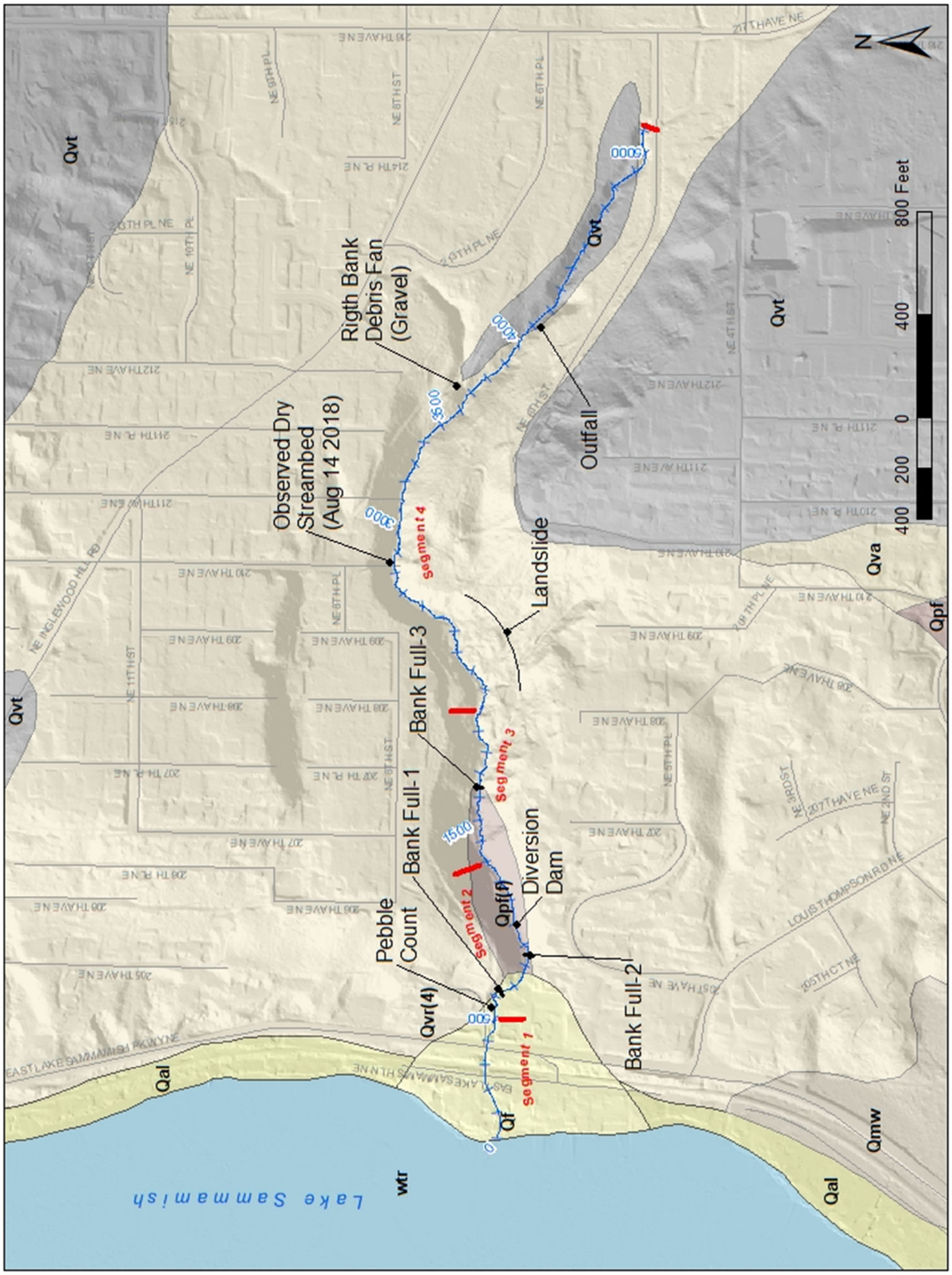

Figure 2. Reach overview map showing reach segment breaks, bank full and pebble count sample locations, field observations, and underlying geology (Booth et al., 2012).

2.1.1 Segment 1

Segment 1 is the most downstream and modified portion of George Davis Creek. Segment 1 is, on average, the steepest reach and unsurprisingly, presents the most significant barriers to upstream fish passage. Natural morphologic processes are suppressed in Segment 1 due to a combination of a high flow bypass and sedimentation basin just upstream of ELSP. Geologic mapping shows the entirety of Segment 1 as a fan deposit (Qf) (Booth et al., 2012). Such deposits formed through natural deposition of materials, ranging from boulder to sand-sized particles, transported from the upstream ravine since the last glaciation. Subsequent regrading and stream channelization have occurred. Segment 1 can be divided into five distinct sub-segments, 1a through 1e.

2.1.1.1 Segment 1a – Linde Property

Segment 1a, identified as the Linde Property (parcel number 0777100045), spans approximately 100 feet, from the mouth of George Davis Creek at Lake Sammamish upstream to the outlet of a 24-inch-diameter culvert. The segment was restored circa 2009 (Parametrix, 2017) to provide fish habitat within the segment, consisting first of 60 feet of open channel followed by 40 feet of enclosed channel underneath an existing residence. The upstream culvert outlets at the eastern foundation of this residence. The downstream open channel segment consists of a series of constructed step-pools, with channel top widths ranging from 3 to 9 feet, and an average gradient of 8 percent (0.08).

Steps are 0.5 to 1 foot in height and composed of boulder clusters. Channel banks are armored with similar boulder material and pool sections contain gravel-sized material. A boulder groin at the creek mouth extends approximately 15 feet into the lake and bends to the south to isolate potential sedimentation to a single property. Negligible sedimentation was observed on the lake shore during the site visit. The upstream portion of this segment is confined within an 8-foot-wide opening, effectively acting as an oversized box culvert, through the basement of the residence. The channel in this portion of the segment maintains a step-pool morphology composed of gravel and cobbles. A deck/footbridge spans the channel where it outlets the house, and the surrounding grounds are landscaped. Observation of Kokanee in Segment 1a during the reach assessment suggests fish passage is possible, but the reach is static from a geomorphic standpoint, as incoming sediment load and higher flood flows are diverted at a sedimentation and diversion structure located upstream of ELSP.

2.1.1.2 Segment 1b – 24-inch Private Culvert

Segment 1b consists of an approximately 150-foot-long, 24-inch-diameter clay pipe that carries George Davis Creek under East Lake Sammamish Shore Lane NE (ELSSL) and two lakefront properties. The estimated elevation drop through the culvert is 10 feet, with a slope of approximately 7 percent.

2.1.1.3 Segment 1c – East Lake Sammamish Trail

Segment 1c encompasses the 60-foot portion of George Davis Creek between ELSP and ELSSL, where it crosses the former Burlington Northern Railroad track and current King County pedestrian trail, called the East Lake Sammamish Trail (Trail). The Creek flows under the Trail through a 36-inch corrugated metal pipe (CMP) and 18-inch concrete culverts, but a King County trail project plans to replace these structures with a 14-foot-wide by 7-foot-high box culvert, backfilled with stream sediments to a slope of 1.2 percent to meet Washington Department of Fish and Wildlife (WDFW) stream simulation guidelines (Parametrix, 2016).

Segment 1c has an average slope of approximately 5 percent and channel top widths of 10 to 15 feet. Boulders armor the banks and three boulder weirs to provide grade control at the outlet of the ELSP culvert immediately upstream.

2.1.1.4 Segment 1d – ESLP Culvert

George Davis Creek crosses under ELSP through a 68-foot-long, 60-inch-diameter concrete culvert at a 7-percent slope (King County, 1995). This culvert and accompanying upstream control structure, overflow conveyance system, and sediment basin were constructed in 1994–95, after the previous undersized crossing experienced severe flooding during a January 1990 event (Parametrix, 2011). Inflow is controlled by an 18-inch-diameter inlet pipe that drains to manhole then finally into the 60-inch ELSP culvert. A perforated standpipe and weir at the rim of the manhole allow for additional overflow into the ELSP culvert during high water events or if the inlet becomes plugged with sediment. Flow through the manhole can be regulated with a shear gate. A 1- to 1.5-foot-high drop occurs at the culvert outlet.

2.1.1.5 Segment 1e – Sediment Basin

Segment 1e consists of a sedimentation basin that measures approximately 30 feet long, 25 feet wide, and 4 to 5 feet deep. The basin has a storage volume of approximately 80 cubic yards. City staff reported that the basin typically requires maintenance twice a year to remove trapped sediment (personal communication, October 20, 2018). Two elevated manhole overflows are located on the right (north) side of the pond. Overflow into these structures divert Creek flood waters through a bypass that follows ELSP and ultimately discharges to Lake Sammamish north of the mouth of the Creek. A 2-foot-high log and boulder weir structure spans the Creek immediately upstream of the sedimentation basin. Primarily functioning as grade control, the weir also helps divert high flows to the bypass system through a gated 18-inch pipe.

2.1.2 Segment 2 – Lower Ravine

Segment 2 represents a transition between the relatively undisturbed upstream ravine and the highly modified Segment 1. The lowermost 200 feet of Segment 2 is channelized as it emerges from the ravine and is routed around a private property to the downstream sedimentation basin. Vertical banks 2 to 6 feet high were observed along an approximately 100-foot reach immediately upstream of the sedimentation basin. Parametrix (2011) identified these vertical banks as incisional features. Just upstream, the channel rounds a sharp bend immediately adjacent to the residence. The channel is generally trapezoidal, showing evidence of moderate bank erosion, but much of the bank is armored along the outside of the bend. During the site assessment, the resident reported to NHC that the highest stream level they had observed had reached just below the back deck.

The upstream portion of Segment 2 begins at a private property fence line and continues upstream approximately 500 feet. Past the fence line, the Creek enters the relatively undisturbed upland ravine, flanked by steep forested hillsides. Parametrix (2011) identified a 12-inch stormwater tightline along the northside of the ravine in this reach, but it was not observed during our visit. Naturally occurring large woody debris (LWD) deposits were observed along the reach. At approximately the 1,000-foot station, a 2-foot-high by 25-foot-wide concrete weir spans the channel, identified as an abandoned water supply diversion dam. The first of a series of log jams installed by the County (King County, 1994) was observed in this vicinity. Upstream of the dam, a 30-foot-long by 6-foot-wide gravel lobe has deposited, and vegetation is thick within the channel corridor. Here, flanking of another County log jam is resulting in vertical bank erosion of the south valley wall.

2.1.3 Segment 3 – Middle Ravine

Segment 3 begins approximately 200 feet upstream of the former diversion dam and the channel gradient noticeably steepens as suggested by the presence of boulder-sized material (> 256 mm) armoring a narrowed channel. At approximately station 1,900, the channel reaches maximum confinement between a narrow 50-foot-wide section of the ravine. Channel incision here has exposed underlying densely consolidated pre-glacial material from which seeping was observed. Narrow ravine conditions continue for another 200 feet with nearly vertical banks and evidence of landslides.

2.1.4 Segment 4 – Upper Ravine

Segment 4 begins at approximately station 2,100 where a distinct choke point was observed. Upstream of this choke point, the gradient flattens and flow is noticeably reduced but the channel widens due to the excess deposition of uniform, medium-sized gravel. At station 2,900 a heavily damaged 24-inch-diameter corrugated CMP was observed in the channel. A short distance upstream, surface creek flow in the creek ceased. Significant amounts of relatively uniform, clean, medium-sized gravel was observed in the channel, much of which appears to be depositing behind log structures installed by the County for several hundred feet.

At station 3,800 a 30-foot-wide, alluvial fan-like deposit composed of clean sand and medium gravel was observed entering the channel from the north. It appears the deposit originates from a small creek tributary that enters from the north near 213th Place NE. LiDAR data shows a road feature running along the north ravine wall in this reach. It is speculated that the fan deposit in the creek formed when flow from the small tributary collected behind the road and breached during high flow. Immediately upstream of the fan deposit duff-like organic material covered the channel, indicating backwater influence, but farther upstream the channel was still composed of relatively clean medium-sized gravel. At station 4,100 a stormwater tightline and energy dissipater was observed entering the Creek from the south side of the ravine. From this location upstream to the head of the ravine at NE 6th (station 5,000), the presence of moss growth on cobble-sized material and increasing amounts of organic duff material observed in the channel indicate infrequent and/or low-energy flow conditions.

2.2 Longitudinal Profile

The longitudinal profile of George Davis Creek upstream of ESLP exhibits variations, suggesting underlying geologic controls as well as influences from hillslope morphologic processes (Figures 1 and 2) . Geologic mapping from Booth et al (2012) shows the Creek path transitioning over a fan deposit (Qf) along the lower 750-foot stream length to a 700-foot segment over older (pre-glacial) fine-grained materials (Qp(f)). This finer grained pre-glacial material is well compacted, has some cohesive properties, and is more resistant to erosion; thus, the transition to the alluvial fan deposit (near station 700) represents a geologic control on stream grade. Upstream the Creek runs over a long 2,300-foot segment of loose, erodible, and relatively permeable recessional outwash (Qvr(4)). The uppermost 1,000 feet the Creek, before reaching NE 6th Street, runs over relatively impermeable, compacted glacial till (Qvt).

Between stations 1,800 and 2,800, LiDAR topography suggests a major slump, or landslide, occurred along the south rim of the ravine (Figure 1). An abrupt break in the longitudinal profile occurs in this vicinity (station 2,000), indicating the landslide blocked the channel. It is uncertain when this large landslide occurred but based on the relatively steep slope in the landslide vicinity and lower slope observed upstream, it is apparent the Creek is still adjusting by eroding (headcutting) through the deposit.

3 ORDINARY HIGH WATER MARK AND BANK FULL WIDTH

The ordinary high water mark (OHWM) on any site is not a static line or elevation and may change over time due to natural events or permitted actions (Anderson et al., 2016). OHWM determinations for waterways rely on the use of geomorphic and vegetative field indicators, and the Washington State Department of Ecology (Ecology) protocol requires that the OHWM be based on the physical and biological indicators present on the site.

We used methodologies described in *Determining the Ordinary High Water Mark on Streams in Washington State* (Anderson et al., 2016) to delineate the OHWM of George Davis Creek. According to Ecology's manual, there are three physical criteria within the OHWM definition that apply to all shoreline types: "Presence and action of *waters*… marks upon the *soil*… in respect to *vegetation*… distinct from that of the abutting upland… ." Ecology states that the OHWM is the dynamic boundary between the aquatic and terrestrial environments and, in most cases, is not a static elevation. Regular (ordinary) inundation produces visible abiotic (change in topography or substrate) and biotic (change in vegetation) signs on the landscape.

In order to design new stream crossings on George Davis Creek, the bank full width and OHWM were measured upstream and downstream of the existing culvert. Bank full width is defined as the width of channel when water just begins to overflow the bank into the active floodplain. Bank full indicators are related to water flows that move bedload sediment. The OHWM indicators include soil and vegetation, in addition to channel indicators (Anderson et al., 2016). The OHWM is a physical and ecological mark on the ground due to the presence of periodic and regular (that is, ordinary) inundation. At many sites, it is found in the transition zone between the aquatic and terrestrial environments. Depending on location, the transition may be very narrow and easily discernible. The OHWM and bank full water stage locations are generally equivalent where a stream channel exhibits plane bed morphology and characteristics that are straight, slightly incised, steep, moderately confined, and contains coarse-sized sediment. These characteristics were met by George Davis Creek in the vicinity of the project area.

Measurement of a single, representative bank full width was challenging on George Davis Creek due to the combination of anthropogenic modifications around ELSP and rapidly varying channel conditions upstream. The latter can be attributed to the steep gradient and relatively small size of the creek. In many locations, the channel banks were shallow and poorly defined while in others the channel was constricted by either large woody debris (manmade or natural) and dense vegetation. In general, the channel still exhibits signs adjusting to landslide activity and high sediment loads.

Bank full measurements were collected at three locations upstream of ELSP (Figure 1 and Table 2). Locations were selected in single thread channel segments with naturally defined alluvial banks. Bank full width measurements ranged from 9 to 12 feet, with an average of approximately 11 feet. These values are consistent with the 10-foot value selected by Parametrix (2016) for design of the East Lake Sammamish Trail box culvert, although it is unclear where Parametrix's channel measurements were taken. Based on observations made in August 2018, an average bank full width of approximately 11 feet was selected for alternative evaluation.

Table 2. George Davis Creek Measured Bank Full Widths

Field Measurement	Station (feet)	Bank Full Width (feet)
BF-1	630	9
BF-2	780	11
BF-3	1650	12

4 STREAMBED COMPOSITION

Substrate composition is a useful indicator to describe how a channel stores and transports sediment. The most common substrates in the lower reaches (Segment 1) below the ravine were coarse gravels interspersed with some cobble and fine gravel typical of higher gradient streams (Photo 1).

Photo 1: Typical riparian habitat and stream substrate observed downstream of the property fence (Segment 1).

The streambed in the lower ravine (Segment 2) contained fewer fine gravels than upstream reaches. The substrate coarseness increased progressively upstream of the diversion dam in Segment 3, transitioning from cobble to boulder dominated (Photo 2). Upstream in Segment 4, bed material varied but was dominated by coarse gravels, cobbles, and boulders with fines (Photo 3). An increase in finer sediment input in this reach was observed, possibly due to mobilization of substrates from upstream sources. The fine sediments in these reaches may be the result of erosion from landslides upstream (photo of large landslide). These landslides may have increased the rate of fine sediment and gravel recruitment into these reaches, causing the stream channel to expand in a manner like an alluvial fan. Much of George Davis Creek is located within an erosion hazard area and are prone to landslides. These landslides act as a feeder source for gravels and fines that are then transported downstream during high flow events.

A pebble count was conducted near the transition between Segments 1 and 2, approximately 150 feet upstream of ELSP (Photo 1 and Figure X). This site was selected after observing channel conditions along the entire reach from ELSP up to NE 6th Street. Selection of a suitable pebble count site was challenging for the same reasons choosing a bank full width measurement site was difficult; that is, conditions varied significantly along the reach. Although the site selected for the pebble count was located within a channelized portion of the Creek, it was determined to best represent possible future bed composition in the transition between the upstream ravine and ELSP vicinity. Figure 3 shows the grain size distribution computed from the pebble count sample.

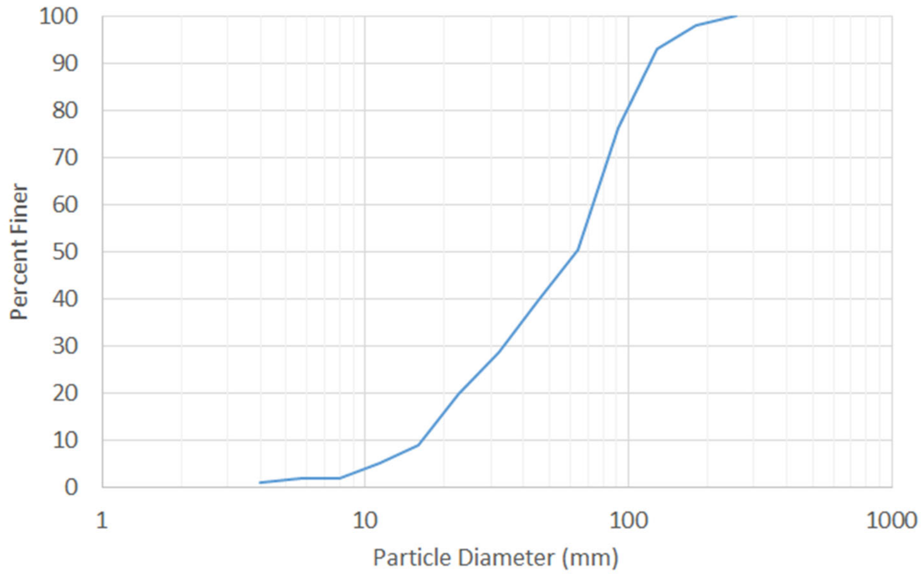

Figure 3. Grain size distribution from pebble count sample on George Davis Creek, upstream of ELSP.

The bed material in this reach is primarily composed of coarse gravel and cobble-sized material. The median particle diameter (D_{50}), the size for which 50 percent of the sample is finer, is approximately 64 mm, while D_{90} is approximately 120 mm. This composition represents an armored surface layer that has adjusted to local hydraulics and incoming sediment loads. Upstream, both coarser cobble-boulder reaches (Photo 2) and finer gravel deposits were observed (Photo 3).

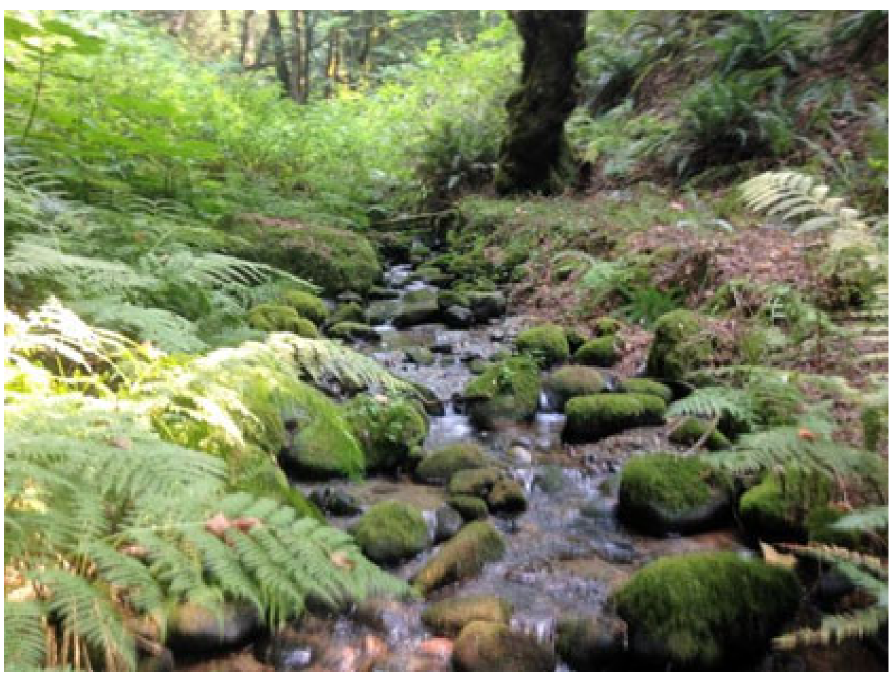

Photo 2: Typical riparian habitat and stream substrate observed upstream of the property fence in the lower ravine reach (Segment 2).

Photo 3: Typical riparian habitat and stream substrate observed in the flatter, middle ravine reach (Segment 3).

4.1 Aquatic Habitat and Fisheries

George Davis Creek aquatic habitat was characterized from the stream mouth at Lake Sammamish, upstream to the farthest extent of flowing water during the low-flow conditions observed during the late summer and farther onto the culvert at NE 6th Street crossing. The Creek was divided into four sections based on gradient and habitat conditions (please refer to Table 1).

Adjacent land use activities upstream and downstream of ELSP have altered stream habitat conditions and the riparian corridor. George Davis Creek passes through a mixed-use area consisting of a single-family residence, and areas with both native and non-native vegetation. Downstream of the City's property fence, the creek was observed to be entrenched and incised, with little to no connection to the floodplain. Currently, a series of fish passage barriers on and downstream of ESLP restricts migrating fish from access to nearly 1 river mile of quality riparian habitat in canyon reach of George Davis Creek. Ebright Creek is unchannelized in the canyon reaches upstream of property fence and exhibits an overall complex stream habitat of native riparian vegetation and LWD, especially considering its location as a stream in an urban environment.

4.2 Substrate

The stream reaches above the property fence are thought to be able support Kokanee salmon and cutthroat trout. Suitable spawning substrate for salmonids was observed in all ravine reaches during the time of surveying (Photo 4), except for the incised and channelized reaches below the City's property line fence. Fines and gravels are ideal substrate for kokanee salmon spawning, suggesting that reaches above the concrete weir have the best potential for spawning.

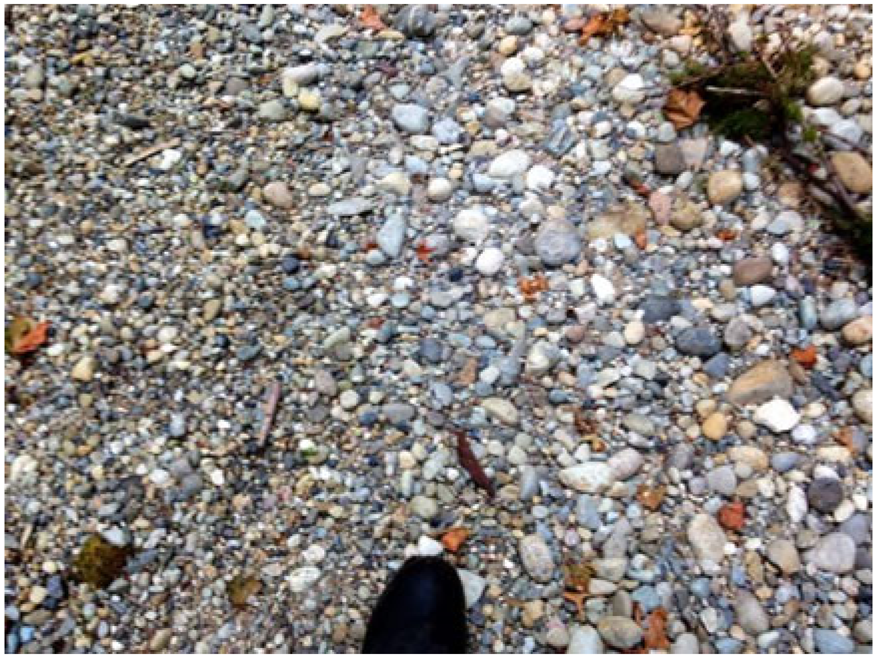

Photo 4: Typical substrate habitat observed in the ravine reach (Segments 3 and 4) suitable for kokanee spawning.

4.3 Riparian and Wetlands

Potential stream and wetland areas within 100 feet of the stream corridor were estimated using aerial photography and observations made during the field investigation. No wetlands were observed either upstream or downstream of the culvert, or within 100 feet of the project area. Wetlands were observed outside of the project area, upstream of the culvert at the NE 6th Street crossing.

George Davis Creek flows through a second-growth forest above the project site through a relatively steep ravine on the east side of the Sammamish Plateau. Several seeps were observed around the base of a landslide scar roughly 2,250 feet upstream in the canyon reach. The stream habitat and riparian corridor along the lower reaches of George Davis Creek, within City property, is in relatively good condition. The stream corridor is largely undeveloped and has not been extensively ditched or channelized, native riparian vegetation and large woody material (LWM) is present, overall habitat complexity is relatively high for a stream in an urban environment, and the stream contains ideal habitat for Kokanee and other native salmonids.

While the reach upstream of the property line fence exhibited good riparian condition, it lacked pool habitat. The stream gradient sometimes approaches 10 percent through the steeper section of the canyon reach, forming tiered, or staircase, features that result in patchy gravel areas and small volume pools that are favored by resident cutthroat trout.

Overall, the riparian buffers upstream of the property fence appear to be functioning properly and the stream channel is generally stable. Riparian vegetation provides important shade for the stream, a source of recruitment for wood, and reduced rates of erosion. The riparian condition observed below the property fence was mostly restored mixed deciduous forest, shrubs, and invasive species with lawns, driveways and residential areas adjacent to the narrow stream riparian corridor. The reach above the property fence is in a steeper ravine with second-growth coniferous trees present in the riparian zone (Photo 5). Riparian condition from the steep section of the ravine to NE 6th Street consisted of second-growth mixed forest of big leaf maple (*Acer macrophyllum*), Western red cedar (Thuja plicata), and Douglas fir (*Pseudotsuga menziesii*) with a closed canopy. The understory was dominated by salmonberry (*Rubus spectabilis*), devil's club, and sword fern (*Polystichum munitum*).

Photo 5: Typical riparian habitat observed in the ravine reach (Segments 2 through 4).

4.4 Wood

Large woody debris (LWD) is an important component of streams in the Pacific Northwest. LWD was present in good quantities during the time of surveying and was appropriate in most of the George Davis Creek reaches surveyed upstream from ELSP.

4.5 Pools

Limited pool numbers and small size of pools observed during the survey may restrict the capacity of the stream for supporting juvenile fish (both salmon and trout). The shallower pool depth in the upper reaches above the steep ravine reach may be attributed to very low flow levels observed during the summer sampling period, and/or the increase in total area of linear pool habitat in the upper stream section due to stream channel migration and instability because of stream channel formation in the modified streambed due to landslide activity. The stream flow started to significantly disappear at approximately 2,300 feet into the canyon reach and the upper extent of stream flow and the point of when the flow disappeared into the streambed was observed approximately 3,200 feet into the canyon reach.

Unlike other urbanized streams in the Puget Sound lowlands, the section of George Davis Creek within the ravine, located up to the NE 6th Street crossing, is not lacking in riparian corridor, channel bed stability, LWD, and riparian vegetation. The ravine reach is still in a pristine condition with excellent base flow, LWD, and riparian cover. A stream stabilization project conducted by King County Public Works in 2001 along the ravine reach has benefited the geomorphic conditions (width-to-depth ratio, number of pools, sediment size distribution), water quality, and biological integrity of the lower section of the stream. Improvement in bed and bank stability, along with a reduction in flashiness of flows, could help reduce the accretion of fine sediments and gravel throughout the streambed in the upper landslide-prone sections of the ravine reaches.

4.6 Delta

Vulnerable beach spawning areas include near-shore substrates that receive spring-fed upwelling, as well as alluvial fans at stream mouths such as the George Davis Creek delta (HDR, 2009). Although actual spawning numbers are unknown, shore spawning populations of Kokanee could be present in Lake Sammamish.

5 ROADWAY AND UTILITIES

George Davis Creek crosses ELSP, the East Lake Sammamish Trail, and then ELSSL. ELSP is a two-lane arterial with bike lanes, narrow shoulders, and no pedestrian facilities. The Trail is a 10-foot-wide path that is currently undergoing a redesign to a paved path. ELSSL is approximately 20 feet wide and paved. ELSSL exists within the King County right-of-way and provides access to the adjacent parcels with access easements.

Many utilities are located within the crossing locations and are listed below:

- ELSP
    - 15-inch sanitary sewer – Sammamish Plateau Water
    - 8-inch municipal water – Sammamish Plateau Water
    - 4-inch gas main – Puget Sound Energy
    - Miscellaneous communication
- ELSSL
    - 2-inch gas main – Puget Sound Energy
    - 8-inch water – Sammamish Plateau Water
    - 4-inch sanitary sewer – Sammamish Plateau Water

6 RESIDENTIAL AREAS AND ZONING

The existing area is an established neighborhood of single-family waterfront homes connected by a private drive. Although many different vintages of houses are present nearby, several have been remodeled or expanded within the last 10 years. Accessory dwelling units (ADU) have also been built on several properties, following a provision in the zoning code that permits an increase of allowable lot coverage if an ADU is present on site.

Properties adjacent to the lakefront generally follow the established tax lots, which are 50-foot-wide parcels perpendicular to the water and are of varying lengths, some of which are over 200 feet long. The houses built on the shorefront lots are large and densely spaced facing the water, often built from setback to setback. Lots on the east side of ELSP follow a transitional development pattern of rural development to suburban: large rectangular lots intermingled within cul-de-sac properties.

The zoning of the area is R-4; that is, four dwellings are allowed per acre. Lot coverage up to 45 percent of the area of a lot is allowed. Tree removal is limited but may be modified for public works. The area is documented as an existing Erosion and Landslide environmentally critical area, as demarcated by the City of Sammamish. Special erosion control methods would be required for construction work performed in this area.

This section gives information required for any sort of structure modifications associated with Options 1 or 3. Specific information for the parcel at 629 E. Lake Sammamish Shore Lane NE (Linde Property):

Zoning: R-4

Lot size: 10,527 sq. ft.

ECA: Site is in existing Erosion and landslide environmentally critical areas as demarcated by the city of Sammamish.

Lot coverage/impervious area: 45% allowed if an ADU is built on site.

Nonconforming Use: It is likely this project would be considered a nonconforming use. Nonconforming uses are allowed increases of building square footage, impervious area, parking, and building height of up to 10%.

Permit documents note that lot coverage allowance of 55%. The documents show that the remodel performed on the house in 2008-2009 reduced the lot coverage and impervious area on site to 43.15%. This project would still fall under the provisions of a nonconforming residential use.

7 ALTERNATIVES

The alternatives were developed through a process that took many evaluation criteria into account. The intention was to develop alternatives that would create a fish passable project while at the same time meet sometimes conflicting project criteria. For instance, a certain alternative may be very desirable for permitting, but be extremely costly. The criteria used to evaluate each alternative are listed below and are discussed in detail in Section 11 of this report.

1. Fish Passage
2. Long-Term Stability
3. Cost
4. Timeline
5. Permit Risk
6. Public Acceptance
7. Legal Hurdles
8. Operations/Maintenance
9. Construction

The following private properties will be affected by one or more of the alternatives:

- Linde Property (Alternatives 1 and 3)
  Parcel number: 0777100045
  Address: 629 East Lake Sammamish Shore Lane NE

- Sigmar Property (Alternative 4)
  Parcel number: 0777100040
  Address: 635 East Lake Sammamish Shore Lane NE

- Overflow Parcel (Alternative 2)
  Parcel numbers: 3575300002 and 3575300003
  Address: 801 East Lake Sammamish Shore Lane NE

7.1 Alternative 1

This alternative would install a 15-foot-wide fish passage culvert beneath ELSP. From there, the Creek would remain open, with a bridge over the East Lake Sammamish Trail. From this point, the channel would be open, with a bridge beneath ELSSL, and a 15-foot-wide culvert would be constructed beneath the existing ADU located at the Linde Property. The Creek would then be open until it meets the existing 8-foot culvert beneath the existing home on the Linde Property. The existing ADU would be reconstructed with this option.

7.2 Alternative 2

This alternative would install a 15-foot-wide fish passage culvert beneath ELSP, which would then turn north and parallel the Trail and the western embankment of ELSP. From this point it would be carried into a 15-foot-wide culvert that would head west beneath ELSSL and into an parcel adjacent to the Overflow property at 801 ELSSL. This parcel is where the existing overflow is located now, and would replace the existing overflow. From this point, the Creek would discharge into Lake Sammamish. Alternative 2 would require that the Trail be moved approximately 300 feet to the west.

7.3 Alternative 3

This alternative would install a 15-foot-wide fish passage culvert beneath ELSP. From there, the Creek would remain open, with a bridge over the Trail. From this point, the channel would be open, with a bridge beneath

ELSSL. From there a 15-foot-wide culvert would be constructed beneath the existing ADU on the Linde Property. The Creek would then be open until it is carried beneath another 15-foot-wide culvert beneath the Linde home. The ADU and the house would be reconstructed with this option.

7.4 Alternative 4

This alternative would install a 15-foot-wide fish passage culvert beneath ELSP. From there, the Creek would remain open with a bridge over the Trail. From this point the channel would be open with a bridge beneath ELSSL. From there the Creek would be open and run through the Sigmar Property, which would be restored entirely to Creek and associated buffer. This option would require the acquisition of the Sigmar Property.

8 HYDROLOGY AND HYDRAULICS

8.1 Hydrology

Hydrologic analysis for George Davis Creek was initially anticipated to be conducted using an existing HSPF model encompassing the East Lake Sammamish tributary streams (that is, tributaries entering the lake from the Sammamish Plateau between Issaquah Creek and Evans Creek). The East Lake Sammamish (or regional) model was originally developed, and subsequently modified, by King County and was most recently updated by NHC as part of an ongoing project for the County. The George Davis Creek basin is represented in the regional model, but basin-specific flow routing is not accounted for. Based on frequency analysis over a long-term simulation, estimates of frequency flows at the mouth of George Davis Creek range from 108 cubic feet per second (cfs) for a 2-year peak (Q2) to 365 cfs for a 100-year event (Q100).

Subsequent to the initial analysis, NHC reviewed the hydrologic modeling of the basin that was performed by MGS (MGS, 2009 and included in Parametrix, 2011). A significant difference between this basin-specific modeling and the regional model is the assumption that all surface runoff is re-infiltrated into a shallow outwash aquifer, which results in extremely muted peak flows for a basin of this size (Q2 18 cfs, Q100 47 cfs). This assumption would be consistent with field observations upstream of the ravine, where the channel is poorly defined and appears to receive only intermittent flow. The MGS model similarly assumes that drainage local to the ravine has the same groundwater buffer. Given the tightlines observed coming into the ravine and the steeper terrain, it is less clear that surface runoff from these local drainage areas would be attenuated to the same level.

NHC used the regional model to estimate peak flows from just the area's tributary to the ravine, as a simplified representation of minimal upland flow contribution and increasing runoff into the ravine. Flow frequency quantiles for this scenario, which we believe to be a reasonably conservative estimate given current understanding of the system, are tabulated below in Table 2.

Table 2. Preliminary Flow Frequency Estimates for George Davis Creek (cfs)

Preliminary Flow Frequency Estimates for George Davis Creek (cfs)				
2-year	10-year	25-year	50-year	100-year
38	74	99	121	148

Both NHC and the MGS modeling study recommended stream flow gaging to better understand storm flow patterns and the range of flows the site experiences. The City authorized NHC to install a stream gage and monitor flows in the ravine through the upcoming wet season. This information will be used to help confirm flow magnitudes and to refine the flow estimates prior to final design.

8.2 Hydraulics

Hydraulic analysis of George Davis Creek was conducted using the U.S. Army Corps of Engineers (USACE) HEC-RAS modeling software. The model is steady-state, one-dimensional (1D) model and included the lower 1,300 feet of the Creek. Newly collected survey, County as-built drawings, and LiDAR topographic data were used to construct model geometry. Existing conditions were evaluated as well as a preliminary assessment of the four alternatives presented above. The downstream boundary condition assumed an average lake level of the 31.14 ft, NAVD 88 (cite) and the flows presented in Table 2 were simulated. The current model resolution is considered appropriate for evaluation of the preliminary alternatives; however, additional model refinement will be required for final design.

8.3 Existing Conditions

An existing conditions model was developed to evaluate current hydraulic controls at the sedimentation and flood diversion facility upstream of ELSP. The flood diversion components to this facility are complex, as they limit the amount of flow allowed to move down the mainstem of George Davis Creek through a series of culverts and under the private residence at the lakefront. Flow down the mainstem of the Creek is regulated by an 18-inch-diameter culvert connected to the inlet of the 60-inch-diameter culvert under ELSP. The constriction created by the 18-inch inlet culvert causes flood waters to back up in the pond facility and divert overflow to a bypass through two elevated drop structures (Rim El. 63.6 ft, NAVD 88). The flood bypass consists of a culvert that parallels ELSP and ultimately discharges into Lake Sammamish north of the Creek mouth. During extreme events, or if the pond were filled with sediment, a third overflow structure (Rim El. 65.1 ft, NAVD 88) located adjacent to ELSP will route flow down the mainstem of George Davis Creek.

The original design calculations for this structure are unavailable, so precise operation of the flow split is uncertain. To estimate facility operation, the HEC-RAS model was used to compute a stage-discharge rating curve for the 18-inch inlet culvert, from which lateral weir calculations could be used to compute overflow into the bypass. This computation is simplified by neglecting the influence of several components in the facility (for example, several gates, a perforated standpipe, and an additional 18-inch lateral culvert) as well as the influence of sedimentation on hydraulic performance, the complexity of which is beyond the capabilities of HEC-RAS. Despite these simplifying assumptions, the methodology is considered reasonable for this level of assessment.

Results indicate that the maximum capacity of the 18-inch culvert directing flow down the mainstem is approximately 10 cfs. Between stream flows of 12 to 14 cfs, water surface elevations in the pond rise and activate the two lower elevation drop structures. When the pond reaches the elevation of the third higher drop structure, the flow capacity of the system is 142 cfs, or approximately equivalent to the 100-year discharge reported in Table 2. If stream flows were to exceed this threshold, overtopping of ELSP could be expected.

8.4 Alternative 1

Alternative 1 was evaluated by modifying the existing HEC-RAS model to include a 15-foot-wide stream simulation culvert under ELSP and abandonment of the bypass system. Downstream, the Creek would be conveyed through alternating open channel and culvert/bridge segments, with slopes ranging from 4 to 9 percent, under the Trail, ELSSL, and the ADU on the Linde Property. The 8-foot culvert opening through the main house would remain, as would the existing channel down to the lake. Alternative 1 is computed as being able to convey up to the estimated 100-year flow (Table 2) in all segments, but overbank flooding could be expected downstream of the house because the existing channel to the lake would be undersized. Some instability could also be expected at the abrupt slope transition near the upstream side of the house. Computed 1- to 100-year profiles (Table 1) for Alternative 1 are shown in Figure XX.

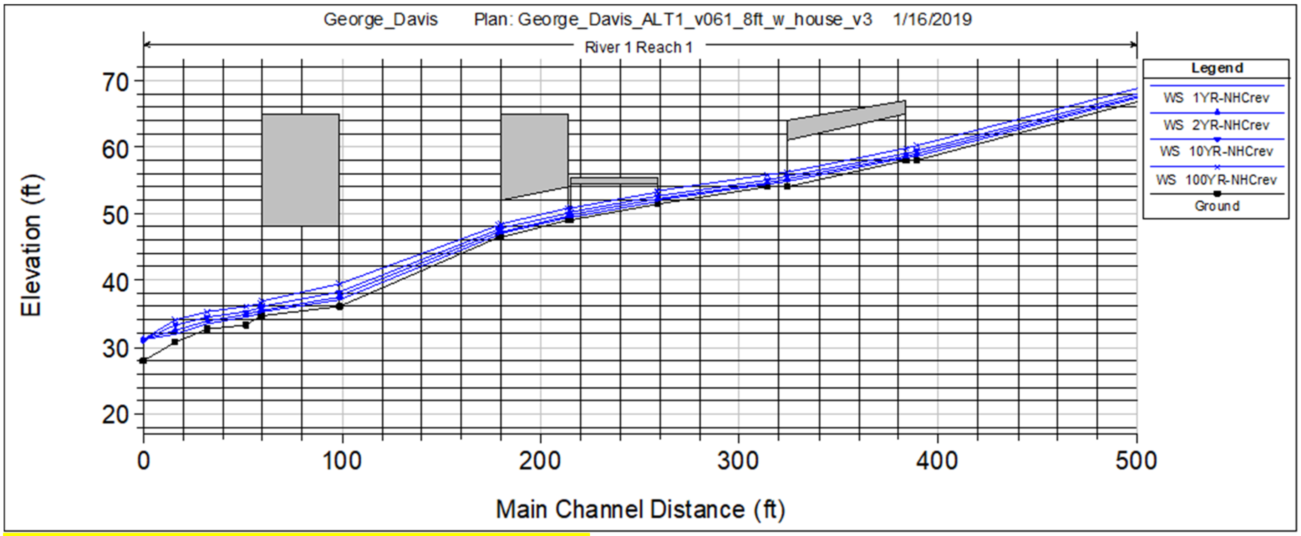

Figure 4. Computed flood profile for Alternative 1.

Reconnection of the Creek to the lake without the existing upstream ELSP basin would result in sediment being directed to the lake. The City indicated the basin typically needs to be cleaned twice a year and the estimated volume of the basin is on the order of 60 cubic yards, suggesting annual sediment loads would be approximately 120 cubic yards per year. Assuming this rate, delta formation could extend up to 50 to 80 feet into the lake over a 10-year time span (Figure 5).

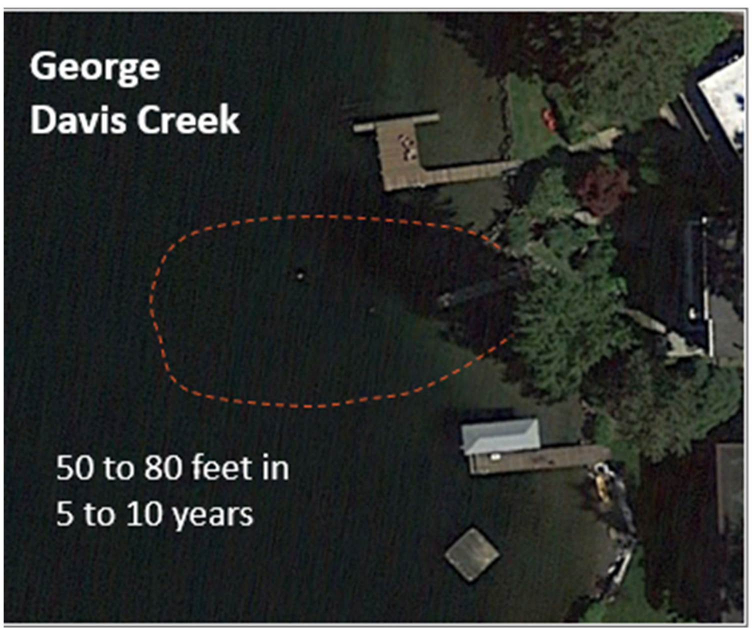

Figure 5. Estimated delta extent at existing mouth of George Davis Creek.

8.5 Alternative 2

Alternative 2 consists of a 15-foot-wide stream simulation culvert under ELSP and directing George Davis Creek northward approximately 500 feet along the Trail corridor and discharging to the lake at the location of the existing overflow outfall. The existing bypass would be abandoned as part of Alternative 2. A 12-foot-wide channel dimension was assumed for the redirected open channel segments. Extension of creek channel length results in a significantly lower stream gradient along the segment parallel to the Trail (less than 2-percent), compared to 4 to 9 percent upstream. This abrupt transition in stream gradient could pose sedimentation problems as sand to cobble-sized material transported from upstream may settle in the channel. From a flood capacity standpoint, the assumed channel width and slope could contain flows up to the 100-year event without flooding the trail, at least temporarily. However, ongoing sedimentation would reduce flood capacity in the channel over time. Similar to Alternative 1, delta formation could be expected at the relocated Creek mouth. Computed 1- to 100-year profiles (Table 1) for Alternative 2 are shown in Figure 6.

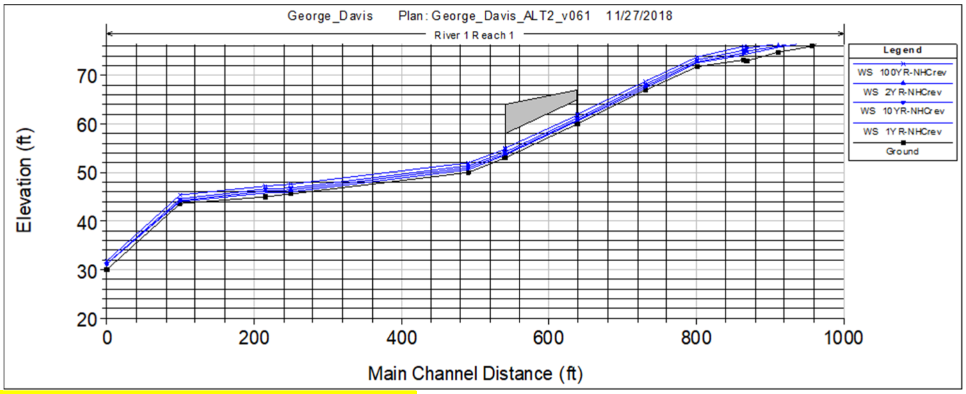

Figure 6. Computed flood profile for Alternative 2

8.6 Alternative 3

Alternative 3 consists of providing fish passage along, roughly, the existing Creek alignment and abandonment of the existing bypass system. The Creek would be conveyed through alternating open channel and culvert segments, with slopes ranging from 4 to 9 percent. Open channel segments were assumed, as were 15-foot-wide stream simulation culverts under the existing lakefront residence, ELSSL, and ELSP. Results show that the proposed channel would be capable of conveying up to the 100-year discharge (Table 2) without overbank flooding, although additional channel expansion may be required where the Creek emerges from the private residence at the lakeshore. As with Alternatives 1 and 2, removal of the upstream sedimentation facility will result in delta growth into Lake Sammamish. Computed 1- to 100-year profiles (Table 1) for Alternative 3 are shown in Figure 7.

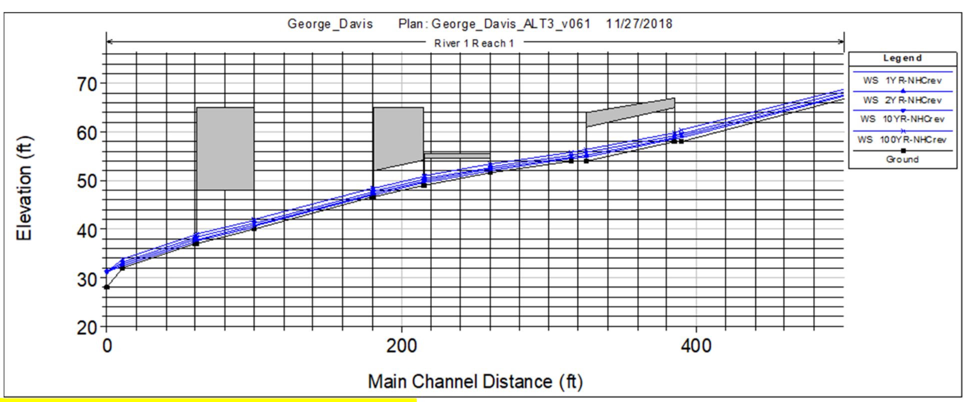

Figure 7. Computed flood profile for Alternative 3

8.7 Alternative 4

Alternative 4 was not modeled in HEC-RAS because it was assumed it would be similar to Alternative 3.

9 PERMITTING

The following assessment identifies the permits that are likely to be necessary to construct and replace the culvert. Formal and informal permitting agency consultation with federal, state, and local agencies, as well as external stakeholders and land users, is a critical component of the permitting processes in Washington State. Consultation generally involves analysis of a proposed project to determine any potential environmental effects and to develop effective monitoring, mitigation, and adaptive management measures necessary to prevent, minimize, and/or mitigate project effects on the environment. Permitting may take multiple months; therefore, consultation should start as early as possible to ensure that the correct environmental documentation and needs of both the project and agencies overseeing the permitting efforts are met.

9.1 Joint Aquatic Resource Permit Application

In Washington, the Joint Aquatic Resource Permit Application (JARPA) is a streamlined environmental permitting process. This application is sent to multiple local, state, and federal agencies including, but not limited to the USACE, Ecology, and the Washington Department of Natural Resources (DNR). The information contained within the JARPA will also be provided to WDFW, but in a different form, as described below. To successfully complete this culvert replacement project, permits will also likely need to be obtained from King County. A detailed description of each permit and authorization is described below.

9.2 Federal

The USACE has authority over navigable waters defined as *"…those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce."* As such, USACE permits are necessary for any work, including construction and dredging, in U.S. navigable waters.

In western Washington, the JARPA is used to apply for permits (that is, Standard or General permits) from USACE's Seattle District for work in the waters of the U.S. As the lead federal agency, the USACE may consider the views of other federal and state agencies including consultations with National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS), collectively known as the Services, and the State Historic Preservation Office (SHPO); land use participants including Native American tribes; as well as the general public.

Upon the completion of these consultations and review of the project details, the USACE can authorize dredge and fill activities with a Standard Permit, such as an Individual Permit or Letter of Permission; or a General Permit, such as a Nationwide Permit (NWP) or Regional Permit. Based on the level of impacts associated with a proposed project, the USACE will make a determination on what type of permit review and authorization is appropriate once an application has been submitted.

Before issuing a decision on a Standard Permit, which will include approval under Section 404 of the Clean Water Act (CWA), the USACE may provide a public notice period (20 days minimum). Also, the USACE must provide notice of, and opportunity for, public hearings before issuing a permit. For Individual Permits, permit decisions are made within two to six months from the receipt of a completed application. The public notice period is in addition to this time frame.

The USACE handles the actual issuance of the permits. It determines whether a particular area is *waters of the U.S*. The USACE also has primary responsibility for ensuring compliance with permit conditions, although the U.S. Environmental Protection Agency (EPA) plays a role in compliance and enforcement.

9.2.1 Section 404 of the Clean Water Act

Section 404 of the CWA is regulated under the authority of the USACE and the EPA. The USACE administers the day-to-day program and is responsible for permit decisions and jurisdictional determinations. Section 404 applies to work within *waters of the United States*, including wetlands. For the purpose of this project, *waters of the U.S.* include waters of George Davis Creek that run beneath ELSP and drains into Lake Sammamish, as well as any associated tributaries and wetlands. The replacement of the culvert may be considered to be "fill" under Section 404, requiring compliance.

9.2.2 Nationwide Permit (NWP# 14 – Linear Transportation Projects)

The NWP# 14 refers to activities required for crossings of waters of the U.S. associated with the construction, expansion, modification, or improvement of linear transportation projects, such as roads and highways. In this case, a possible culvert replacement under ELSP would constitute a linear transportation project. There are a number of conditions that an applicant must meet before being issued this NWP, particularly if the project involves bank stabilization work and Ecology's 401 General Conditions. The NWP process time takes approximately 60 days to complete; however, this can be extended due to the Endangered Species Act (ESA) consultation process, as described below.

9.2.3 Nationwide Permit (NWP# 27 –Aquatic Habitat Restoration, Enhancement and Establishment Activities)

The NWP# 27 refers to activities in waters of the United States associated with the restoration, enhancement, and establishment of tidal and non-tidal wetlands and riparian areas, the restoration and enhancement of non-tidal streams and other non-tidal open waters, and the rehabilitation or enhancement of tidal streams, tidal wetlands, and tidal open waters, provided those activities result in net increases in aquatic resource functions and services.

To the extent that a USACE permit is required, activities authorized by this NWP include, but are not limited to the removal of accumulated sediments; the installation, removal, and maintenance of small water control structures, dikes, and berms, as well as discharges of dredged or fill material to restore appropriate stream channel configurations after small water control structures, dikes, and berms, are removed; the enhancement, restoration, or establishment of riffle and pool stream structure; the placement of in-stream habitat structures; modifications of the streambed and/or banks to restore or establish stream meanders; the backfilling of artificial channels; and the installation of structures or fills necessary to establish or reestablish wetland or stream hydrology.

There are several conditions that an applicant must meet before being issued this NWP, particularly if the project involves bank stabilization work, culvert crossings, stream habitat restoration and Ecology's 401 General Conditions. The NWP process time takes approximately 60 days to complete; however, this can be extended due to the Endangered Species Act (ESA) consultation process, as described below.

9.2.4 Consultations

In its application review, the USACE may consult with other federal agencies to evaluate potential impacts, such as effects on fish and wildlife, water quality, navigation, historic, cultural, scenic and recreational values, and economics. Coordination may be triggered as part of the USACE's review of the project's permit application. USACE is responsible for determining if consultation is required and coordinating compliance. This interagency consultation process also involves review and negotiations to identify conservation measures that can help protect and mitigate potential project impacts.

Depending on the impact of the proposed culvert to both the natural and/or cultural resources of an area, the USACE may coordinate with the Washington SHPO, USWFS, and NMFS. The SHPO regulates impacts to culturally and archeologically significant resources under Section 106 of the National Historic Preservation Act (NHPA), while the USFWS and NMFS regulate impacts to federally listed species (or their designated critical habitat), under Section 7 of the ESA. NMFS also regulates essential fish habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) of 1976.

Brandon Clinton of the USACE Settle District Regulatory Branch attended a regulator site meeting on October 9, 2018. The USACE representatives recommended using an NWP# 14 or 24 for fish passage restoration activities. They were also interested in the restoration of a more natural sediment regime in the stream and for the design to be sustainable passing sediment and restoring a delta at the mouth that would not create a navigational issue in the lake.

9.2.5 Cultural Resources

Section 106 of the NHPA requires federal action agencies, which are those federal agencies that issue licenses, leases and/or permits, to identify and assess the effects of its actions or actions it authorizes on historic (above ground) and archaeological (below ground) resources. The NHPA also requires federal action agencies (for example, the USACE) to allow the Advisory Council on Historic Preservation opportunity to comment on the proposed action. In Washington, Section 106 of the NHPA is administered by the Washington Department of Archaeology and Historic Preservation (DAHP).

Any action funded, taken, or approved by a federal agency (that is, the requirement of a permit from the USACE) is required to consider the action’s effects on historic properties. Federal action agencies must consult with appropriate state and local officials, including the SHPO (that is, DAHP) to consider their views and concerns about historic preservation issues when making final project decisions. The SHPO would act as the lead agency in the consultation process, with the USACE seeking concurrence from SHPO.

Consultation requirements with SHPO may include (1) the assessment of the Area of Potential Effect to determine the level of effect on cultural and archaeological resources and (2) preparation of a letter addressed to SHPO requesting concurrence with the “effect” determination. An application for consultation, which is submitted to DAHP, may include the following data:

1. Project name.
2. The project owner and authorized representative’s contact information.
3. Identification of an Area of Potential Effect.
4. Project location including address, city, county, section/township/range.
5. A map of the project. The street name and the project location should be marked; a U.S. Geological Survey topographical map is preferred.
6. Information on the presence of structures, and whether they are located on the National Register of Historic Places, or whether they are eligible for listing.
7. Original construction date(s) of any structures.
8. Original construction material type.
9. Information regarding any previous alternations to structure.
10. Determination of effect of project.

11. Project description.

SHPO will either concur with the "determination(s)" and "effect" call(s) or does not concur. If SHPO concurs, one of the following effect determinations will be made:

- *No Historic Property:* You are finished with the Section 106 Review consultation process.
- *No Adverse Effect:* You are finished with the Section 106 Review consultation process.
- *Adverse Effect:* The Agency enters into a "Memorandum of Agreement" (MOA) to mitigate the adverse effect or submits a research design to mitigate adverse effects through proper recovery. The MOA is signed by the Agency and SHPO. The federal agency submits the MOA to the Advisory Council, along with a description of the project and the alternatives that were considered to mitigate the "adverse effect". The Advisory Council has 30 days to review the project and decide if it is willing to sign the MOA. Once the MOA is signed, the documentation should be completed and accepted by designated repositories before the project begins.

Should it be determined that the Project will have no effect to known cultural and archaeological resources, concurrence is expected within 30 days of submitting a letter requesting concurrence from SHPO on the determination of no effect. This letter will be submitted independently of the JARPA but referencing the application submittal to Ecology and the USACE. SHPO's letter of concurrence will be distributed to Ecology, USACE, and the County, completing the State and Federal's Section 106 consultation.
If SHPO does not concur, then the USACE may only make a final determination on their own with assistance from other federal agencies such as the Keeper of the National Register of Historic Places, or the Advisory Council on Historic Preservation.

9.2.6 Government to Government

The USACE ensures that their leadership and federally recognized Indian tribal leaders meet as governments and recognize that tribes have the right to be treated in accordance with principles of self-determination. As such, the USACE is required to contact and consult with the appropriate Native American Nations when a project takes place on tribal lands or could affect Native American cultural sites. For this project, the USACE may consult with the Muckleshoot Tribe and/or Snoqualmie Tribe. This Government-to-Government consultation typically runs concurrent with the 30-day public notice period.

As part of this Permit Feasibility Study, a 48 NORTH biologist solicited input from the Snoqualmie Tribe. David Steiner and McKenna Sweet Dorman of the Snoqualmie Tribe Natural Resource Department and Martin Fox of the Muckleshoot Tribe (MIT) Natural Resource Department attended a regulator site meeting on October 9, 2018. The tribal representatives requested that they would like to be updated on the progression of the project as well as be involved with the public outreach portion of this project.

The Snoqualmie Tribe is interested in the cultural importance of the George Davis Creek site (such as culturally modified large trees, fishing grounds, ceremonial sites, etc.) as well as the restoration of George Davis Creek. The MIT expressed interest regarding the use of the Stream Simulation method as better for fish passage evaluation as well as a desire to keep the project simple, provide more complexity in the channel with the use of wood, and to provide fish passage at the margins of the restored George Davis channel. Martin Fox also stated that an overflow channel would not be acceptable to the MIT if it was not designed as fish passable and to Stream Simulation standards.

9.2.7 Threatened and Endangered Species

Section 7 of the ESA requires federal agencies to ensure actions it authorizes, or permits are not likely to jeopardize the continued existence of listed species or adversely modify designated critical habitats. The Services share responsibility for administering Section 7 of the ESA.

Consultation with the Services may be required if the Project requires a federal permit from the USACE, which is considered a federal nexus. Projects that have a federal nexus (that is, receive federal funds, occur on federal lands, or require federal permits or approval) trigger the completion of Section 7 consultation with the Services.

Consultation under the ESA would require the County to submit either a letter of "no effect" or request a Biological Assessment (BA) for informal (determination of "may effect, is not likely to adversely affect"), or formal consultation (determination of may affect, is likely to adversely affect") to the Services.

The USACE is responsible for initiating and coordinating the consultation process and obtaining the Services concurrence. The County is responsible for preparing either a "letter of no effect" or a BA to address the potential impacts and possible mitigation measures to offset these impacts.

Consultation requirements with the Services may include (1) an assessment of the proposed construction of the culvert replacement to determine the level of effect on federally listed species (or their designated critical habitat), protected by the respective agencies and (2) preparation of a letter (or report, depending on the level of effect) addressed to the Services requesting concurrence with the effect determination. The USACE will issue a permit once they receive concurrence from the Services (among other items).

If a formal Section 7 consultation is required by USFWS and/or NMFS, it could take up to 135 days to review after the project documentation, such as a BA, is determined complete. If these agencies determine that the Project merits an informal consultation, there is no set time frame, but it generally takes 2 to 5 months to complete a review.

Kokanee salmon have been documented in the lower reach of George Davis Creek (HDR, 2009) and are the target fish species for this fish passage project. Lake Sammamish Kokanee were not considered by the USFWS to meet the criteria as a Distinct Population Segment (DPS), and therefore the Lake Sammamish late-run population is not listed for protection under the Endangered Species Act (ESA) in 2011 (USFWS, 2011). WDFW's SalmonScape online mapping tool indicates presence of sockeye salmon (*Oncorhynchus nerka*), fall run Chinook salmon (*Oncorhynchus tshawytscha*), and winter run steelhead trout (*Oncorhynchus mykiss*) (WDFW, 2018) in the Lake Sammamish basin. George Davis Creek is not designated critical habitat for Puget Sound Chinook salmon DPS and steelhead DPS (WDFW, 2018). It is recognized above that ESA-listed species do not occur in George Davis Creek, but they do occur in Lake Sammamish and may utilize habitat in the delta of George Davis Creek. WDFW's SalmonScape online mapping tool also lists two priority fish species within George Davis Creek: residential coastal cutthroat trout (*Oncorhynchus clarki*) and coho salmon (*Oncorhynchus kisutch*) (WDFW, 2018).

If a Project is considered by USFWS and/or NMFS as having the potential to *may affect* an ESA-listed species, they go through an informal consultation. However, if the USACE determines that the action is likely to adversely affect an ESA-listed species, they may submit a request for formal consultation to NMFS and/or USFWS. Most Section 7 consultations are considered "informal" by the Services.

9.2.8 Essential Fish Habitat

The MSA protects EFH for the coastal pelagic species fishery, Pacific coast groundfish fishery, and Pacific Coast salmon species fishery. Amended in 1999, the MSA requires federal agencies to consult with NMFS on all authorized/proposed activities that may have an adverse effect to EFH. Consultation under the MSA is only required if the USACE determines the culvert replacement project may have an adverse effect on EFH. Consultation for EFH is generally completed in concert with a BA for federally protected fish species under the ESA. An EFH assessment and any associated conservation recommendations are included in either a separate letter to NMFS or as an appendix to the BA to NMFS. The EFH assessment can refer to the BA rather than reiterating much of the information, as similar information is relied upon for the EFH assessment. The resulting determination is either that the project "may adversely affect" or "will not adversely affect" designated EFH.

For the George Davis Fish Passage Project, the EFH will address the Pacific Coast salmon that may occur in the area, including Chinook (*Oncorhynchus tshawytscha*), and coho (*Oncorhynchus kisutch*) salmon. An effect determination will be made for the group of species rather than for each species.

9.3 State

9.3.1 Water Quality

In Washington, one water quality related permit is applicable to this project: Water Quality Certification (WQC). Ecology has authority over discharge into all wetlands and streams, and can impose buffers and compensatory mitigation for impacts under 90.48 RCW depending on the proposed project and amount of impacts to aquatic resources. Section 401 WQC can cover both the construction and replacement of the culvert. For water quality permits, a copy of the JARPA will be submitted to the USACE and Ecology concurrently, with submission of a USACE Section 10/404 permit and a State Section 401 WQC, respectively. Review of the JARPA for the WQC will occur concurrently with the State Environmental Policy Act (SEPA) process. Although the WQC cannot be issued until the SEPA process is completed, it is normally issued approximately 30 days after the conclusion of the SEPA appeal period.

Ecology's Section 401 WQC will be made available before the USACE Section 10/404 permit is issued. However, Ecology must receive a copy of the USACE's public notice or NWP authorization letter prior to making a Section 401 decision. For an individual Section 401 WQC, Ecology has up to 1 year to certify, condition, or deny a project receiving a federal permit. There are no application fees associated with this permit. Ms. Rebekah Padgett at Ecology's Northwest Region Office will likely be the Ecology's lead for this Section 401 review.

9.3.2 Hydraulic Project Approval

WDFW reviews any project that may impact fish, shellfish, and/or their habitat. Upon their review, if applicable, a Hydraulic Project Approval (HPA) is issued by WDFW. An HPA is a mechanism to protect state fisheries and is required if a project uses, diverts, obstructs, or changes the natural flow or bed of state waters.
The information included in the JARPA is used for the HPA application. Unlike the other state agencies, the information included in the JARPA is uploaded onto the WDFW APPS online application system. Once successfully uploaded, WDFW reviews and comments on the complete application as to whether or not the permit is necessary. A SEPA determination needs to be completed prior to WDFW making their final determination and issuance of an HPA. Once a completed application has been received by WDFW, it may take up to 45 days to issue an HPA.

Miles Penny of the WDFW attended a regulator site meeting on October 9, 2018. Casey Costello of the WDFW conducted a project site visit with the City of Sammamish on May 24, 2017, to discuss this potential culvert removal and to walk the length of George Davis Creek. He acknowledged that an HPA will be required and that he will likely oversee the application process and would like to be updated on the progression of the project.

9.3.3 Tribal Consultation

Since tribal and non-tribal fishers impact the fishing resources over much of Washington State, it is important that WDFW and the tribes work cooperatively to develop management strategies that can meet the needs of both. Many tribal governments take an active role in the management of fish resources. Most tribes with off-reservation fishing rights have a tribal fish committee that meets to develop regulations and management strategies. The tribes are co-managers of Washington States fisheries resources with WDFW. Co-management is a term used to describe the government-to-government relationship between the state of Washington and the Indian tribes whose rights were established in treaties signed by the federal government in the 1850s. It is also used to describe state-tribal management of salmon, steelhead, groundfish, and shellfish in the Northwest. As such, during the HPA review, WDFW will consult regional tribes such as the Muckleshoot and Snoqualmie Tribes to solicit input on a project before issuing an HPA.

9.4 Local

9.4.1 SEPA Checklist

The SEPA is a state policy that requires state and local agencies to consider the likely environmental consequences of a proposal before approving or denying the proposal. One agency is usually identified as the lead agency to evaluate the environmental consequences of the proposal. For the proposed culvert replacement, the City of Sammamish would likely be the SEPA lead agency.

There are three levels of environmental review under SEPA. Some minor projects do not require environmental review, so the City will first decide if environmental review is needed. If the George Davis Fish Passage Project is deemed as the type of project that is categorically exempt from SEPA review, no further environmental review will be needed. If the project is not categorically exempt, the City will complete an environmental checklist. The answers in the checklist will help the City decide if an environmental impact statement (EIS) is needed. If an EIS is required, the City may then need to write the EIS. The EIS evaluates the proposal and reasonable alternatives, the affected environment, and possible mitigation measures.

If the project is not likely to have a significant environmental impact, the City will issue a Determination of Non-Significance (DNS). However, significance may need to be mitigated, as such a Mitigated DNS could be issued after the City identifies conditions that will reduce impacts to a non-significant level. Regardless of the environmental review, it is likely that the SEPA document will require a public comment period (typically 30 days). As part of this public comment period, the City will consider any comments received. The City of Sammamish's Planning Department will likely oversee the SEPA review.

9.4.2 Critical Areas

The City of Sammamish regulates critical areas (for example, wetlands, streams, and their buffers) per Chapter 21A.50 (Environmentally Critical Areas) of the Sammamish Municipal Code (SMC). All wetlands and streams within the project area are regulated by the City and all critical areas in and around a project area must be identified. Activities that modify wetlands, streams, or their buffers require authorization from the City, including a critical areas assessment report or habitat management plan that adequately evaluates the proposed action and potential impacts to support any land use application (SMC 21A.50.110). These assessments will identify if wetlands are present and, if so, where in relation to the project; if there are threatened and/or endangered species present; and if surface waters are present in addition to those identified as being present in the project area. These reports or information contained within them will support permit applications, including the JARPA, Conditional Use Permit, and SEPA Checklist.

As part of the design, critical areas such as wetlands should be avoided where practical. If they cannot be avoided, impacts should be minimized to the greatest extent practical. As part of the critical areas assessment, a wetland delineation and/or OHWM delineation would be necessary to avoid these impacts. As part of the Permit Feasibility Study, 48 NORTH conducted an OHWM delineation and wetland reconnaissance (see Section 4). It is recognized above that ESA-listed species do not occur in George Davis Creek, but they have been documented in Lake Sammamish.

9.5 Permitting Alternatives

9.5.1 Alternative 1

This alternative would install a 15-foot-wide fish passage culvert beneath ELSP, tying into the King County culvert, passing through a bridge beneath ELSSL, through a 15-foot-wide culvert the existing ADU located on the Linde Property. The Creek would then be open until it meets the existing 8-foot culvert beneath the existing home on the Linde Property.

The configuration would meet WDFW stream simulation requirements for crossing width for ELSP and the Trail crossing, but not in the lower section underneath the Linde Property and the open section downstream of the house. This option would potentially be the least favorable to the USACE and local tribes since fish passage would not be restored to the whole system. If a fish passable channel designed to stream simulation standards is not constructed as part of this option for the lower section of the Creek, there could be a significant delay of 12 months or more or the project would not be acceptable by the MIT or WDFW due to a treaty violation. The MIT stated that any alternative would not be acceptable to the MIT if not designed as fish passable and to stream simulation standards.

9.5.2 Alternative 2

This alternative would install a 15-foot-wide fish passage culvert beneath ELSP and realigned into a new constructed channel running north along the Trail. From this point it would be carried into a 15-foot-wide culvert that would head west beneath ELSSL and into an existing parcel adjacent to the Overflow parcel, where the existing overflow currently discharges into the lake.

This configuration would meet WDFW stream simulation requirements for crossing width but there is no ecological reference reach available for this option that would possibly extend and configure the newly created stream reach to the north from just upstream of ELSP. A new stream channel will need to be constructed, there is not much area to work with, and there are serious stream grade issues to deal with in this realignment. A new stream channel route could also possibly trigger an EIS with considerable permitting implications. This option would potentially be less favorable to the USACE and local tribes. It would require more documentation, more consultation, and more mitigation since a new channel will have to be constructed where no channel existed before, flow and sedimentation issues could arise due to the shallow grade of the new routing, the Trail would need to be realigned, and numerous large trees would have to be removed.

9.5.3 Alternative 3

This alternative would install a 15-foot-wide fish passage culvert beneath ELSP, tying into the King County culvert, passing through a bridge beneath ELSSL, through a 15-foot-wide culvert beneath the existing ADU on the Linde Property, open channel through the north side of the property (avoiding large trees), through another 15-foot-wide culvert beneath the existing home and exiting out into Lake Sammamish.

This configuration would meet WDFW stream simulation requirements for crossing width. This option and stream routing would potentially be more favorable to the USACE and local tribes since culturally modified trees will be avoided. This option also will require less documentation, consultation, and less mitigation. Increased sediment input into Lake Sammamish and how to manage the new delta formation will need to be addressed since sediment processes and sediment transport will be restored to the new channel restoration.

USACE stated that provisions must be included so lakeside docks are not affected by sediment being transported from the Creek. Sediment management and modeling must be incorporated in the design of the Creek mouth delta restoration design. This is a separate permit issue for the USACE and a secondary permitting element that must be incorporated into the design of the Creek delta so lakeside dock owners are not adversely impacted. Additional local permitting may be required depending on modifications to the existing property.

9.5.4 Alternative 4

This alternative would install a 15-foot-wide fish passage culvert beneath ELSP, pass under a bridge at the Trail, and flow under a bridge beneath ELSSL. From there the Creek would be open and run through the Sigmar Property in a newly restored stream channel in the relic George Davis delta location.

This configuration would meet WDFW stream simulation requirements for crossing width. This option is similar to Alternative 3 and would also be potentially be more favorable to the USACE and local tribes; require less documentation, consultation, and less mitigation since the Sigmar Property would be acquired and will be restored with an appropriate stream buffer. Increased sediment input into Lake Sammamish and how to manage the new delta formation will need to be addressed since sediment processes and sediment transport will be restored to the new channel restoration.

USACE stated that provisions must be included so lakeside docks are not affected by sediment being transported from the Creek. Sediment management and modeling must be incorporated in the design of the Creek mouth delta restoration design. This is a separate permit issue for the USACE and a secondary permitting element that must be incorporated into the design of the of the Creek delta, so lakeside dock owners are not adversely impacted. Additional permitting may be required due to the creation of a new channel from the Trail crossing to the lake.

10 PUBLIC INVOLVEMENT

Text will be provided after future public meeting(s) take place.

11 ALTERNATIVES ANALYSIS

In order to choose a preferred alternative, the alternatives were thoroughly analyzed using a number of criteria. To start with, the overarching goals of the George Davis Creek Fish Passage Project should be stated:

The preferred alternative should (1) provide fish passage for multiple species in Lake Sammamish, (2) significantly reduce flooding, (3) be realistic and affordable to construct, and (4) be as maintenance free as possible.

In previous sections of this report, the fish passage, hydraulic performance, and permitting elements were discussed in great detail as they compose the main elements of analysis in relation to the stated goals. The other criteria listed below are just as important and were weighted equally, though the level of analysis (because it was not necessary to arrive at a score) was not as in depth as fish passage, hydraulics, and permitting.

All of the scoring criteria are discussed in this Alternatives Analysis section and the score for each alternative is given.

11.1 Criteria

The scoring criteria, or criteria used to analyze each alternative, are listed below:

1. Fish Passage
2. Long-Term Stability
3. Cost
4. Timeline
5. Permit Risk
6. Public Acceptance
7. Legal Hurdles
8. Operations and Maintenance
9. Construction

The criteria were developed from multiple meetings that involved diverse stakeholders. These stakeholders included regulators, City maintenance crews, civil engineers, biologists, and concerned citizens. The criteria developed resulted in analysis of each alternative that rigorously tests it against each of the goals. A scale from 1 to 10 was used to score each criterion; a lower number indicates a better score. The score is somewhat subjective and meant to depict a relative difference between options.

11.1.1 Criterion 1: Fish Passage

The fish passage analysis for each alternative is discussed in detail in earlier sections of this report. The scoring for this criterion ranged from completely not passable on the high-scoring end to an ideal fish passage on the low-scoring end.

Alternative 1

Alternative 1 provides fish passage from the upstream end of the culvert beneath the existing residence up to the upstream end of the project east of ELSP. As this alternative utilizes the existing undersized opening beneath the house, it is at risk of both erosion and deposition, which can cause a fish barrier to form. For this reason this alternative was given a slightly higher score:

Score = 4

Alternative 2
Alternative 2 provides fish passage from the overflow location at the lake to the upstream end of the project east of ELSP. This alternative requires a significant variance in grade along the Trail. This puts the project at risk for sedimentation and erosion, which can cause a fish barrier to form. For this reason this alternative was given a slightly higher score:

Score = 4

Alternative 3
Alternative 3 provides fish passage from the lake up to the upstream end of the project east of ELSP. This alternative provides a full stream simulation design for the entire reach; therefore, this alternative does contain multiple culverts and has to work around multiple restrictions. In addition, the reach is quite steep and the Creek has flashy flows. All of this poses a slightly higher risk of Creek forces, creating a fish barrier at some point. For this reason this alternative was given the following score:

Score = 3

Alternative 4
Alternative 4 provides fish passage from the lake up to the upstream end of the project east of ELSP. This alternative provides a full stream simulation design for the entire reach. This option flows in an open channel at the downstream end and eliminates two culverts. This option is the best option from the fish passage standpoint, but is still within a steep reach with flashy flows. For this reason this alternative was given the following score:

Score = 2

11.1.2 Criterion 2: Long-Term Stability
Long-term stability for each alternative is defined as how long the project will function with little intervention. A low score means low intervention and long term stability and a high score means almost constant intervention.

Alternative 1
Alternative 1 connects the fully restored reach to the existing undersized opening beneath the Linde Property's residence. The hydraulics are such that this configuration successfully passes the entire flow regime. With that said, the constriction at the house will cause the Creek to change in unforeseen ways. These changes can take the form of head cuts, deposition, bank erosion, or other destructive actions that can destabilize the Creek. For this reason this alternative was given a slightly higher score:

Score = 5

Alternative 2
Alternative 2 requires a significant variance in grade along the Trail. This puts the project at risk for sedimentation and erosion, which can cause a fish barrier to form. It is likely that this alternative will require routine maintenance to deal with sediment. For this reason this alternative was given a slightly higher score:

Score = 5

Alternative 3
Alternative 3 provides a full stream simulation design for the entire reach. With that said the reach is quite steep and the Creek is flashy. All of this poses a slightly higher risk of Creek forces creating a fish barrier at some point. For this reason this alternative was given the following score:

Score = 3

Alternative 4
Alternative 4 provides a full stream simulation design for the entire reach. This option flows in an open channel at the downstream end and eliminates two culverts. This alternative is the best option from the stability standpoint, as it provides the most room for the Creek to change as it needs to. For this reason this alternative was given the following score:

Score = 2

11.1.3 Criterion 3: Cost

The cost criterion not only includes planning-level cost estimates (see Appendix B) but also the expected cost risk. The specifics of cost risk are discussed below. In general, a low score means low planning-level cost and low cost risk whereas a high score means higher planning-level cost and high risk.

Alternative 1
Alternative 1 requires the installation of multiple culverts and significant site restoration costs. As this alternative requires negotiation with a private property owner, the risk is considered higher. The expected costs are between $1.7 and $2.1 million. Risk along with cost result in a higher score:

Score = 6

Alternative 2
Alternative 2 requires the installation of multiple culverts and moving the Trail to the west. This alternative requires the most coordination with the construction of the Trail and therefore introduces cost risk. The expected costs are between $1.6 and $2.0 million. This alternative was given a slightly higher score:

Score = 5

Alternative 3
Alternative 3 requires a complicated and significant site restoration cost that encompasses the cost of replacing two structures. This alternative carries significant cost risk because of the negotiation factor. The expected costs are between $3.0 and $3.7 million. This alternative was given the following score:

Score = 7

Alternative 4
Alternative 4 requires purchasing the Sigmar property, which is a lakefront property. In addition, this purchase will require the partnership with third parties or grant funding agencies because the City does not have this cost within its capital budget at this time. The expected costs are between $6.5 and $8.0 million. This alternative was given the following score:

Score = 8

11.1.4 Criterion 4: Timeline

Timeline is defined around a 2020 construction season. A low score is means a high likelihood of a 2020 construction and a high score means an indefinite timeline.

Alternative 1
Alternative 1 requires negotiation with a private property owner. As this option is fish passable, the permit timing is low. Also, the coordination with King County is considered low risk as the crossing is roughly in the same place as their design has it. These factors make the timeline for this option predictable and could result in a 2020 construction. This alternative was given the following score:

Score = 3

Alternative 2
Alternative 2 requires the installation of multiple culverts and moving the Trail to the west. This alternative requires the most coordination with the construction of the Trail and therefore introduces timeline risk. In addition, it is anticipated that this alternative will require an EIS. These factors put the timeline for this alternative at some point after 2020. This alternative was given a slightly higher score:

Score = 7

Alternative 3
Alternative 3 requires a complicated and significant site restoration cost that encompasses negotiation to replace two structures. With that said the property owner is very agreeable and it is assumed that these negotiations will not be drawn out. Permitting for this alternative is relatively straightforward. These factors make the timeline for this option predictable and could result in a 2020 construction. This alternative was given the following score:

Score = 3

Alternative 4
Alternative 4 requires the purchase of the Sigmar Property, which is a lakefront property. In addition, this purchase will require the partnership with third parties or grant funding agencies because the City does not have this cost within their capital budget at this time. The lack of funding results in an indefinite timeline. This alternative was given the following score:

Score = 8

11.1.5 Criterion 5: Permit Risk
Permit risk is defined as the level of risk associated with obtaining permits for a 2020 construction. A low score means a low risk of not having permits issued by 2020, and a high score means a high risk of not having permits issued by 2020.

Alternative 1
Alternative 1 provides a full stream simulation design so it should not receive a great amount of opposition. The other permit factors are discussed in detail in earlier in this report, but in general the permit risk is considered moderate. This alternative was given the following score:

Score = 5

Alternative 2
Alternative 2 provides a full stream simulation design but will require a complete rerouting of the Creek, along with a much more complicated shoreline permit and an anticipated EIS. This alternative was given a slightly higher score:

Score = 6

Alternative 3
Alternative 3 provides a full stream simulation design so it should not receive a great amount of opposition. The other permit factors are discussed in detail earlier in this report, but in general the permit risk is considered moderate. This alternative was given the following score:

Score = 4

Alternative 4
Alternative 4 provides the best alternative from a permitting standpoint due to reduction in culverts and interaction with private property owners. This alternative was given the following score:

Score = 3

11.1.6 Criterion 6: Public Acceptance.

Public acceptance is defined as the risk of public opposition. A low score means that the risk of public opposition is low and a high score means that the risk of public opposition is high.

Alternative 1
Alternative 1 requires negotiation with the owner of the Linde Property. The alternative does provide fish passage and does not significantly impact other private property owners. The owner of the Linde Property is a major advocate of this project. However, the necessary agreement with the property owner will entail a significant site restoration cost, which brings possible public opposition. This alternative was given the following score:

Score = 3

Alternative 2
Alternative 2 requires installing multiple culverts and moving the Trail to the west. This alternative requires the most coordination with the construction of the Trail and, therefore, introduces public opposition risk because any impacts to the KCT is highly controversial in this area. In addition, it is anticipated that this alternative will require an EIS. These factors put a high risk of public opposition. This alternative was given a higher score:

Score = 7

Alternative 3
Alternative 3 requires a complicated and significant site restoration cost that involves negotiation for replacement of two structures on the Linde Property. However, the property owner is very agreeable. Similar to Alternative 1, this does not significantly impact other property owners, but because of the high site restoration costs, it could cause public opposition. This alternative was given the following score:

Score = 3

Alternative 4
Alternative 4 requires the purchase of the Sigmar Property, which is a lakefront property. In addition, this purchase will require the partnership with third parties or grant funding agencies because this cost is not within the City’s capital budget at this time. The purchase of lakefront property for the purpose of a Creek restoration could appear as a questionable use of limited City funds. This makes the risk of public opposition higher. This alternative was given a higher score:

Score = 8

11.1.7 Criterion 7: Legal Hurdles

Legal hurdles are defined as a combination of the complexity associated with legal agreements and the risk of legal action from a third party or liability taken on by the City associated with the project. A low score means that these combined factors present a low risk and a high score means that these combined factors present a high risk.

Alternative 1
Alternative 1 requires negotiation with a private property owner. The resulting agreement with the private property owner will include language to indemnify the City against future legal action. Still, this alternative carries significant legal risk as the City will be reconstructing a Creek on private property that terminates at an existing residence. As stated previously, this alternative has significant risk of possible erosion or destruction. These elements combined makes this alternative a high legal risk and was given a higher score:

Score = 7

Alternative 2
Alternative 2 requires installing multiple culverts and moving the Trail to the west. This alternative requires the most coordination with the construction of the Trail and is anticipated to require an EIS. Many residents along the corridor have presented legal challenges to projects in the past. The resident at the overflow location, the location where this alternative outlets, has sued King County, and the settlement agreement allows for this resident to sue again. This alternative would possibly create a delta at the outlet of the creek, which is likely to increase the risk of legal action from this resident. These factors put the legal risk quite high. This alternative was given a higher score:

Score = 7

Alternative 3
Alternative 3 requires a complicated and significant site restoration cost that involves negotiation for replacing two structures on the Linde Property. However, the property owner is very agreeable. Unlike Alternative 1, this alternative allows for full site design through the property. What this accomplishes is significant risk mitigation that the project will cause destruction to the property in the future, thus lowering the legal risk considerably. This alternative was given the following score:

Score = 3

Alternative 4
Alternative 4 requires the purchase of the Sigmar Property, which is a lakefront property. In addition, this purchase will require the partnership with third parties or grant funding agencies because the City does not have this cost within its capital budget at this time. In order to successfully partner with third parties to fund this project, complex legal agreements will be required. These agreements, coupled with a drawn out timeline, introduce a significant level of risk. This alternative was given a higher score:

Score = 7

11.1.8 Criterion 8: Operations and Maintenance
Operations and Maintenance is defined by the level of either expected or unexpected maintenance combined with the difficulty associate with such maintenance. A low score means almost no expected maintenance and a high score means not only expected regular maintenance but a high risk of unexpected maintenance.

Alternative 1
Alternative 1 connects the fully restored reach to the existing undersized opening beneath the residence on the Linde Property. The hydraulics are such that this configuration successfully passes the entire flow regime. With that said, the constriction at the house will cause the Creek to change in unforeseen ways. These changes can take the form of head cuts, deposition, bank erosion, or other destructive actions that can destabilize the Creek. Any one of these actions will require some level of

interaction by City maintenance crews. Also, these events carry the risk of displacing the resident. For this reason this alternative was given a slightly higher score:

Score = 6

Alternative 2

Alternative 2 requires a significant variance in grade along the Trail. This puts the project at risk for sedimentation and erosion, which can cause a fish barrier to form. It is likely that this alternative will require routine maintenance to deal with sediment, which will require coordination with King County Parks. For this reason, this alternative was given a slightly higher score:

Score = 5

Alternative 3

Alternative 3 provides a full stream simulation design for the entire reach. Even though the reach is quite steep and the Creek is flashy, all of this poses a slightly higher risk of Creek forces, creating a fish barrier at some point. If any events occur that require mitigation, this maintenance will have to occur on a private residence. For this reason this alternative was given the following score:

Score = 4

Alternative 4

Alternative 4 provides a full stream simulation design for the entire reach. This option flows in an open channel at the downstream end and eliminates two culverts. This alternative is the best option from the stability standpoint, as it provides the most room for the Creek to change as it needs to. As the Creek will be in an ideal as possible corridor, the maintenance theoretically will be non-existent. For this reason this alternative was given the following score:

Score = 2

11.1.9 Construction

Construction is defined as the risk associated with construction. Factors including traffic control, utility coordination, and space to work greatly impact construction difficulty and thus cost and risk. A low score means a relatively straightforward project with plenty of room to work and little maintenance of traffic, while a high score means extremely tight areas, complicated maintenance of traffic, and complicated project elements such as working right next to residences.

Alternative 1

Alternative 1 connects the fully restored reach to the existing undersized opening beneath the residence. The construction of this option requires construction on ELSP, which is a high risk from the utility and maintenance of traffic standpoint. In addition, this requires coordination with King County and the relocation or avoidance of multiple utilities. The construction on the Linde Property will be tight and provide little access with a lack of staging areas. For this reason this alternative was given a slightly higher score:

Score = 6

Alternative 2

Alternative 2 requires a significant variance in grade along the Trail. This option requires construction on ELSP, which is a high risk from the utility and maintenance of traffic standpoint. The construction coordination with the Trail project will be complicated and the work will require the relocation or avoidance of multiple utilities. The work near the lake will be tight and offer little room for staging. For these reasons, this alternative was given a slightly higher score:

Score = 6

Alternative 3
Alternative 3 connects the fully restored reach to the existing undersized opening beneath the residence. The construction of this option requires construction on ELSP, which is a high risk from the utility and maintenance of traffic standpoint. In addition, this requires coordination with King County and the relocation or avoidance of multiple utilities. The construction on the Linde Property will be tight and provide little access, with a lack of staging areas. This alternative will impact two structures in a major way, thus increasing the risk. For this reason this alternative was given a slightly higher score:

Score = 6

Alternative 4
Alternative 4 provides a full stream simulation design for the entire reach. This option flows in an open channel at the downstream end and eliminates two culverts. The construction of this option requires construction on ELSP, which is a high risk from the utility and maintenance of traffic standpoint. In addition, this requires coordination with King County and the relocation or avoidance of multiple utilities. This alternative is the best option from the construction standpoint because it offers the most room for a contractor to work. For these reasons, this alternative was given the following score:

Score = 4

11.2 Analysis and Scoring
All of the scores were compiled and the aggregate score for each was calculated. The lower the score is, the more desirable the alternative is in relation to the scoring criteria.

Alternative	Fish Passage	Long-Term Stability	Cost	Timeline	Permit Risk	Public Acceptance	Legal Hurdles	Operations & Maintenance	Construction	Overall Score
1	4	5	6	3	5	3	7	6	6	46
2	4	5	5	7	6	7	7	5	5	53
3	3	3	7	3	4	3	3	4	6	39
4	2	2	8	8	3	4	7	2	4	44

12 CONCLUSIONS

Based on the scoring criteria used, Alternative 3 is preferred alternative. Alternative 3 has the lowest score and fits best within the project goals of *(1) providing fish passage for multiple species in Lake Sammamish, (2) significantly reducing flooding, (3) being realistic and affordable to construct, and (4) be as maintenance free as possible*.

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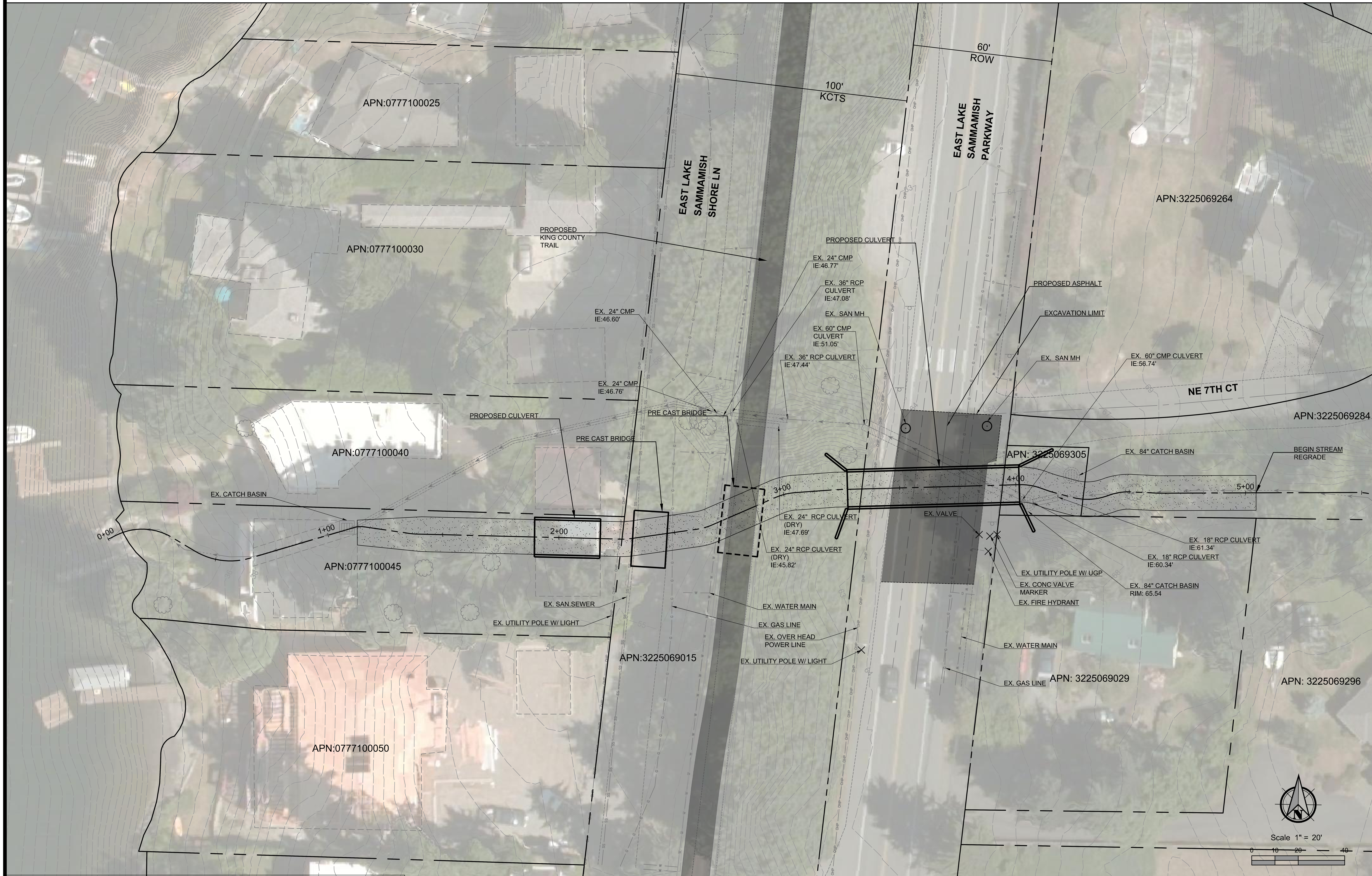
Appendix A

S32, T25N, R6E

ALTERNATIVE 1



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GEORGE DAVIS CREEK

ALTERNATIVE 1

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

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S32, T25N, R6E

ALTERNATIVE 2

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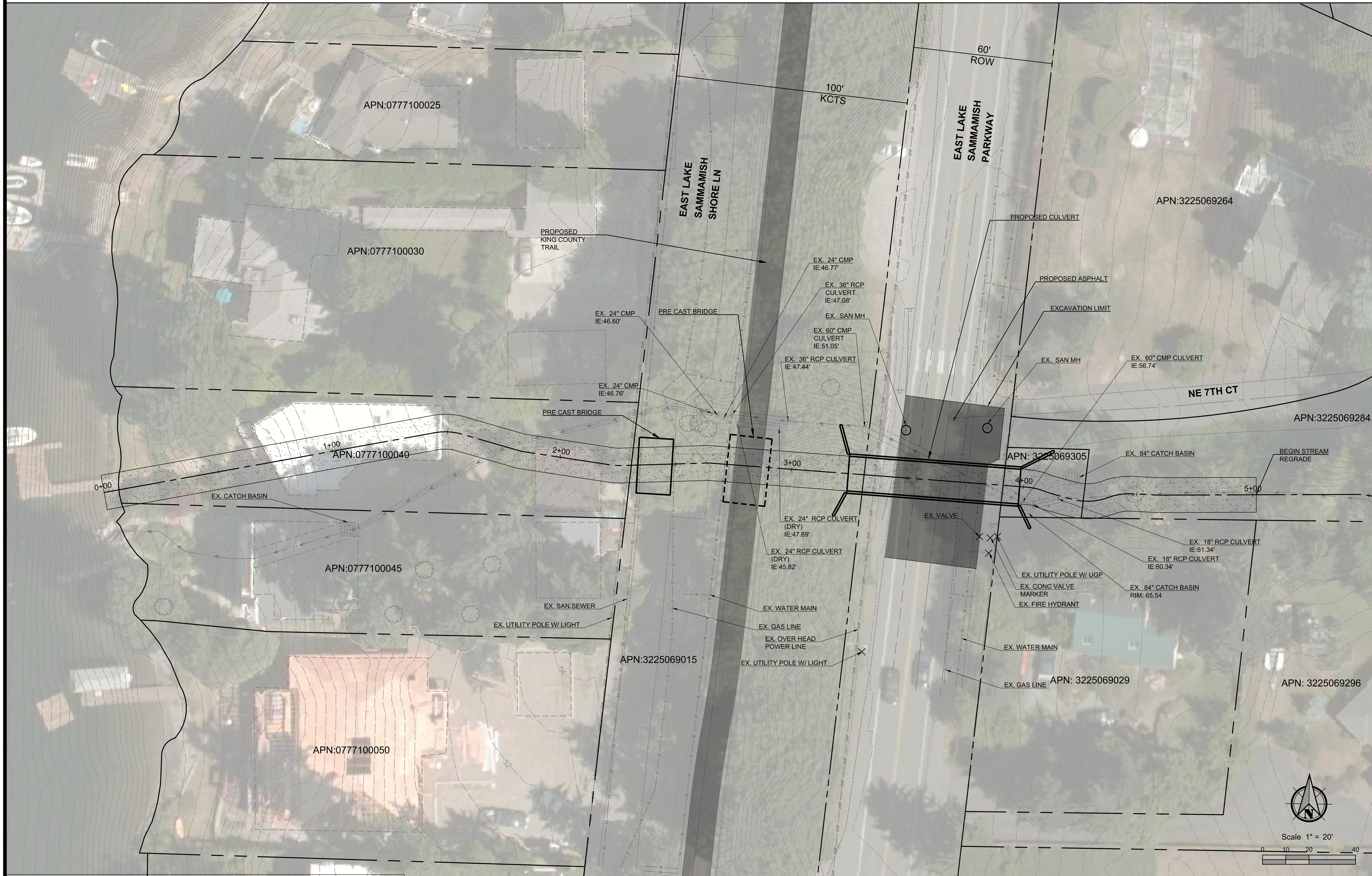
ALTERNATIVE 4



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ALTERNATIVE 4

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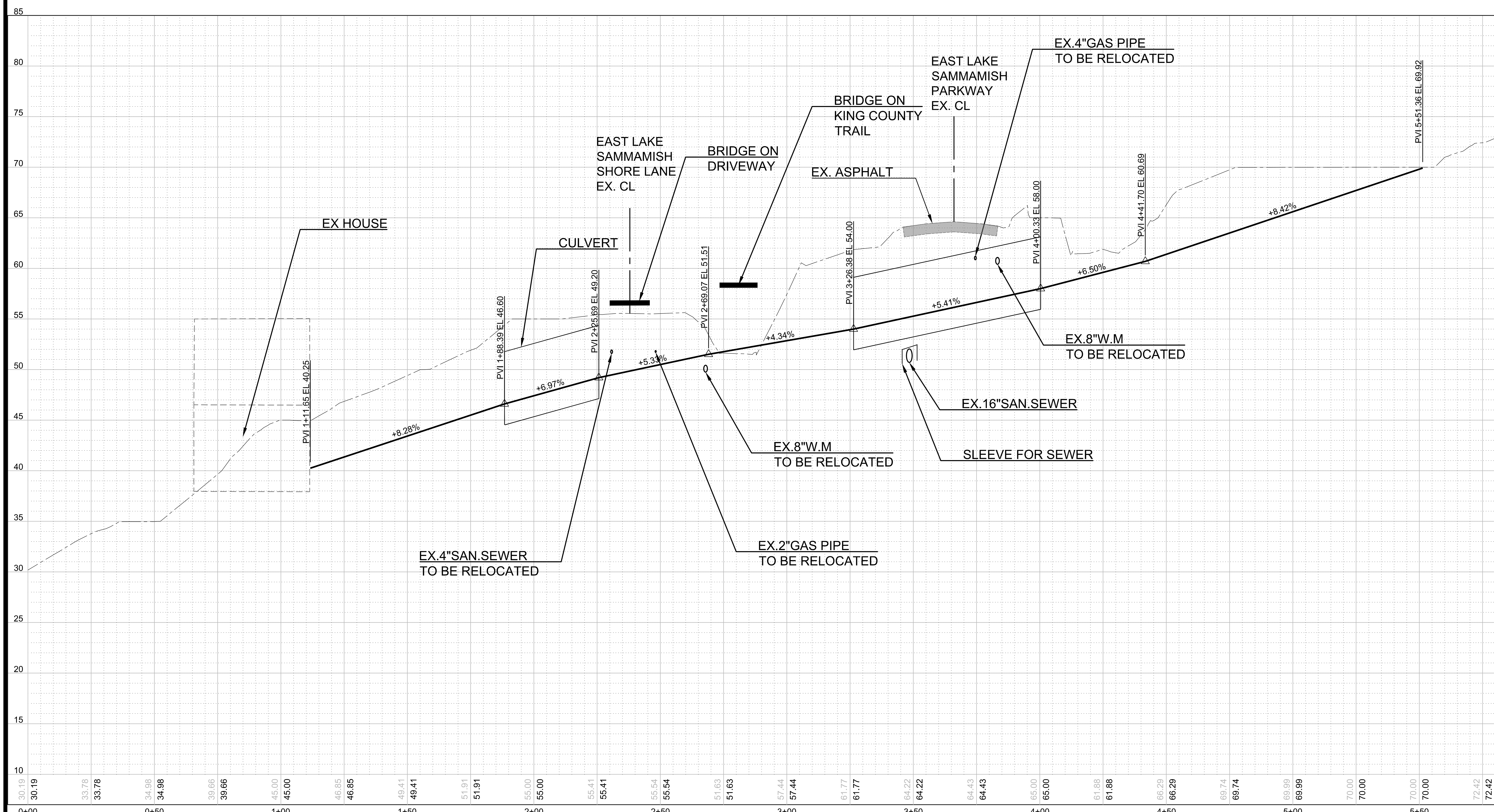

SCALE
H 1" = 5'
V 1" = 25'

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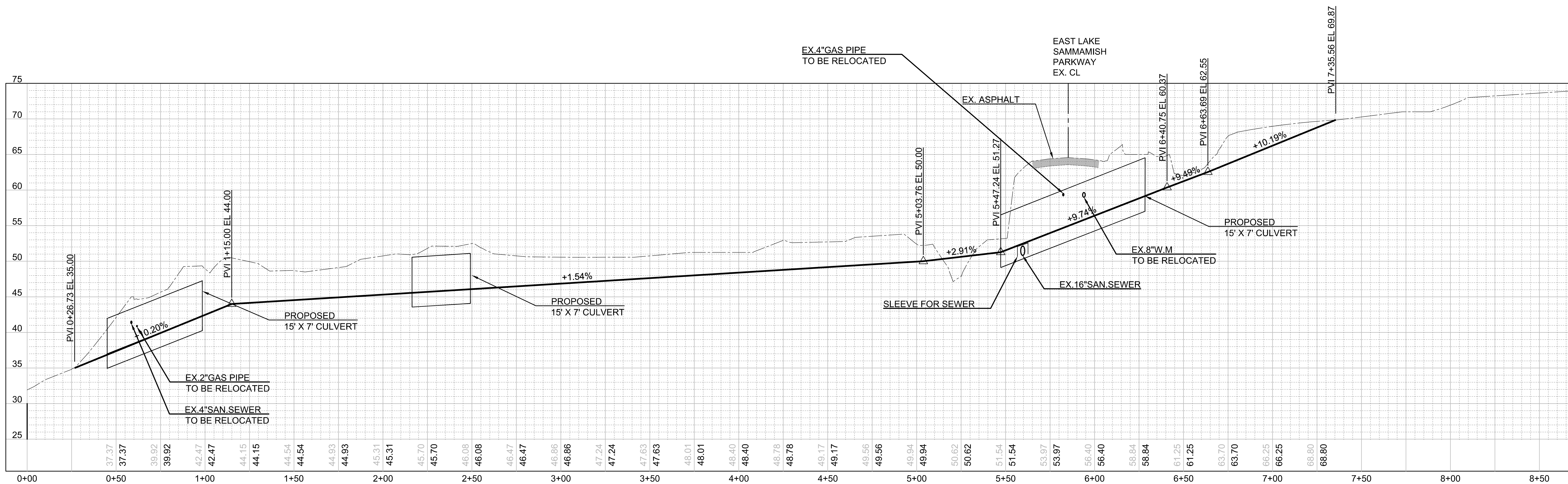

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PBS

GEORGE DAVIS CREEK
ALTERNATIVE 2

811
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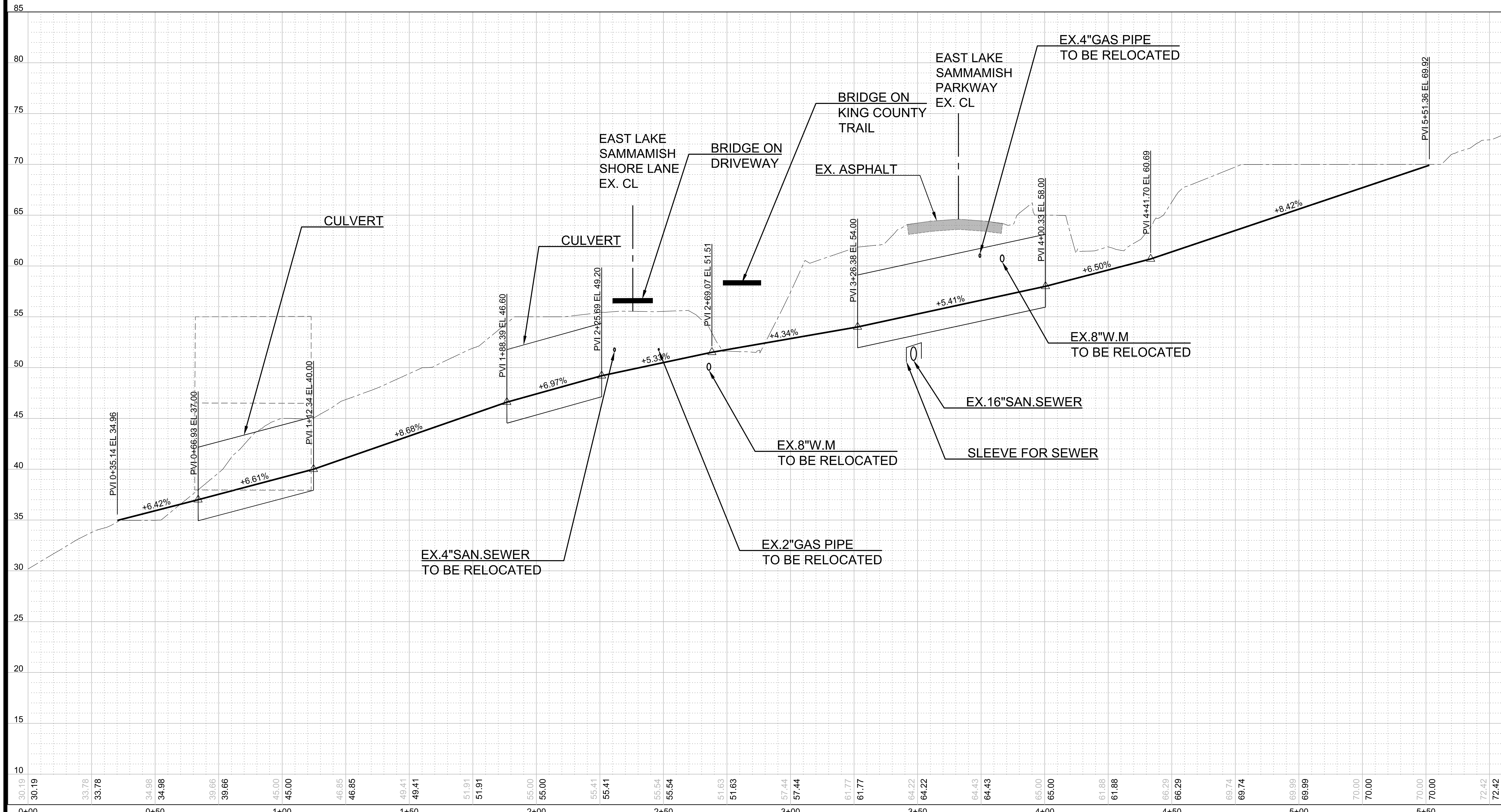
Call before you dig.

DESIGNED:

CHECKED:

SHEET ID

SHEET OF



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GEORGE DAVIS CREEK
ALTERNATIVE 3

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Call before you dig.

DESIGNED:

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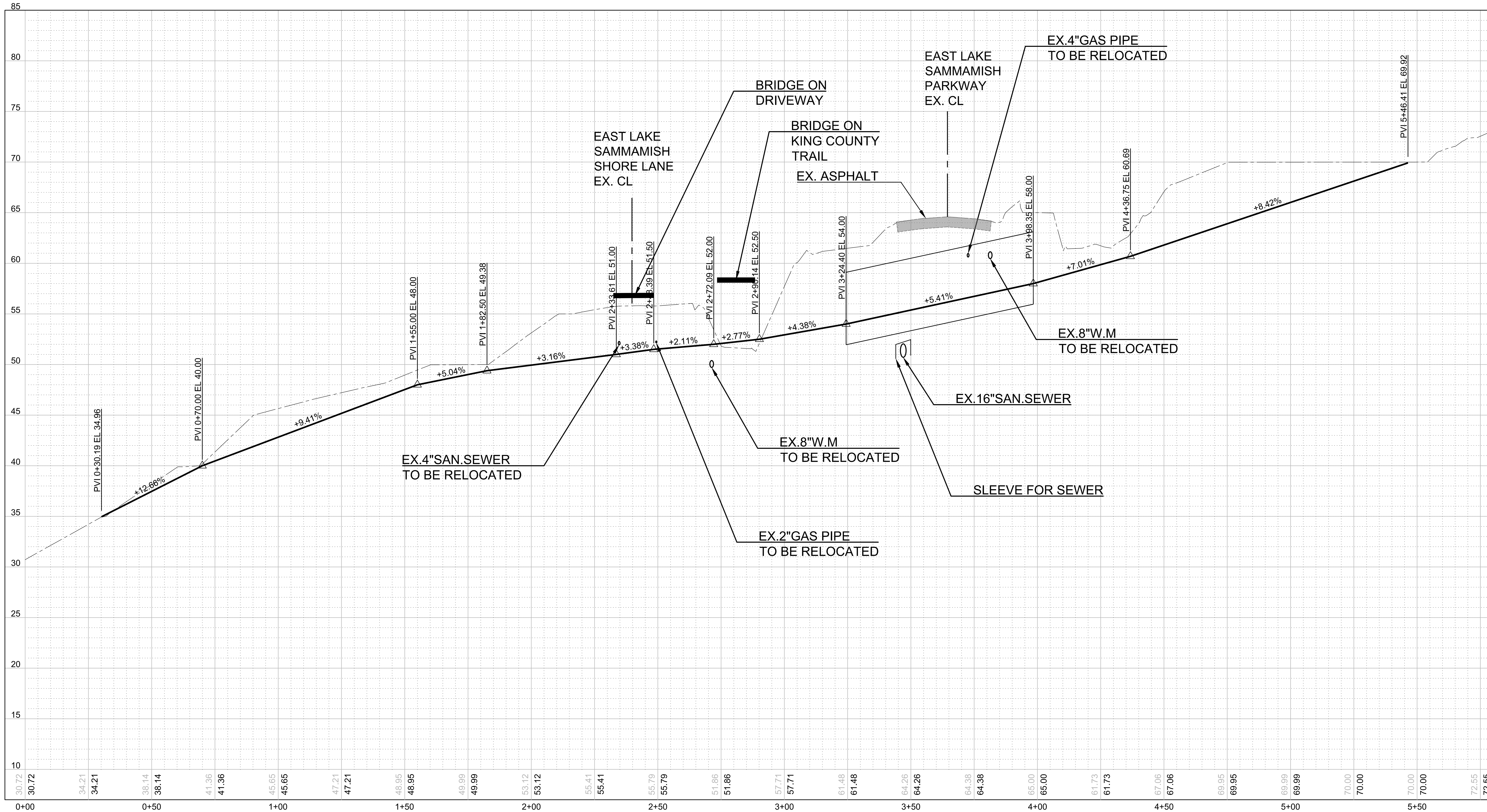

SCALE
H 1" = 5'
V 1" = 25'

Full Size Sheet Format Is 22x34; If Printed Size Is Not 22x34, Then This Sheet Format Has Been Modified & Indicated Drawing Scale Is Not Accurate.

PBS Engineering and Environmental Inc.
1180 NW Maple St, Ste 160
Issaquah, WA 98027
425.654.8775
pbsusa.com

PBS

GEORGE DAVIS CREEK
ALTERNATIVE 4

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

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Appendix B

Alternative Analysis Cost Estimate

PROJECT TITLE:		DESCRIPTION OF WORK
George Davis Creek Fish Passage Project		Alternative 1 - East Lake Sammamish Parkway Fish Passage Culvert, Two Bridges, No Improvements to house
REGION:	Sammamish, Washington	

Grading					**$ 104,563**
Roadside Cleanup	L.S.	1	$ 5,000	$ 5,000	
Clearing and Grubbing	ACRE	0.55	$ 24,000	$ 13,200	
Common Borrow Incl Haul	TON	500	$ 16	$ 8,000	
Roadway Excavation Incl. Haul	C.Y.	150	$ 16	$ 2,400	
Structure Excavation Incl. Haul	C.Y.	1500	$ 16	$ 24,000	
Channel Excavation Incl. Haul	C.Y.	2000	$ 16	$ 32,000	
Shoring or Extra Excavation Class B	L.S.	1	$ 10,000	$ 10,000	
Saw-Cut	L.F.	350	$ 3	$ 963	
Gravel Backfill for Wall	TON	225	$ 40	$ 9,000	
Structures					**$ 625,000**
Precast Reinf. Conc. Split Box Culvert	L.S.	1	$ 385,000	$ 385,000	
Precast Bridges	L.S.	1	$ 200,000	$ 200,000	
Headwall/Wingwall	EA	4	$ 10,000	$ 40,000	
Paving and Surfacing					**$ 29,490**
HMA Pavement	TON	120	$ 95	$ 11,400	
Crushed Surface Base Course	TON	330	$ 48	$ 15,840	
Shoulder Finishing	TON	30	$ 75	$ 2,250	
Stream Improvements					**$ 65,550**
Streambed Material	TON	1350	$ 45	$ 60,750	
Large Wood Debris	EA	12	$ 400	$ 4,800	
Landscape Restoration					**$ 43,500**
Planting Restoration	L.S.	1	$ 40,000	$ 40,000	
Seeding and Mulching	ACRE	0.25	$ 14,000	$ 3,500	
Traffic Safety Devices					**$ 28,790**
Pavement Marking - Plastic Crosswalk	LF	80	$ 30	$ 2,400	
Pavement Marking - Center/Lane Line	LF	260	$ 2	$ 390	
New or Relocated Signing	L.S.	1	$ 10,000	$ 10,000	
Beam Guardrail Type 31	L.F.	200	$ 30	$ 6,000	
Beam Guardrail Type 31 Non-Flared Terminal	EA	4	$ 2,500	$ 10,000	
Utilities					**$ 35,000**
Adjust Utilities to Grade/ Misc Adjustments	L.S.	1	$ 5,000	$ 5,000	
Utilty Relocations	L.S.	1	$ 30,000	$ 30,000	
Other Items					**$ 595,889**
Private Property Restoration	L.S.	1	$ 250,000	$ 250,000	
Temp Erosion Control - See Breakdown	L.S.	1	$ 32,000	$ 32,000	
Workzone Traffic Control - See Breakdown	L.S.	1	$ 35,000	$ 35,000	
Upstream Demo	L.S.	1	$ 50,000	$ 50,000	
Misc. Division 1 Items - See Breakdown	L.S.	1	$ 45,000	$ 45,000	
Temporary Stream Diversion	L.S.	1	$ 25,000	$ 25,000	
Dewatering	L.S.	1	$ 20,000	$ 20,000	
Mobilization (10%)	L.S.	1	$ 138,889	$ 138,889	
Engineering					**$ 303,000**
Engineering and Permitting	L.S.	1	$ 150,000	$ 150,000	
Construction Engineering	L.S.	1	$ 153,000	$ 153,000	
		Alternative 1 Construction Cost			**$ 1,830,782**
		25% Contingency			**$ 457,695**
		Alternative 1 Total Cost			**$ 2,288,477**

Alternative Analysis Cost Estimate

PROJECT TITLE:		DESCRIPTION OF WORK			
George Davis Creek Fish Passage Project		Alternative 2 - East Lake Sammamish Parkway Fish Passage Culvert, Open Channel to the North, and Two additional Fish Passage Culverts Before Open Channel to Lake Sammamsih			
REGION:	Sammamish, Washington				

Grading					**$ 120,853**
Roadside Cleanup	L.S.	1	$ 5,000	$ 5,000	
Clearing and Grubbing	ACRE	1	$ 24,000	$ 24,000	
Common Borrow Incl Haul	TON	500	$ 16	$ 8,000	
Roadway Excavation Incl. Haul	C.Y.	75	$ 16	$ 1,200	
Structure Excavation Incl. Haul	C.Y.	1200	$ 16	$ 19,200	
Channel Excavation Incl. Haul	C.Y.	3000	$ 16	$ 48,000	
Shoring or Extra Excavation Class B	L.S.	1	$ 10,000	$ 10,000	
Saw-Cut	L.F.	310	$ 3	$ 853	
Gravel Backfill for Wall	TON	115	$ 40	$ 4,600	
Structures					**$ 540,000**
Precast Reinf. Conc. Split Box Culvert	L.S.	1	$ 480,000	$ 480,000	
Headwall/Wingwall	EA	6	$ 10,000	$ 60,000	
Paving and Surfacing					**$ 58,475**
HMA Pavement	TON	265	$ 95	$ 25,175	
Crushed Surface Base Course	TON	600	$ 48	$ 28,800	
Shoulder Finishing	TON	60	$ 75	$ 4,500	
Stream Improvements					**$ 84,800**
Streambed Material	TON	1600	$ 45	$ 72,000	
Large Wood Debris	EA	32	$ 400	$ 12,800	
Landscape Restoration					**$ 108,000**
Planting Restoration	L.S.	1	$ 80,000	$ 80,000	
Seeding and Mulching	ACRE	2	$ 14,000	$ 28,000	
Traffic Safety Devices					**$ 43,153**
Pavement Marking - Plastic Crosswalk	LF	80	$ 30	$ 2,400	
Pavement Marking - Center/Lane Line	LF	335	$ 2	$ 503	
New or Relocated Signing	L.S.	1	$ 12,000	$ 12,000	
Beam Guardrail Type 31	L.F.	275	$ 30	$ 8,250	
Beam Guardrail Type 31 Non-Flared Terminal	EA	8	$ 2,500	$ 20,000	
Utilities					**$ 30,000**
Adjust Utilities to Grade/ Misc Adjustments	L.S.	1	$ 5,000	$ 5,000	
Utilty Relocations	L.S.	1	$ 25,000	$ 25,000	
Other Items					**$ 386,728**
Private Property Restoration	L.S.	1	$ 40,000	$ 40,000	
Temp Erosion Control - See Breakdown	L.S.	1	$ 35,000	$ 35,000	
Upstream Demo	L.S.	1	$ 50,000	$ 50,000	
Workzone Traffic Control - See Breakdown	L.S.	1	$ 42,000	$ 42,000	
Misc. Division 1 Items - See Breakdown	L.S.	1	$ 50,000	$ 50,000	
Temporary Stream Diversion	L.S.	1	$ 25,000	$ 25,000	
Dewatering	L.S.	1	$ 20,000	$ 20,000	
Mobilization (10%)	L.S.	1	$ 124,728	$ 124,728	
Engineering					**$ 257,000**
Engineering and Permitting	L.S.	1	$ 120,000	$ 120,000	

Alternative Analysis Cost Estimate

PROJECT TITLE:		DESCRIPTION OF WORK				
George Davis Creek Fish Passage Project		Alternative 2 - East Lake Sammamish Parkway Fish Passage Culvert, Open Channel to the North, and Two additional Fish Passage Culverts Before Open Channel to Lake Sammamsih				
REGION:	Sammamish, Washington					
Construction Engineering		L.S.	1	$ 137,000	$ 137,000	
			Alternative 2 Construction Cost			**$ 1,629,008**
			25% Contingency			**$ 407,252**
			Alternative 2 Total Cost			**$ 2,036,260**

Alternative Analysis Cost Estimate

PROJECT TITLE:		DESCRIPTION OF WORK
George Davis Creek Fish Passage Project		Alternative 3 - East Lake Sammamish Parkway Fish Passage Culvert, Two Bridges, Through/Under Existing House, Open Channel to Lake Sammamsih
REGION:	Sammamish, Washington	

Grading					**$ 104,563**
Roadside Cleanup	L.S.	1	$ 5,000	$ 5,000	
Clearing and Grubbing	ACRE	0.55	$ 24,000	$ 13,200	
Common Borrow Incl Haul	TON	500	$ 16	$ 8,000	
Roadway Excavation Incl. Haul	C.Y.	150	$ 16	$ 2,400	
Structure Excavation Incl. Haul	C.Y.	1500	$ 16	$ 24,000	
Channel Excavation Incl. Haul	C.Y.	2000	$ 16	$ 32,000	
Shoring or Extra Excavation Class B	L.S.	1	$ 10,000	$ 10,000	
Saw-Cut	L.F.	350	$ 3	$ 963	
Gravel Backfill for Wall	TON	225	$ 40	$ 9,000	
Structures					**$ 625,000**
Precast Reinf. Conc. Split Box Culvert	L.S.	1	$ 385,000	$ 385,000	
Precast Bridges	L.S.	1	$ 200,000	$ 200,000	
Headwall/Wingwall	EA	4	$ 10,000	$ 40,000	
Paving and Surfacing					**$ 29,490**
HMA Pavement	TON	120	$ 95	$ 11,400	
Crushed Surface Base Course	TON	330	$ 48	$ 15,840	
Shoulder Finishing	TON	30	$ 75	$ 2,250	
Stream Improvements					**$ 65,550**
Streambed Material	TON	1350	$ 45	$ 60,750	
Large Wood Debris	EA	12	$ 400	$ 4,800	
Landscape Restoration					**$ 43,500**
Planting Restoration	L.S.	1	$ 40,000	$ 40,000	
Seeding and Mulching	ACRE	0.25	$ 14,000	$ 3,500	
Traffic Safety Devices					**$ 28,790**
Pavement Marking - Plastic Crosswalk	LF	80	$ 30	$ 2,400	
Pavement Marking - Center/Lane Line	LF	260	$ 2	$ 390	
New or Relocated Signing	L.S.	1	$ 10,000	$ 10,000	
Beam Guardrail Type 31	L.F.	200	$ 30	$ 6,000	
Beam Guardrail Type 31 Non-Flared Terminal	EA	4	$ 2,500	$ 10,000	
Utilities					**$ 35,000**
Adjust Utilities to Grade/ Misc Adjustments	L.S.	1	$ 5,000	$ 5,000	
Utilty Relocations	L.S.	1	$ 30,000	$ 30,000	
Other Items					**$ 1,640,889**
Private Property Restoration	L.S.	1	$ 1,200,000	$ 1,200,000	
Temp Erosion Control - See Breakdown	L.S.	1	$ 32,000	$ 32,000	
Workzone Traffic Control - See Breakdown	L.S.	1	$ 35,000	$ 35,000	
Upstream Demo	L.S.	1	$ 50,000	$ 50,000	
Misc. Division 1 Items - See Breakdown	L.S.	1	$ 45,000	$ 45,000	
Temporary Stream Diversion	L.S.	1	$ 25,000	$ 25,000	
Dewatering	L.S.	1	$ 20,000	$ 20,000	
Mobilization (10%)	L.S.	1	$ 233,889	$ 233,889	
Engineering					**$ 407,000**
Engineering and Permitting	L.S.	1	$ 150,000	$ 150,000	
Construction Engineering	L.S.	1	$ 257,000	$ 257,000	
				Alternative 3 Construction Cost	**$ 2,979,782**
				25% Contingency	**$ 744,945**
				Alternative 3 Total Cost	**$ 3,724,727**

Alternative Analysis Cost Estimate

PROJECT TITLE:		DESCRIPTION OF WORK			
George Davis Creek Fish Passage Project		Alternative 4 - East Lake Sammamish Parkway Fish Passage Culvert, Two Bridges, Open Channel to Lake Sammamish Through Purchased Property			
REGION: Sammamish, Washington					
Grading					**$ 92,563**
Roadside Cleanup	L.S.	1	$ 5,000	$ 5,000	
Clearing and Grubbing	ACRE	0.55	$ 24,000	$ 13,200	
Common Borrow Incl Haul	TON	500	$ 16	$ 8,000	
Roadway Excavation Incl. Haul	C.Y.	150	$ 16	$ 2,400	
Structure Excavation Incl. Haul	C.Y.	750	$ 16	$ 12,000	
Channel Excavation Incl. Haul	C.Y.	2000	$ 16	$ 32,000	
Shoring or Extra Excavation Class B	L.S.	1	$ 10,000	$ 10,000	
Saw-Cut	L.F.	350	$ 3	$ 963	
Gravel Backfill for Wall	TON	225	$ 40	$ 9,000	
Structures					**$ 200,000**
Precast Reinf. Conc. Split Box Culvert	L.S.	1	$ 180,000	$ 180,000	
Headwall/Wingwall	EA	2	$ 10,000	$ 20,000	
Paving and Surfacing					**$ 26,610**
HMA Pavement	TON	120	$ 95	$ 11,400	
Crushed Surface Base Course	TON	270	$ 48	$ 12,960	
Shoulder Finishing	TON	30	$ 75	$ 2,250	
Stream Improvements					**$ 59,750**
Streambed Material	TON	1150	$ 45	$ 51,750	
Large Wood Debris	EA	20	$ 400	$ 8,000	
Landscape Restoration					**$ 64,000**
Planting Restoration	L.S.	1	$ 50,000	$ 50,000	
Seeding and Mulching	ACRE	1	$ 14,000	$ 14,000	
Traffic Safety Devices					**$ 28,820**
Pavement Marking - Plastic Crosswalk	LF	80	$ 30	$ 2,400	
Pavement Marking - Center/Lane Line	LF	280	$ 2	$ 420	
New or Relocated Signing	L.S.	1	$ 10,000	$ 10,000	
Beam Guardrail Type 31	L.F.	200	$ 30	$ 6,000	
Beam Guardrail Type 31 Non-Flared Terminal	EA	4	$ 2,500	$ 10,000	
Utilities					**$ 35,000**
Adjust Utilities to Grade/ Misc Adjustments	L.S.	1	$ 5,000	$ 5,000	
Utilty Relocations	L.S.	1	$ 30,000	$ 30,000	
Other Items					**$ 5,726,674**
Private Property Acquisition, Demolition, Restoration	L.S.	1	$ 5,000,000	$ 5,000,000	
Temp Erosion Control - See Breakdown	L.S.	1	$ 35,000	$ 35,000	
Workzone Traffic Control - See Breakdown	L.S.	1	$ 35,000	$ 35,000	
Misc. Division 1 Items - See Breakdown	L.S.	1	$ 45,000	$ 45,000	
Temporary Stream Diversion	L.S.	1	$ 25,000	$ 25,000	
Dewatering	L.S.	1	$ 20,000	$ 20,000	
Mobilization (10%)	L.S.	1	$ 566,674	$ 566,674	
Engineering					**$ 225,000**
Engineering and Permitting	L.S.	1	$ 110,000	$ 110,000	
Construction Engineering	L.S.	1	$ 115,000	$ 115,000	

Alternative Analysis Cost Estimate

PROJECT TITLE:		DESCRIPTION OF WORK
George Davis Creek Fish Passage Project		Alternative 4 - East Lake Sammamish Parkway Fish Passage Culvert, Two Bridges, Open Channel to Lake Sammamish Through Purchased Property
REGION:	Sammamish, Washington	

Alternative 4 Construction Cost	**$**	**6,458,417**
25% Contingency	**$**	**1,614,604**
Alternative 4 Total Cost	**$**	**8,073,021**

Appendix C

Appendix D