APPENDIX A: EXISTING CRITICAL INFRASTRUCTURE

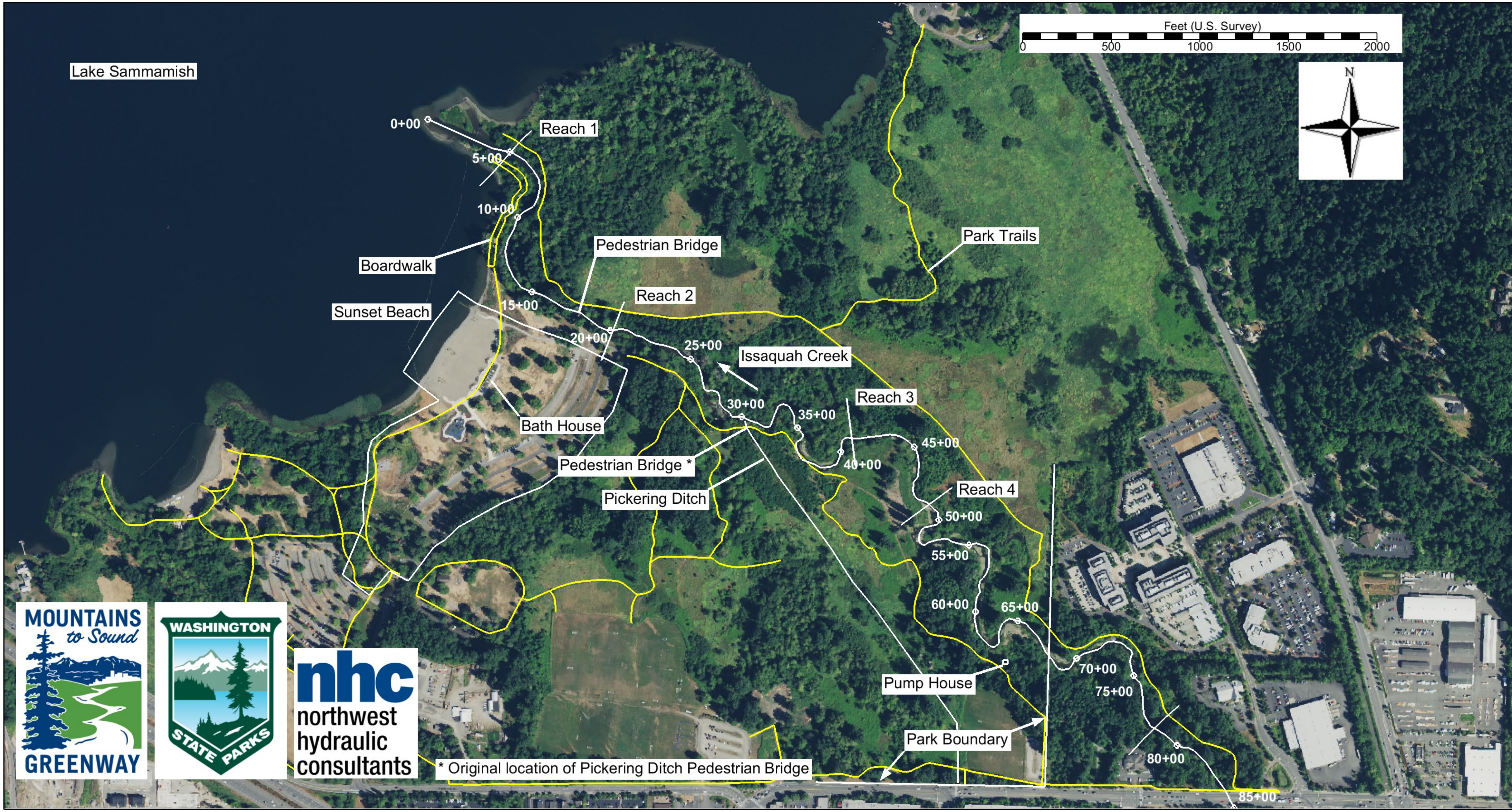

Figure A.1 Existing Critical Infrastructure for Lower Issaquah Creek Restoration at Lake Sammamish State Park

APPENDIX B: VEGETATION RESTORATION

Issaquah Creek at Lake Sammamish State Park 2019

Issaquah Creek at Lake Sammamish State Park 2002

The information included on this map has been compiled by King County staff from a variety of sources and is subject to change without notice. King County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a survey product. King County shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map or information on this map is prohibited except by written permission of King County.

Date: 4/30/2020

Notes:

N

King County

APPENDIX C: FEMA

NOTES TO USERS

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National Geodetic Survey
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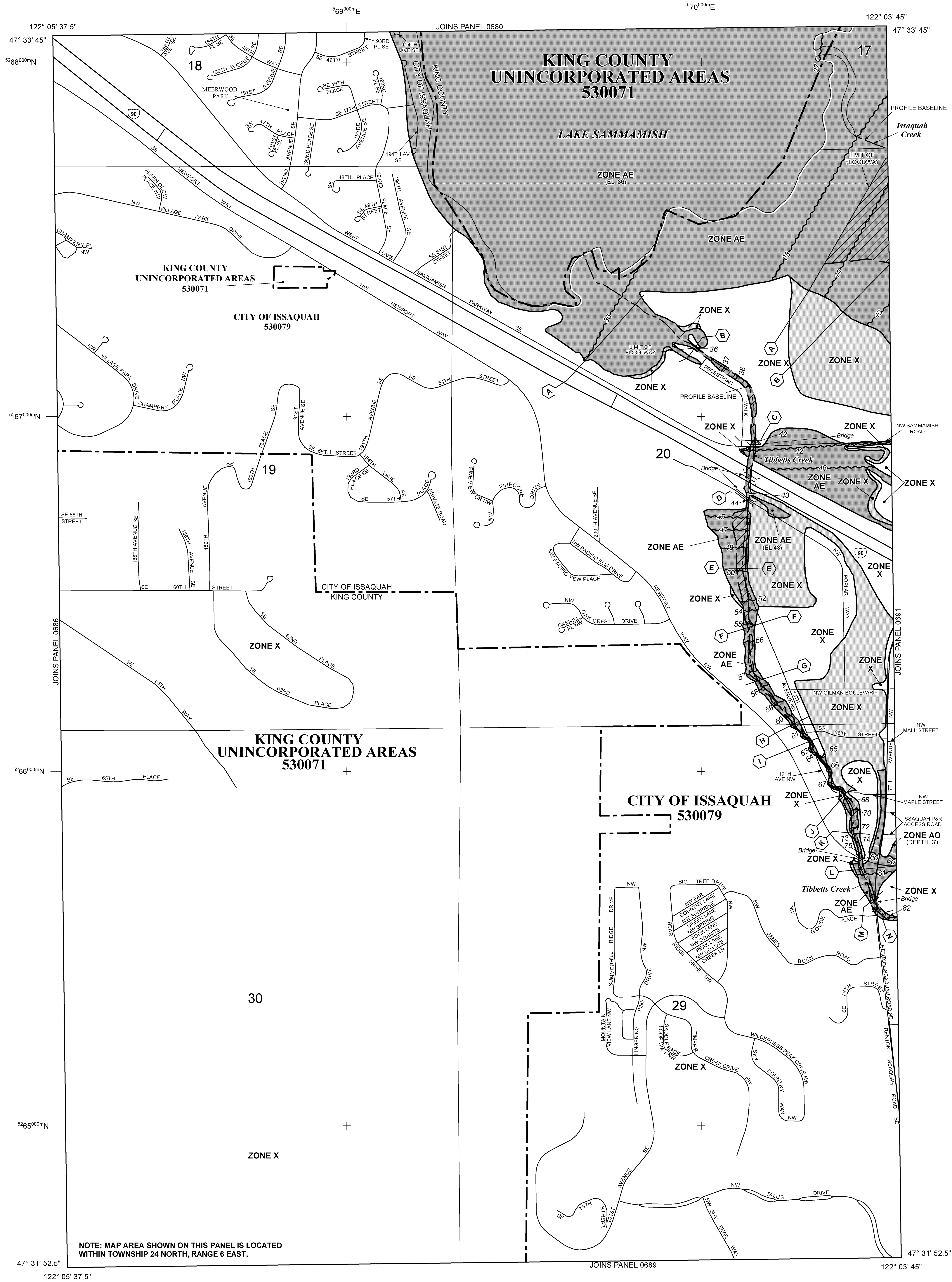

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
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ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

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DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

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250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0687G

FIRM

FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 687 OF 1725
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ISSAQUAH, CITY OF	530079	0687	G
KING COUNTY	530071	0687	G

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MAP NUMBER 53033C0687G

MAP REVISED AUGUST 19, 2020

Federal Emergency Management Agency

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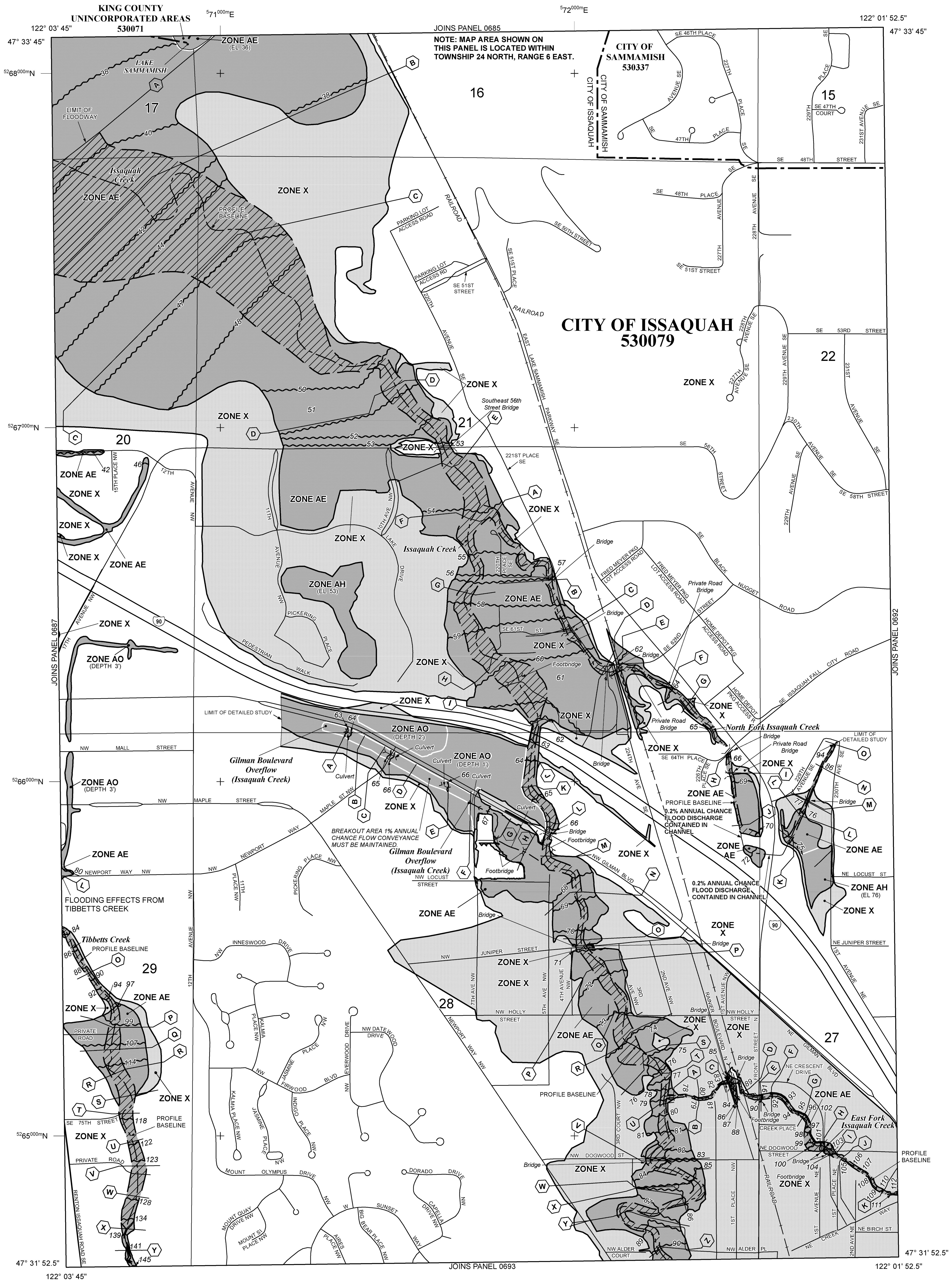

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KING COUNTY	530071	0691	J
SAMMAMISH, CITY OF	530337	0691	J

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MAP NUMBER
53033C0691J

MAP REVISED
AUGUST 19, 2020

Federal Emergency Management Agency

APPENDIX D: CHANNEL MIGRATION ZONE ANALYSIS

12787 Gateway Drive South | Seattle, WA 98168 | 206.241.6000 | www.nhcweb.com

northwest hydraulic consultants

NHC Ref. No. 2003907

May 14, 2020

Mountains to Sound Greenway Trust
2701 First Avenue, Suite 240
Seattle, WA 98121

Attention: **Tor Bell**
Field Program Director

Re: **PRELIMINARY Issaquah Creek Channel Migration Zone Delineation**

1 INTRODUCTION

Northwest Hydraulic Consultants (NHC) is working with the Mountains to Sound Greenway Trust (the Greenway) to develop plans for habitat restoration in the lowest reach of Issaquah Creek, where the creek flows through Lake Sammamish State Park. This reach (the Project Reach) extends upstream approximately 6,500 feet from the delta of the creek into Lake Sammamish. The Greenway has also been focusing efforts on planting native forest vegetation in a buffer around the creek, to provide for long-term wood recruitment and shading of the channel. Throughout the design process, the Greenway has been coordinating the restoration plan with other projects within the park and Issaquah Creek, including a new trail network in the park, which may include a second pedestrian bridge crossing over the creek.

The Greenway has requested that NHC complete a channel migration zone (CMZ) delineation for the portion of the creek flowing through Lake Sammamish State Park to aid in the optimization of the restoration design, riparian planting effort, and ongoing comprehensive planning. This memo describes the methods, results, and limitations of the delineation. It is based on a background understanding of the creeks morphology and geomorphic history documented in a detailed analysis of geomorphic, hydrologic, and hydraulic conditions described in the Conceptual Design Report for the project (NHC and The Watershed Company, 2017). The CMZ delineation is based on the analysis of historical conditions documented in aerial photos from 1937 through the autumn of 2019. Significant floods occurred in the 2019-2020 high flow season and caused notable bank erosion that is not reflected in this assessment. For this reason, we recommend flying the site to delineate changes that occurred since the recent floods and observed bank erosion. In addition, it is important to note that some elements of the planned habitat restoration project may alter channel migration processes and patterns.

2 GEOMORPHIC BACKGROUND

The project reach (Figure 1) flows through surrounding deposits of somewhat cohesive, relatively fine-grained (silt with sand and clay) Holocene alluvium (NHC and The Watershed Company, 2017).

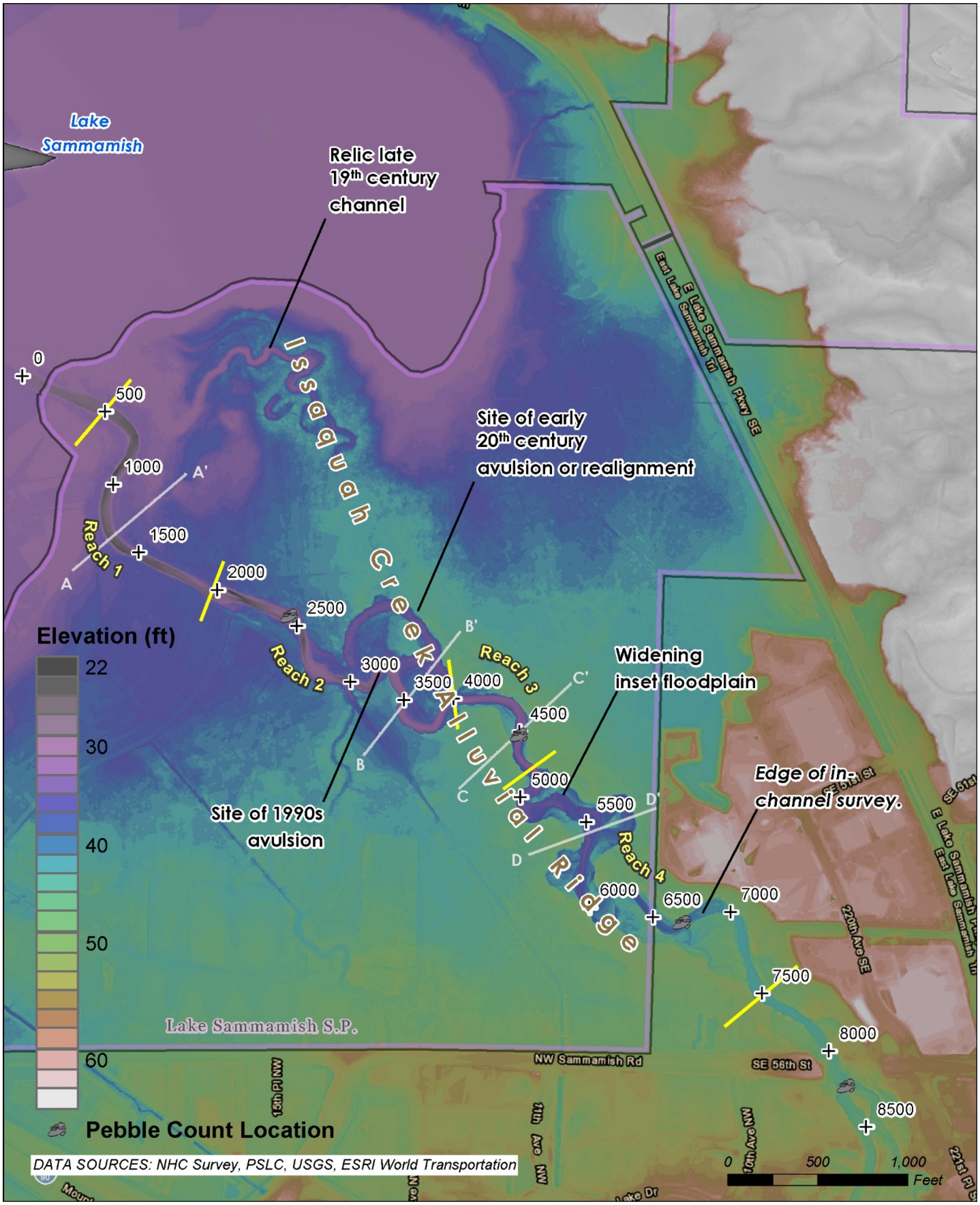


Figure 1: Topographic base map of study reach showing the merged LiDAR and field survey of the wetted channel area. Some key geomorphic features are also noted. Reproduced from NHC and The Watershed Company (2017).

The creek has a concave profile as it approaches Lake Sammamish (Figure 2). The creek profile declines from about a 4% slope near the upstream project boundary to about a 3% slope near Station 4,000 (Station refers to the distance in feet upstream of the mouth of the creek), and then rapidly declining to a nearly flat slope by Station 2,000.

The creek is presently incised up to about 12 feet below the surrounding alluvial surface (Figure 2 and Figure 3). This incision is interpreted to be mostly a result of a late 19th century or early 20th-century avulsion or realignment of the creek. The General Land Office Survey (1864) and present-day topography show a historic channel position along the top of the alluvial ridge to the east of the present channel from about Station 4,000 to Lake Sammamish (Figure 1). This alignment was historically about 1,000 feet longer than the present channel. Based on the observed and inferred slope along the historic alignment, the avulsion would have lowered the base level for the channel upstream by approximately 10 feet (Figure 2). A 1937 aerial photo shows the channel close to its current position, indicating the avulsion occurred between 1864 and 1937.

The base level for the creek was also lowered by a change in typical winter-season water levels in Lake Sammamish resulting from a reconfiguration of the lake's outlet in 1964. The reconfigured outlet lowered typical winter lake levels from a range of 33 to 36 feet to 31 to 33 feet (NAVD 88, from NHC, 2012). Based on an assessment of available USGS lake level and creek flow information, higher lake levels often correspond to geomorphically effective flood flows on Issaquah Creek. The change in the lake's outlet, therefore, may have contributed to an additional two to three-foot drop in the functional base-level control for the creek.

Channel migration following the incision has formed an inset floodplain below the creek's historic alluvial ridge (Figure 1 and Figure 3). This inset floodplain corresponds to the extent of lateral channel migration following the avulsion. It ranges from about 100 feet wide (compared to a typical channel width of about 50 feet) up to about 500 feet wide at locations where meanders have eroded into the surrounding alluvium. Sediment in the inset floodplain is coarser than the surrounding material, consisting of gravel-to cobble sized material that was deposited in the active channel, then buried by overlaying sandy material that was deposited in backwater features and across the floodplain.

The creek has bed material dominated by gravel- and cobble-sized sediment above approximately Station 4,000 and sand-dominated sediment below this. One isolated gravel bar is present at about Station 2,450. Pebble counts were collected at geomorphically-representative bar head locations along the channel profile to quantitatively characterize the texture of the bed material. The observed grain size distribution curves for the surface of four bars are shown in Figure 4.

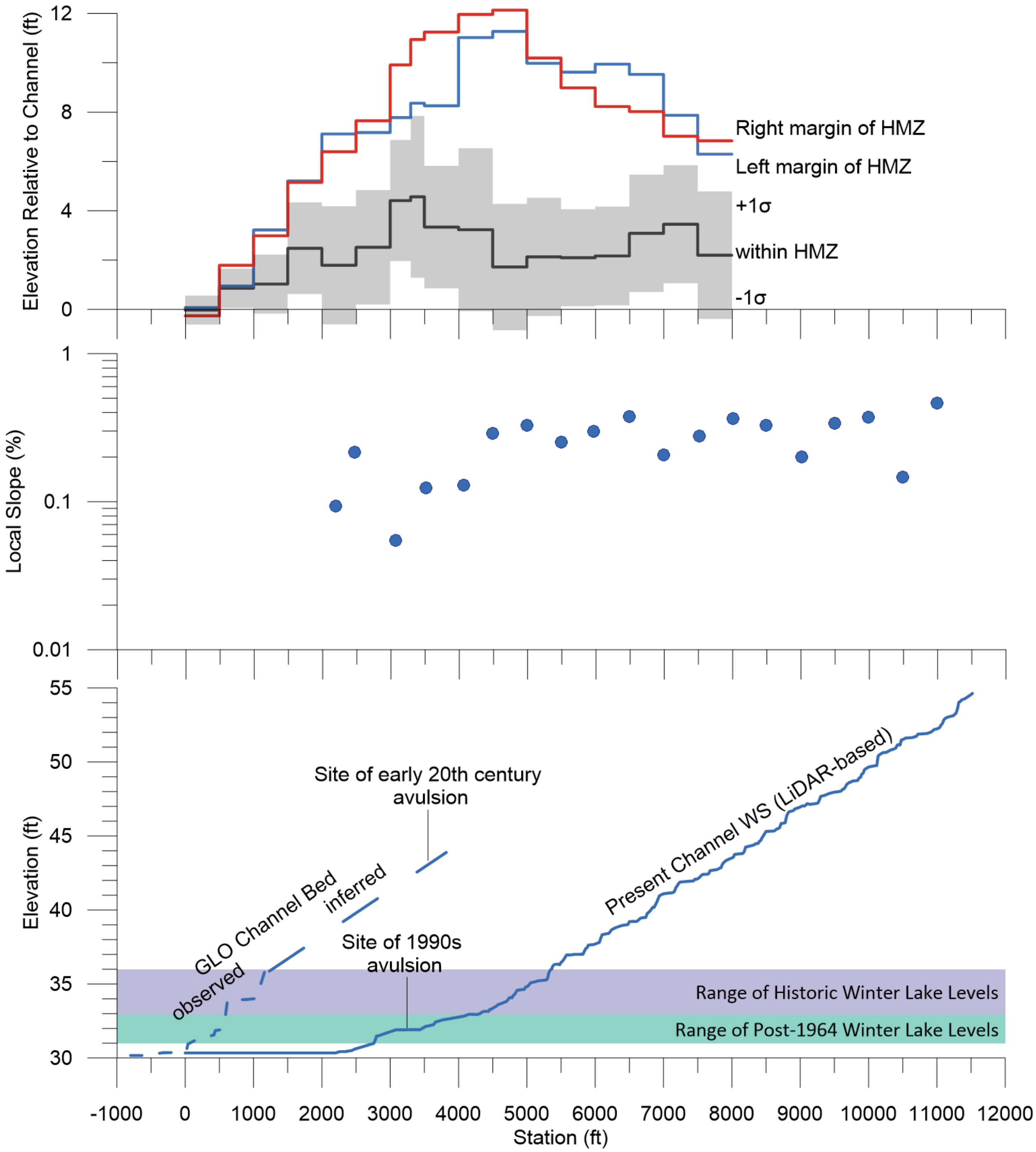


Figure 2: Profile of Lower Issaquah Creek (bottom) showing slopes of the present channel (middle), and bank heights and hypsometry of the surface within the historic channel migration zone (top).

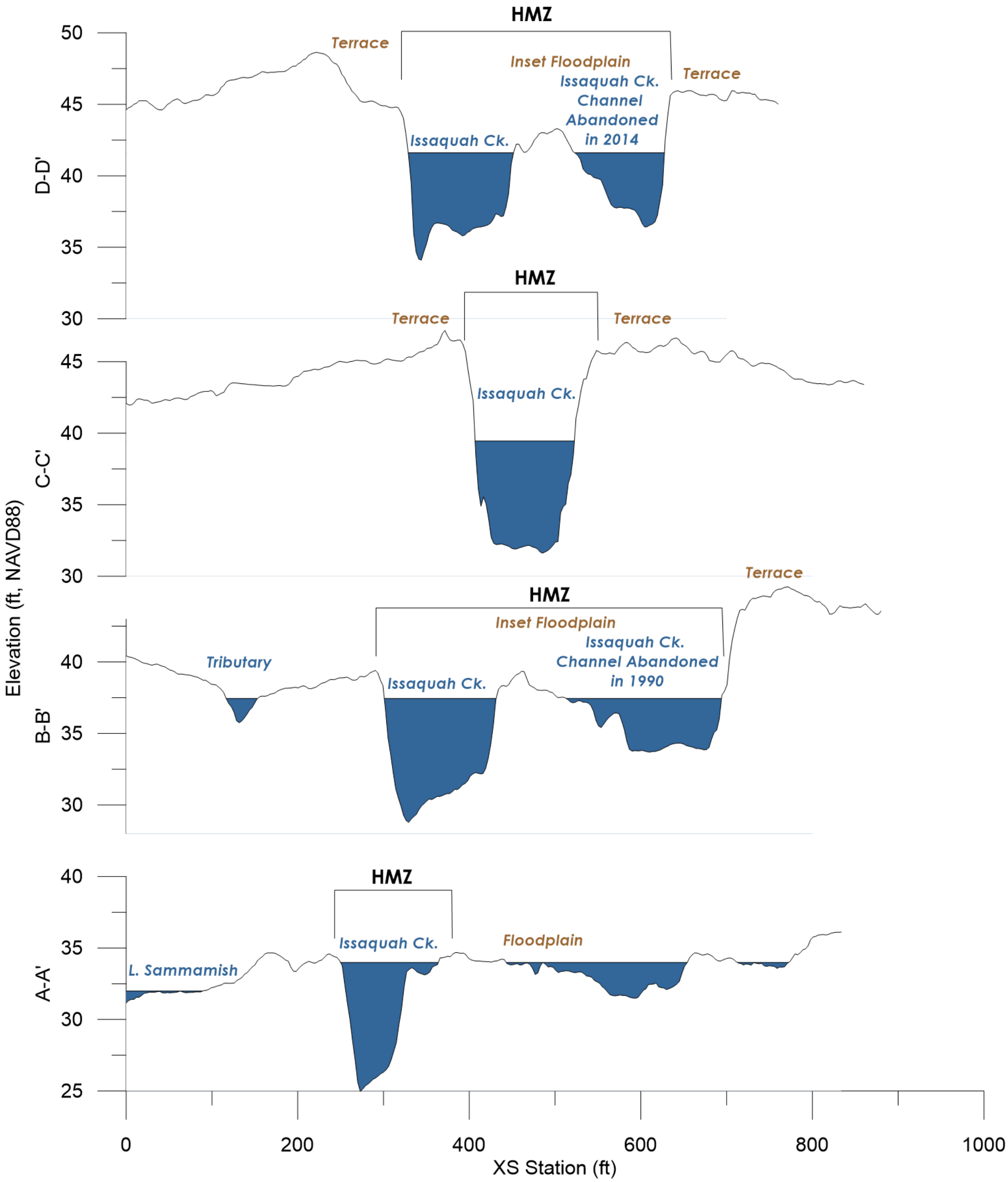


Figure 3: **Select cross sections showing the pattern of historical incision and inset floodplain formation. Cross section locations are shown in Figure 1.**

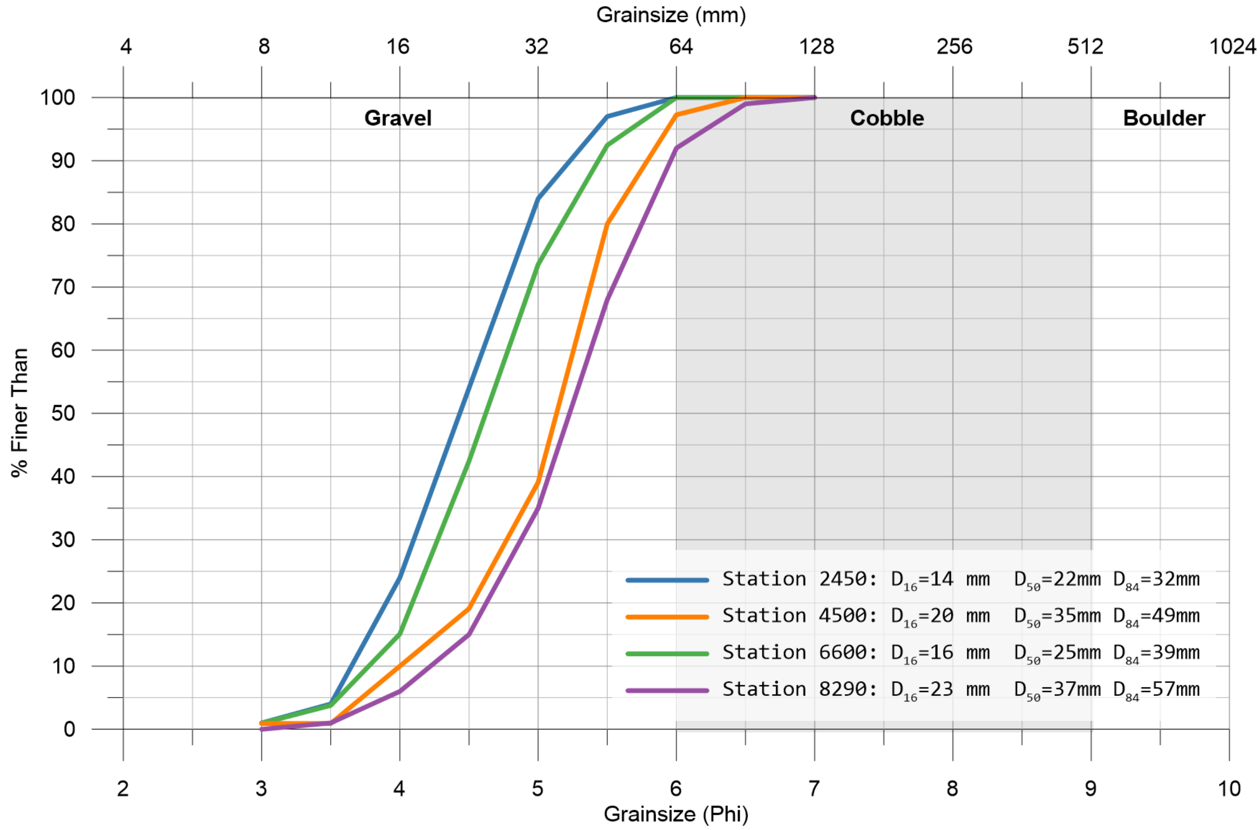


Figure 4: Observed surface grain size distributions based on Wolman pebble counts of bar and riffle-head locations.

3 REACH ANALYSIS

NHC and The Watershed Company (2017) defined four distinct reaches within the project reach based on the geomorphic and habitat conditions in Issaquah Creek, including the channel slope, bed material grain size distribution, floodplain character and extent, and channel migration history. Conditions in each reach are described in detail in the Conceptual Design Report (NHC and The Watershed Company, 2017). These reach divisions apply directly to the CMZ analysis process described here; however, the downstream and upstream limits require further refinement. The locations of the reach breaks adapted for this study are shown in Figure 1. For lateral erosion calculations, the downstream limit of Reach 1 was changed to Station 500 to exclude the active delta, where the primary geomorphic process is land-building into the lake. This allows channel migration rates for each reach to be calculated from the whole historical image time series in places were lateral bank erosion and accretion have been the dominant processes.

The other required refinement is an explicit definition of the upstream boundary of Reach 4, as the limit of that reach from a restoration planning perspective—the state park boundary—is not relevant from a geomorphic perspective. The upstream boundary of that reach was determined to be Station 7,500, where there is a distinct change in the degree of historical channel stability and width of the geomorphic floodplain (Figure 2 of NHC and The Watershed Company, 2017).

4 CHANNEL MIGRATION ZONE DELINEATION METHODS

4.1 Channel Migration Processes

Two distinct kinds of channel migration must be considered in the CMZ delineation process: lateral channel migration and avulsion. Avulsion occurs when a creek suddenly leaves its current path and activates a new (usually shorter and steeper) path across its floodplain.

Lateral channel migration is the more gradual movement of the channel due to erosion on one bank and deposition on the other. Bank erosion occurs when a creek's discharge has enough energy to erode the bank material. Since much of a creek's energy is usually concentrated along the outside and down-valley side of meander bends, bank erosion often occurs there. This often results in the migration of a creek channel toward the outside of bends (meander amplification) and translational movement of the meander down-valley. Erodible banks and high peak flows can result in relatively rapid channel migration during floods. Accumulations of large woody debris (e.g., log jams), accumulations of sediment, or other instream structures can also direct a creek's energy toward banks and result in bank erosion. For Issaquah Creek, the CMZ analysis considers the potential for channel migration via bank erosion by mapping past locations and rates of bank erosion. This is achieved by analyzing historical maps and aerial photographs, considering current bank erodibility, and large woody debris and sediment accumulation potential.

An avulsion is the process where a river suddenly shifts to a new channel location. Avulsions generally occur during peak flood flows, sometimes in response to a large log jam or obstruction in the river that diverts flow out of the former main channel. Avulsions can result in split channels where the flow is divided among several channels with vegetated islands between them. Over time, one of the split channels may become the main channel, and the others may only carry water during floods. Channel migration due to avulsions is more difficult to predict than migration due to bank erosion because the avulsion process is sporadic and often related to unpredictable accumulations of logs and debris in the stream during floods. Avulsion hazards were evaluated by assessing potential flowpaths following blockage of the channel.

4.2 CMZ Delineation Procedure

NHC has followed the standard Washington Department of Ecology CMZ Delineation Methodology, laid out by Rapp and Abbe (2003), to delineate the CMZ for Issaquah Creek at Lake Sammamish State Park. These results we also compared to what would be delineated following the planning level CMZ analysis procedure (Olson et al., 2014). The key steps in the standard methodology are described below and shown graphically in Figure 5. The way these were applied to this project are outlined in Section 5.

1) The approach is to first define the Historical Migration Zone (HMZ), which is the whole area of the valley bottom where channel presence can be documented from historical aerial

photos, historical maps, and/or interpretation of floodplain topography and riparian vegetation.

2) The avulsion hazard area (AHA) is defined based on the topography of the floodplain and characteristics of the channel and may include areas outside the HMZ.

3) The erosion hazard area (EHA) is a buffer around the combined HMZ and AHA. The EHA buffer width is defined based on the historical rate of floodplain erosion and the proportion of time that the channel is likely to be in contact with the edge of the valley at any given location. Channels will reoccupy positions along the edge of the valley through two mechanisms: down valley meander translation and channel migration back and forth across the valley bottom.

4) The width of the EHA is a function of the erosion setback (E_S) which is defined as follows:

$$E_S = T\ C_E\ ,$$

where T is the CMZ delineation timeframe (50 years in the case of this project, as directed by State Parks) and C_E is a coefficient that incorporates the average erosion rate and percentage of time that the river is likely to erode a given portion of the valley wall. Because the channel re-set in a new entrenched valley in the late 19th-early 20th century, most of the erosion since the earliest available aerial photo (1937) has been the erosion of the valley wall. Therefore, the difference in width between the HMZ in 2019 and the 1937 active channel, divided by the elapsed period (82 years), gives an excellent estimate of C_E in the project area.

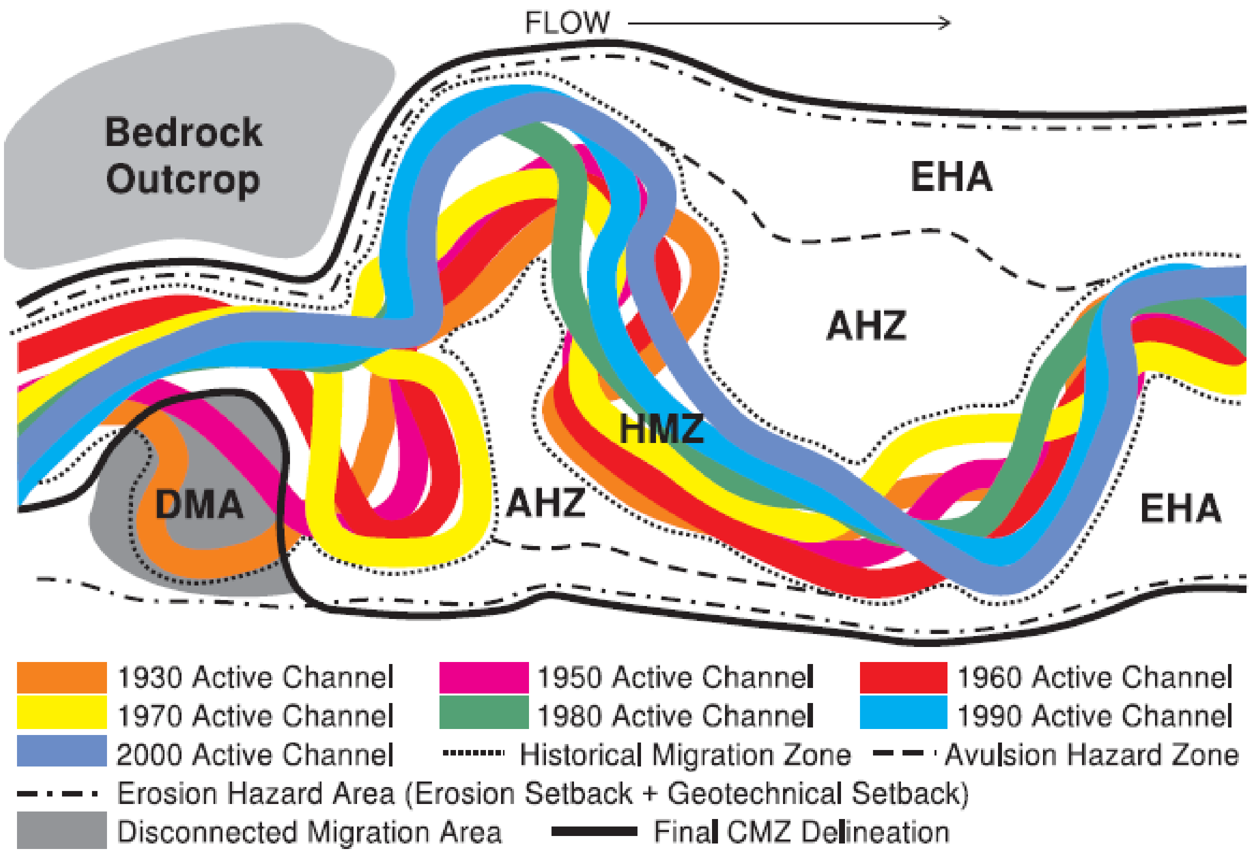


Figure 5: Graphical illustration of the relationship between CMZ components, from Rapp and Abbe (2003).

5) The CMZ analysis also determines areas that are behind permanently maintained dikes, levees, or revetments where it is assumed active human intervention will prevent channel migration. These areas are delineated as the Disconnected Migration Area (DMA). No such areas were identified within the Project Reach.

6) The final Channel Migration Zone is then mapped as the extents of the EHA minus areas within the DMA.

The average erosion setback can be reduced, at the discretion of the CMZ analyst, in areas of relatively unerodable floodplain or valley wall soils (e.g. the bedrock outcrop illustrated in Figure 5). It can also be extended, at the discretion of the CMZ analyst, in areas near individual actively migrating meanders based on the specific rate of movement of that feature. In that case, the erosion rate for the specific feature is calculated using the same approach as for the reach-scale EHA, but the input data are restricted to the period and area of active bank erosion. For this assessment, the reach-average EHA was used as the minimum value but widened around individual actively migrating channel segments based on the historical rate of movement for each feature.

5 CMZ ASSESSMENT RESULTS

5.1 Historical Channel Migration and Historical Channel Migration Zone

The channel position was mapped in historical aerial photos form 1937, 1965, 1981, 1990, 2002, 2005, 2009, 2011, 2014, and 2019 to determine the extent of the HMZ, which is the total area occupied by the channel at any of those dates and any areas in between those (as shown in Figure 6). Evaluation of LiDAR data also showed a few areas of inset floodplain that were identified outside of this zone. It is assumed that these areas must have been occupied by the Issaquah Creek channel, so they were also included in the HMZ. These are areas where overhanging vegetation may have obscured the true bank line in an aerial photo or where a cycle of erosion and channel abandonment occurred between aerial photos. Due to the channel evolution history described in Section 2, the average rate of historic channel occupancy zone expansion (net erosion rate) is interpreted to be a close approximation of C_E in this project area. The width of the eroded area and calculated net erosion rates for each reach are listed in Table 1.

These average rates mask the rapid amplification of numerous individual meanders, which have grown on the order of 150 to 200 feet within one to two decades (Table 2). A meander cutoff avulsion occurred at Station 5,600 between 2014 and 2017, which may indicate a maximum expected meander amplitude of about 200 feet.

Table 1: Observed historical erosion rates for each reach.

Reach	Average Eroded Width (feet)	Erosion Rate (feet/year)
1	57	0.7
2	117	1.4
3	42	0.5
4	139	1.7

Table 2: Rapid amplification of select individual meanders in the historic channel migration record for Issaquah Creek.

Location (Station)	Erosion Period	Maximum Local Erosion Distance (feet)	Erosion Rate (feet/year)
3750	1981-2019	150	3.9
5100	2002-2019	135	7.9
5600	1990-2014	210	8.8
6250	2005-2019	150	10.7
6900	1990-2014	175	6.0

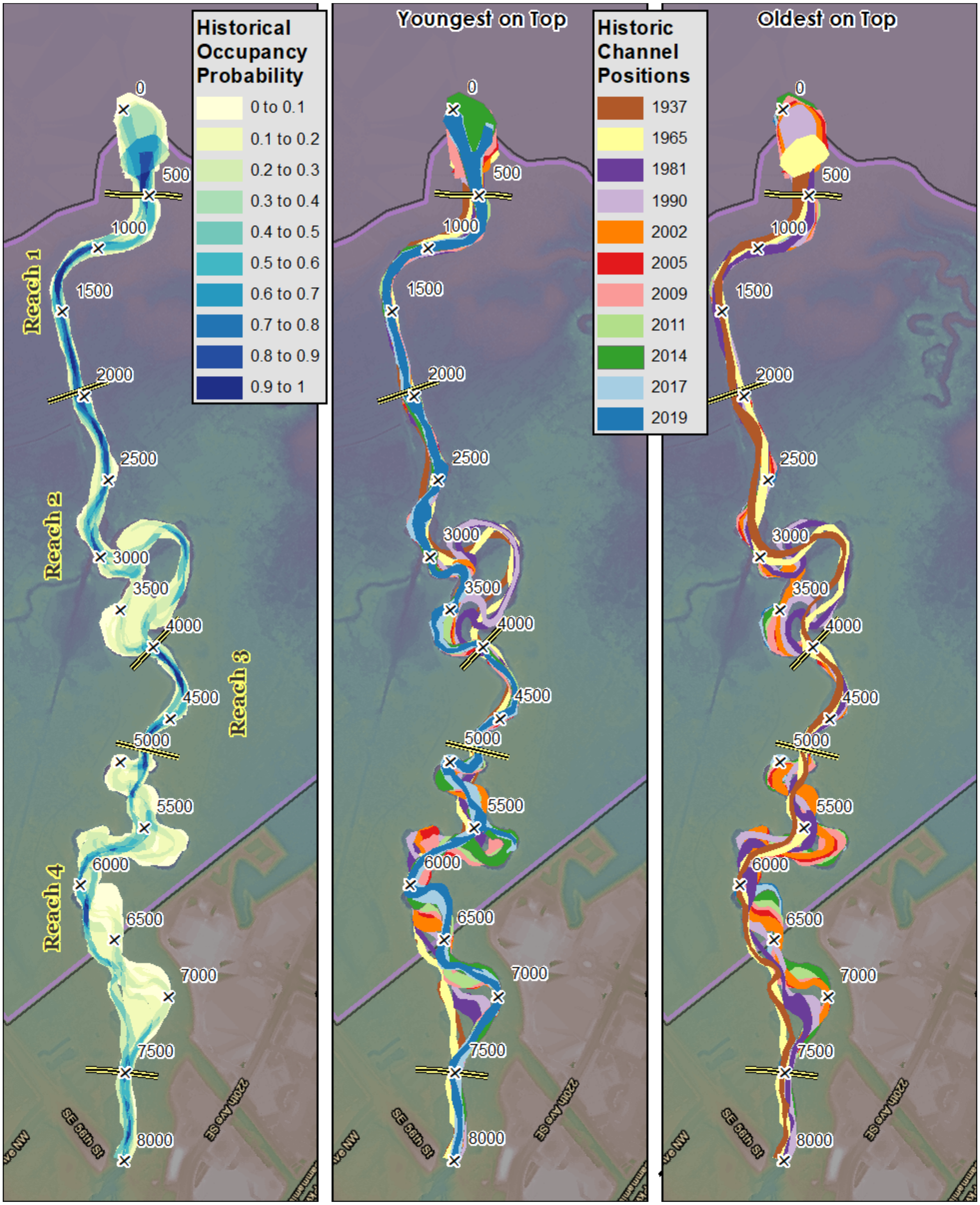


Figure 6: **Historic channel occupancy probability (left, calculated as the proportion of the historical period during which the channel was in any given location) and historical channel positions mapped showing the most recent (youngest) channel occupancy (middle) and the oldest channel occupancy (right).**

5.2 Avulsion Hazard Areas

CMZ delineation guidance (Rapp and Abbe, 2003) suggests that about 2 m (6.5 feet) of vertical bed instability should be assumed in determining the extent of the AHA. Most of the channel length within the project area is incised significantly below the surrounding alluvial surface (Figure 2), limiting avulsion potential to areas already mapped as being within the HMZ. This is not true, however, for the lowest portion of the creek (Reach 1), where the bank height relative to the top of bank elevation for the channel decreases from about six- to zero-feet moving from upstream to downstream. Avulsions are, therefore, possible along this reach. They are most likely to cut across the narrow strip of land between the left bank of the creek and Lake Sammamish, but could also cause the creek to occupy areas of the relict channel and wetland on the right bank (see Figure 7).

5.3 Erosion Hazard Area

The width of the erosion hazard area was calculated for each of the four reaches in the project area based on the historical net erosion rates for each reach (Table 1). For a 50-year delineation timeframe (as directed by State Parks), this yields EHA buffer widths for each side of the channel of 17 feet for Reach 1, 36 feet for Reach 2, 13 feet for Reach 3, and 42 feet for Reach 4. A preliminary erosion hazard area was then mapped as a buffer of the specified width around the delineation HMZ and AHA. This defines the expected position of the edge of the active channel following erosion.

The erosion rate for select individual meanders was evaluated and the width of the EHA was increased to account for the possibility that these features may continue to move at their historical rate over the CMZ delineation timeframe. To do this, the time when the feature started to migrate was determined from the historical channel mapping inventory, and the area between the current bankline and the bankline at the time the feature began to move was divided by the length of the current bankline to determine the average migration distance. This distance was divided by the period of time elapsed since the feature formed to determine an average migration rate. The average erosion timeframe for the identified features was 33- ± 21-years (±1σ), and the shortest and longest durations were 8- and 82-years, respectively. The average calculated erosion rate for these features was 1.78 ±1.31 feet/year.

The banks at the outside edge of the CMZ are relatively high (up to 12 feet above the bankfull water surface Figure 2 and Figure 3). The edge of the CMZ represents the edge of the active channel and so in areas where the bank height is substantially higher than the bankfull water surface, geotechnical relaxation of the slope outside of the delineated CMZ is expected. A formal geotechnical assessment should evaluate slope stability above the channel thalweg elevation starting from the edge of the CMZ as a part of the design process for any structure foundations situated near the edge of the CMZ.

5.4 Other CMZ Features and Constraints on Lateral Migration

Disconnected migration areas are created by revetments meeting the specific criteria of Washington Administrative Code (WAC) 173-26-221 (3)(B) or other permanent infrastructure (e.g. single access roads or railways). Two revetments impact channel migration processes between about Station 5,900 and

Station 6,500 (Reach 4 Geomorphic Overview Map in NHC and The Watershed Company, 2017), but these do not appear to have been maintained to meet the criteria laid out in the WAC. Therefore, no DMAs are mapped within the project area.

5.5 CMZ Summary

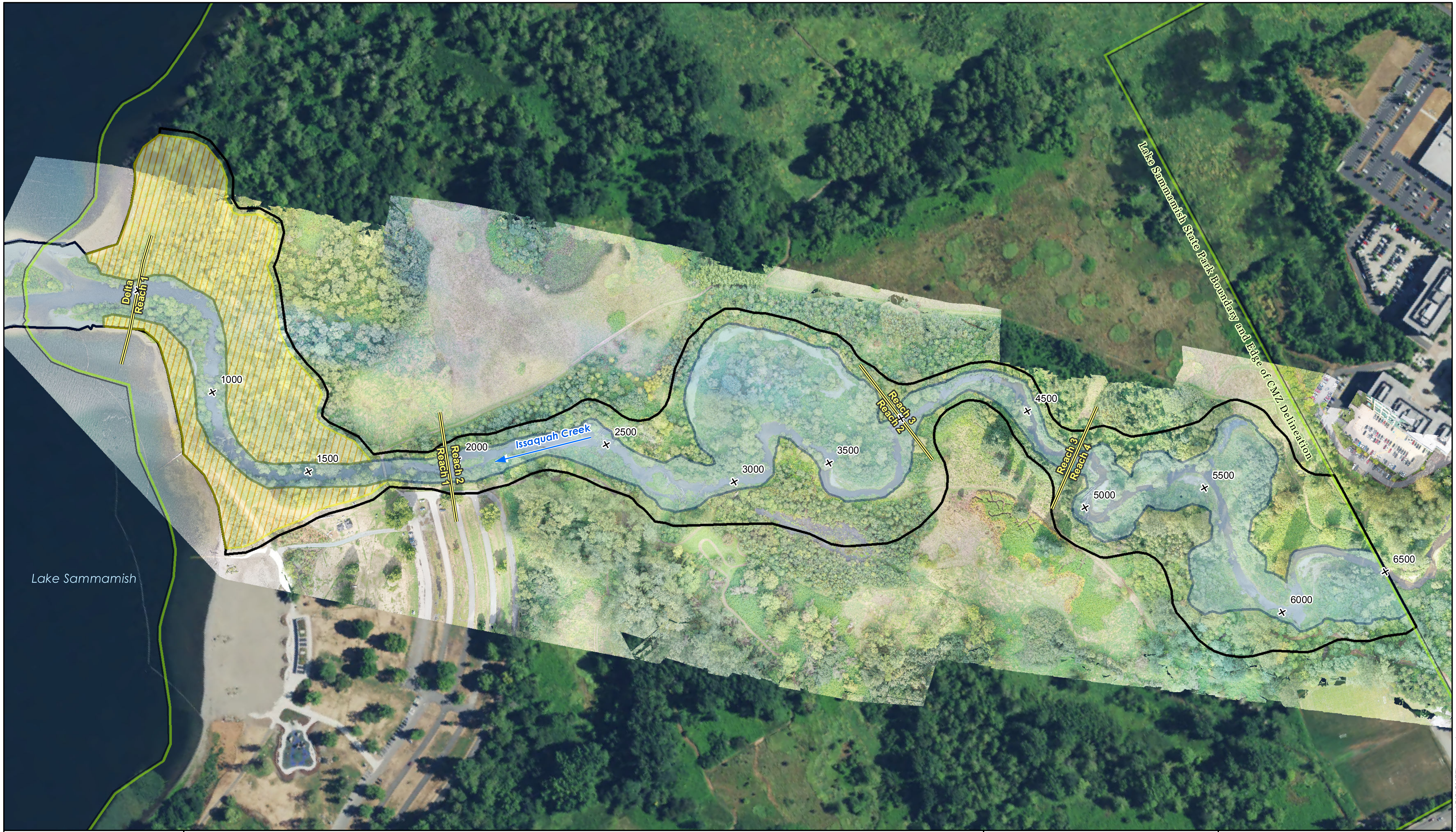
Figure 7 shows the map resulting from the CMZ analysis described above. It is important to note that the Erosion Hazard Area buffers shown in this map are based on historic average migration rates extrapolated into the future, following established guidelines (Rapp and Abbe, 2003) for this procedure. It represents a reasonable projection of the possible channel migration extent over the 50-year delineation timeframe (as directed by State Parks), that follows existing regulatory guidelines. For future comprehensive planning and risk assessments, in addition to the mapped CMZ according to the established guidelines, some further understanding of limitations of the CMZ mapping method and controlling geomorphic processes may provide useful information. The following section provides this information.

5.6 CMZ Limitations and Uncertainty

The exact location of the CMZ boundary identified in this study is not a function of any fundamental barrier to channel migration (e.g. bedrock or a maintained revetment), as described in Section 5.4. Therefore, due to the nature of the mapping procedure, stochastic creek behavior, and uncertainty of the geologic materials along the creek, the actual zone occupied by the channel over the next 50 years may be expected to extend beyond the edge of the CMZ in some locations while not approaching it in other locations. The highest risk areas of the CMZ boundary are expected to be those closest to the present-day active channel—especially areas near the outside and downstream segments of meander bends. The lowest risk areas of the CMZ boundary are expected to be those farthest away from the active channel. This section discusses key underlying assumptions that may result in migration patterns different from those assumed in the regulatory CMZ delineation process (Rapp and Abbe, 2003).

As mentioned previously, the CMZ delineation procedure followed for this assessment is based on the extrapolation of historic patterns under the assumption that they will continue. This produces a reasonable prediction of expected future migration, but it is not (and is not intended to be) a conservative outer boundary for all possible channel movement. The reach-average buffer calculations produce a boundary with about a 50 percent probability of exceedance within the selected time frame.

To reduce the probability that the channel will exceed the reach-average buffer calculations, areas around individual active meanders, based on their individual migration history, were assessed. Although this provides a more refined assessment compared to the reach-average, uncertainty in future channel migration rates remain. This is due to the erodibility of material surrounding the HMZ and stochastic channel migration patterns, as described below.



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Channel Migration Zone Subunits

Historic Migration Zone | Erosion Hazard Area/Outer CMZ boundary.
Avulsion Hazard Zone

DATA SOURCES: 2017 NAIP Orthophoto (background) 2019 NHC uav orthomosaic (foreground)

SCALE - 1:3,500
0 100 200 300 400 Feet
N

Coordinate System: NAD 1983 NSRS2007 STATEPLANE WASHINGTON NORTH FIPS 4601 FT

Job: 2003907 | Date: March 2020

Lower Issaquah Creek

CMZ Delineation

FIGURE 7

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Future erosion rates may change as the creek encounters materials different from those it interacted with during the historical expansion of the HMZ. For example, some areas (e.g. the banks adjacent to the channel in Reach 3) appear to be more erosion resistant than other areas (e.g. the banks adjacent to the channel in Reach 2 and Reach 4). The longitudinal lateral variability in bank strength along the creek suggests that bank strength likely varies perpendicular to the channel as well. Therefore, erosion into the terrace could cause the channel to reach relatively erosion-resistant material that would prevent further migration in Reach 2 or Reach 4. Conversely, erosion could make its way through the higher strength material that has been limiting migration in Reach 3 and begin interacting with less-resistant material and result in accelerated channel migration rates at any point in that reach.

The historic record shows that individual meanders can form and rapidly erode a substantial distance into the terrace (Table 2), as numerous meanders have grown on the order of 150 to 200 feet within one to two decades. Given a relatively short typical lifespan (20- to 30-year average) of individual meanders along the creek over the historical record, it is likely that, in some places, new meanders will form. These may erode at relatively fast rates in concentrated areas, which could result in lateral migration outside of the delineated CMZ. Granting the (very reasonable) assumption that only one episode of meander amplification will occur at any given location along the edge of the HMZ over the 50-year CMZ delineation timeframe, is it possible to apply the observed history of meander cutoffs. The observed history indicates that meanders on the creek rarely exceed an amplitude of about 200 feet before a cutoff occurs, which provides the outer limit of expected channel migration at any given point along the creek. A 200-foot buffer beyond the HMZ, therefore, provides a robust estimate of the maximum expected lateral channel movement away from the HMZ over a 50-year timeframe. This buffer is not shown in the CMZ map (Figure 7) as it exceeds the standards set by the guidance documents followed to produce this study. It may, however, be helpful information for future comprehensive planning and risk assessments for a given asset.

6 REFERENCES

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NHC, and The Watershed Company (2017). *Lower Issaquah Creek Restoration at Lake Sammamish State Park Conceptual Design Report* (002002182). Report prepared by Northwest Hydraulic Consultants and the Watershed Company for Mountains to Sound Greenway Trust.

Olson, P. L., Legg, N. T., Abbe, T. B., Reinhart, M. A., and Radloff, J. K. (2014). *A Methodology for Delineating Planning-Level Channel Migration Zones* (14-06–025). Washington Department of Ecology Shorelands and Environmental Assistance, Olympia, WA. [online] Available from: https://fortress.wa.gov/ecy/publications/SummaryPages/1406025.html.

Rapp, C., and Abbe, T. B. (2003). *A Framework for Delineating Channel Migration Zones* (#03-06-027). Ecology Publication. Washington State Department of Transportation and Washington State Department of Ecology.

DISCLAIMER

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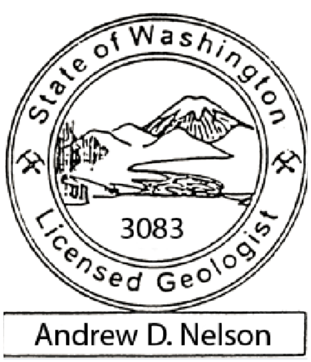
Sincerely,

Northwest Hydraulic Consultants Inc.

Prepared by or under the direct supervision of:



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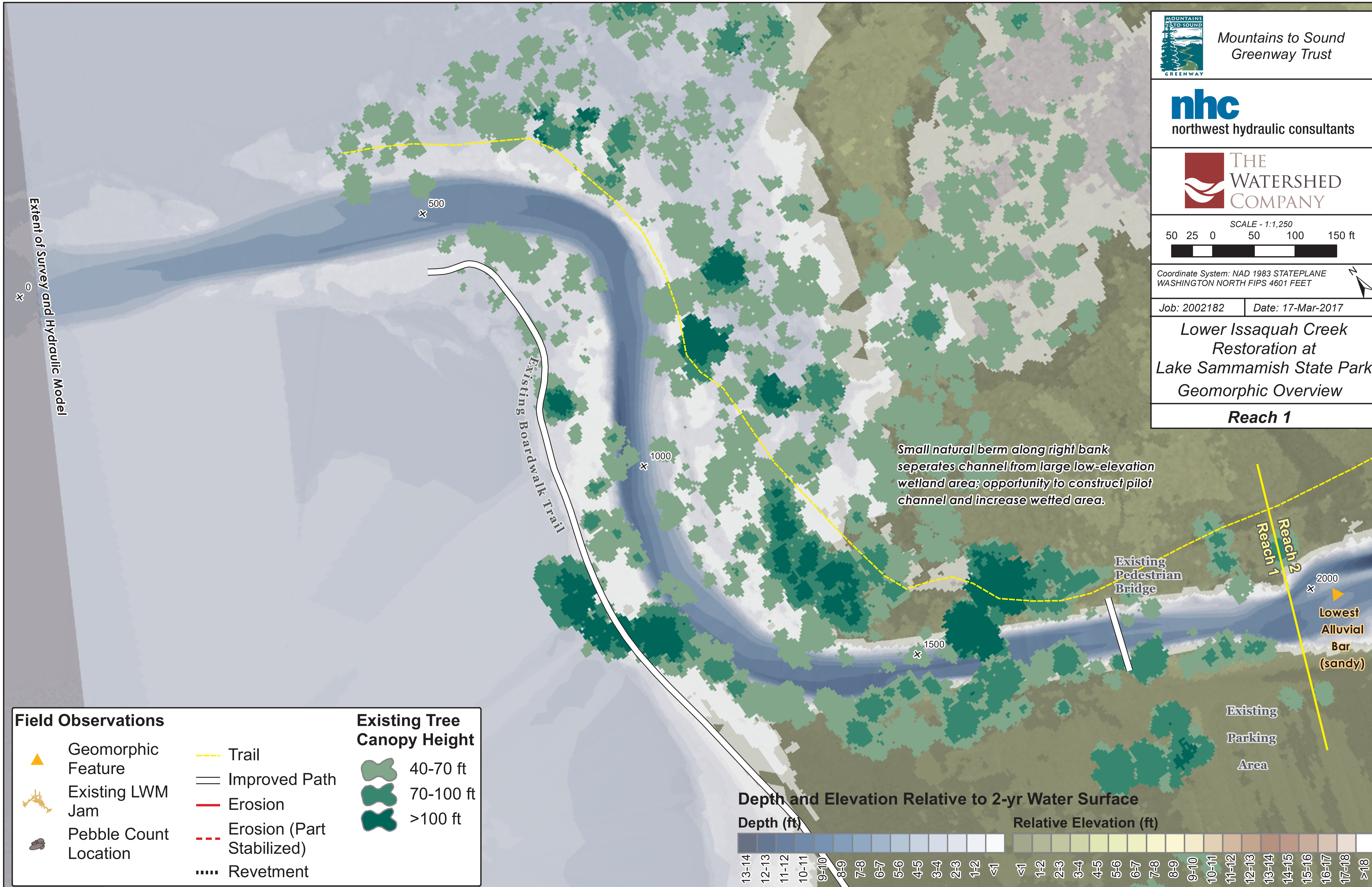
Associate I Senior Geomorphologist
Author

Casey Kramer, PE
Principal River Engineer
Reviewer

APPENDIX E: GEOMORPHIC OVERVIEW



Mountains to Sound Greenway Trust
nhc northwest hydraulic consultants
The Watershed Company
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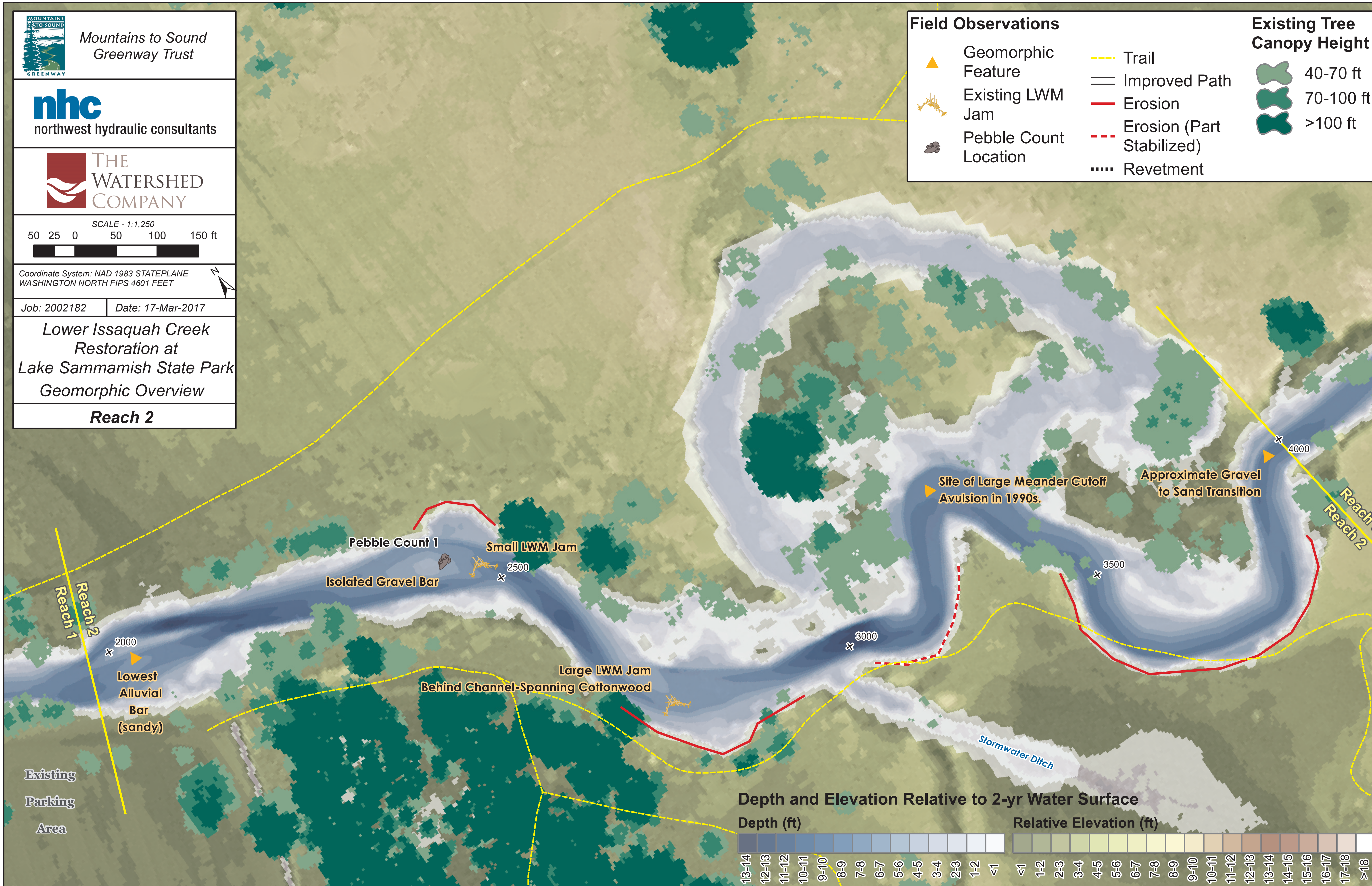
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Geomorphic Overview
Reach 1
Extent of Survey and Hydraulic Model
Existing Boardwalk Trail
Small natural berm along right bank seperates channel from large low-elevation wetland area; opportunity to construct pilot channel and increase wetted area.
Existing Pedestrian Bridge
Reach 1
Reach 2
Lowest Alluvial Bar (sandy)
Existing Parking Area
0
500
1000
1500
2000
Field Observations
Geomorphic Feature
Existing LWM Jam
Pebble Count Location
Trail
Improved Path
Erosion
Erosion (Part Stabilized)
Revetment
Existing Tree Canopy Height
40-70 ft
70-100 ft
>100 ft
Depth and Elevation Relative to 2-yr Water Surface
Depth (ft)
13-14 12-13 11-12 10-11 9-10 8-9 7-8 6-7 5-6 4-5 3-4 2-3 1-2 <1
Relative Elevation (ft)
<1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 12-13 13-14 14-15 15-16 16-17 17-18 >18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The Watershed Company
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Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Geomorphic Overview
Reach 2
Field Observations
Geomorphic Feature
Existing LWM Jam
Pebble Count Location
Trail
Improved Path
Erosion
Erosion (Part Stabilized)
Revetment
Existing Tree Canopy Height
40-70 ft
70-100 ft
>100 ft
Site of Large Meander Cutoff Avulsion in 1990s.
Approximate Gravel to Sand Transition
Reach 3
Reach 2
4000
3500
3000
2500
2000
Pebble Count 1
Small LWM Jam
Isolated Gravel Bar
Reach 2
Reach 1
Lowest Alluvial Bar (sandy)
Large LWM Jam Behind Channel-Spanning Cottonwood
Stormwater Ditch
Existing Parking Area
Depth and Elevation Relative to 2-yr Water Surface
Depth (ft)
13-14
12-13
11-12
10-11
9-10
8-9
7-8
6-7
5-6
4-5
3-4
2-3
1-2
<1
Relative Elevation (ft)
<1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11
11-12
12-13
13-14
14-15
15-16
16-17
17-18
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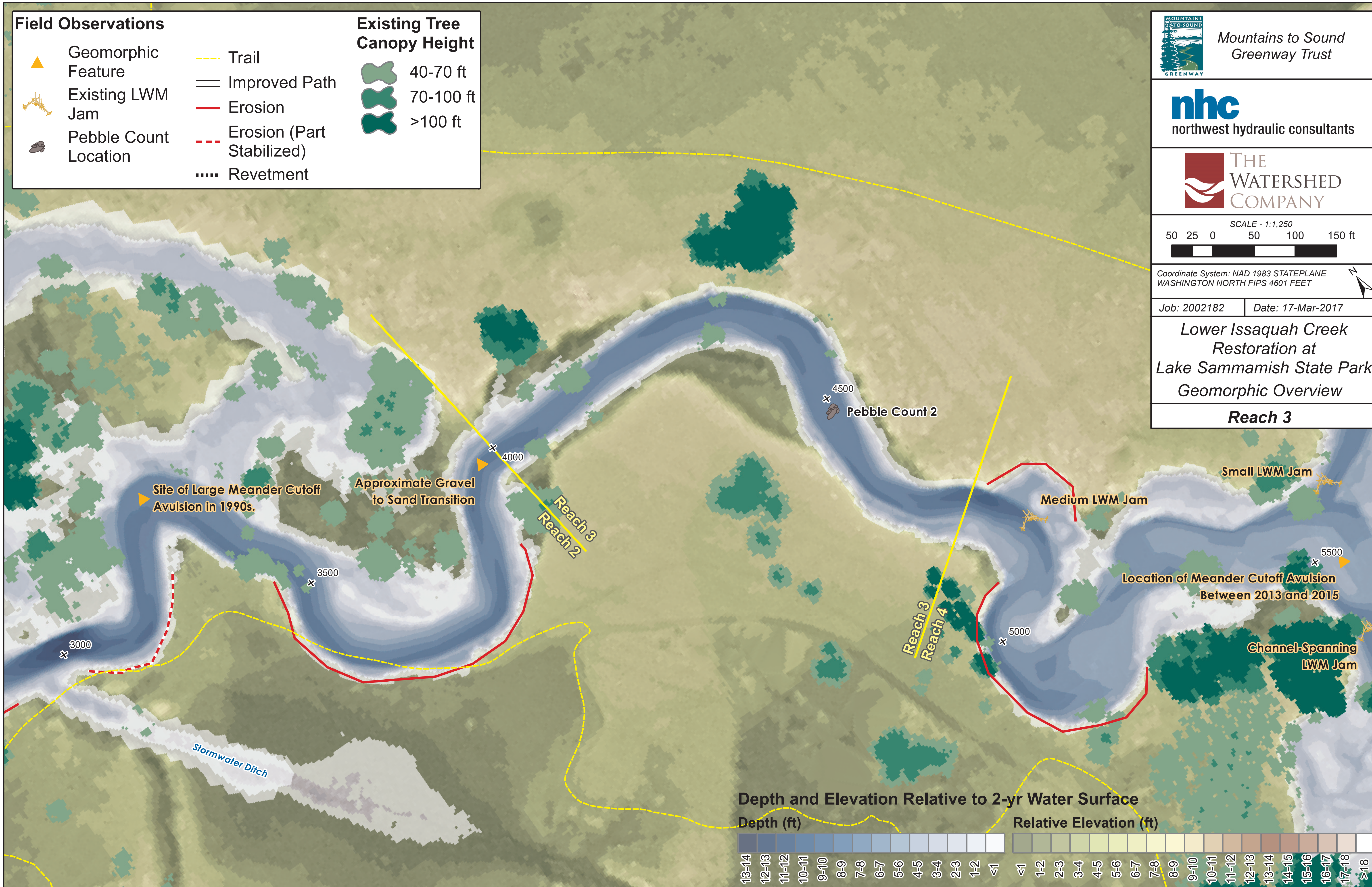

Field Observations
Geomorphic Feature
Existing LWM Jam
Pebble Count Location
Trail
Improved Path
Erosion
Erosion (Part Stabilized)
Revetment
Existing Tree Canopy Height
40-70 ft
70-100 ft
>100 ft
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The Watershed Company
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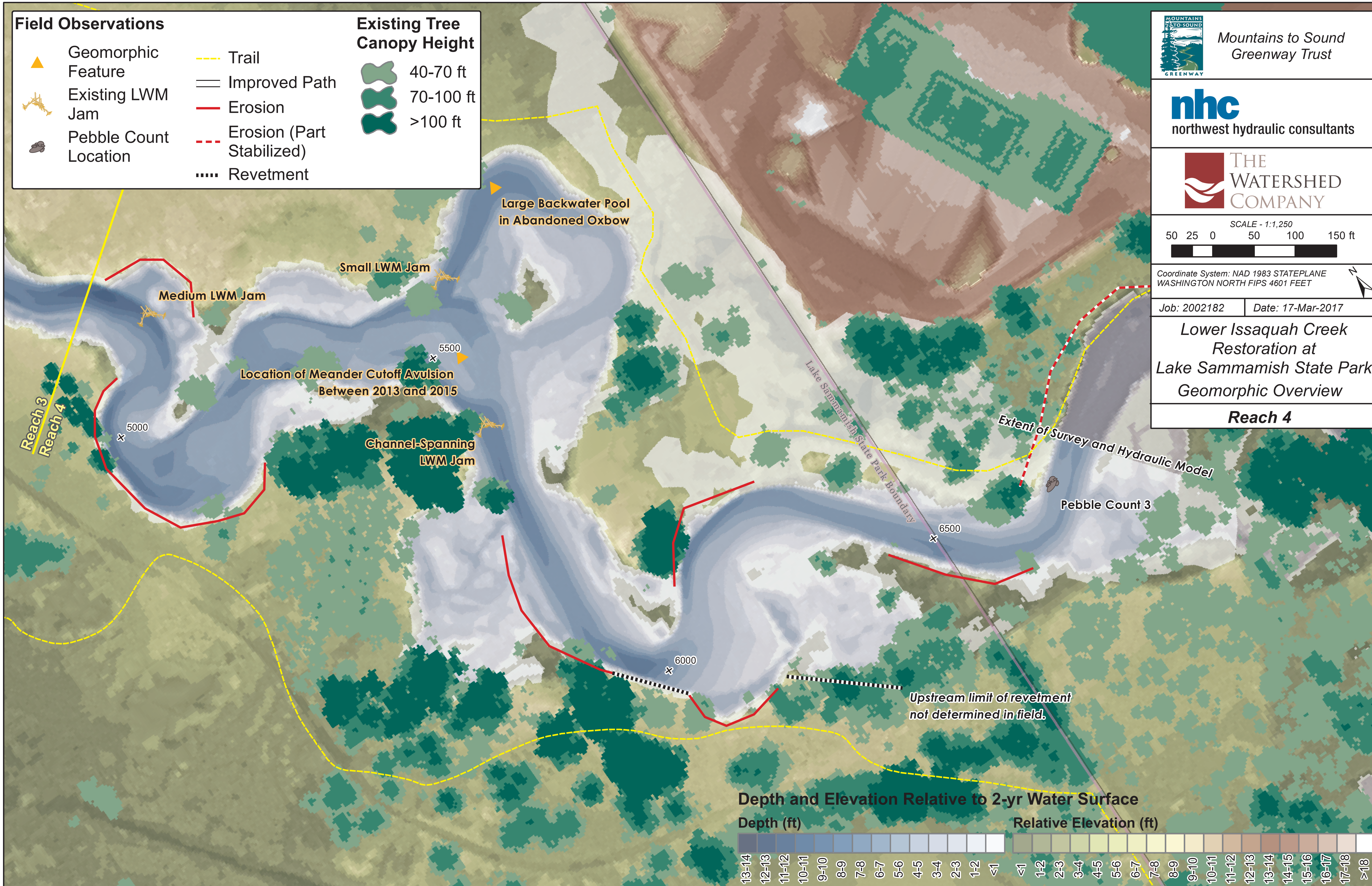
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Geomorphic Overview
Reach 3
Pebble Count 2
4500
4000
3500
3000
5000
5500
Site of Large Meander Cutoff Avulsion in 1990s.
Approximate Gravel to Sand Transition
Reach 3
Reach 2
Reach 3
Reach 4
Small LWM Jam
Medium LWM Jam
Location of Meander Cutoff Avulsion Between 2013 and 2015
Channel-Spanning LWM Jam
Stormwater Ditch
Depth and Elevation Relative to 2-yr Water Surface
Depth (ft)
13-14 12-13 11-12 10-11 9-10 8-9 7-8 6-7 5-6 4-5 3-4 2-3 1-2 <1
Relative Elevation (ft)
<1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 12-13 13-14 14-15 15-16 16-17 17-18 >18



Field Observations
Geomorphic Feature
Existing LWM Jam
Pebble Count Location
Trail
Improved Path
Erosion
Erosion (Part Stabilized)
Revetment
Existing Tree Canopy Height
40-70 ft
70-100 ft
>100 ft
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SCALE - 1:1,250
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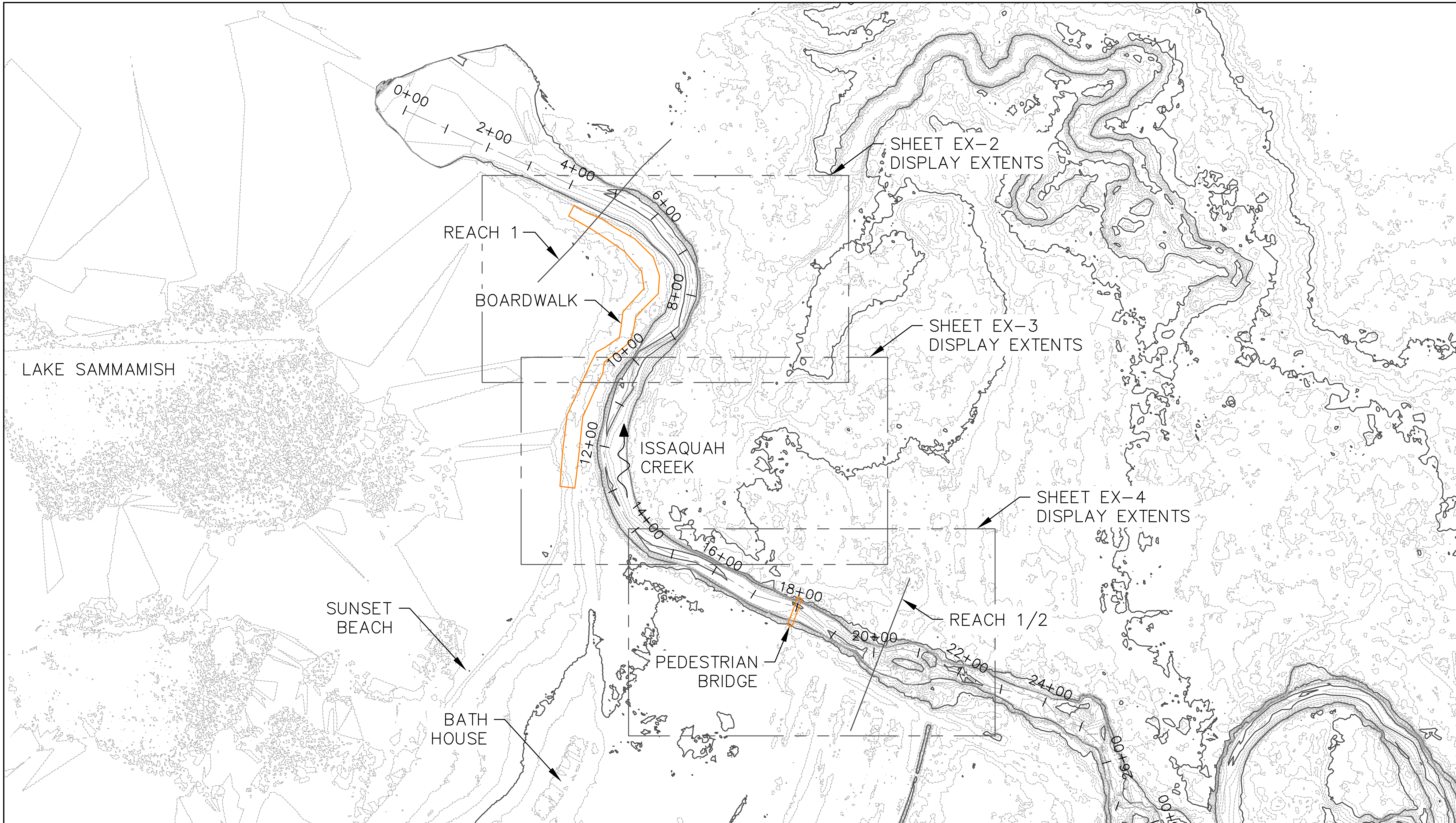
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Geomorphic Overview
Reach 4
Large Backwater Pool in Abandoned Oxbow
Small LWM Jam
Medium LWM Jam
5500
Location of Meander Cutoff Avulsion Between 2013 and 2015
5000
Reach 3
Reach 4
Channel-Spanning LWM Jam
Lake Sammamish State Park Boundary
Extent of Survey and Hydraulic Model
Pebble Count 3
6500
6000
Upstream limit of revetment not determined in field.
Depth and Elevation Relative to 2-yr Water Surface
Depth (ft)
13-14 12-13 11-12 10-11 9-10 8-9 7-8 6-7 5-6 4-5 3-4 2-3 1-2 <1
Relative Elevation (ft)
<1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 12-13 13-14 14-15 15-16 16-17 17-18 >18

APPENDIX F: PRELIMINARY PLANS



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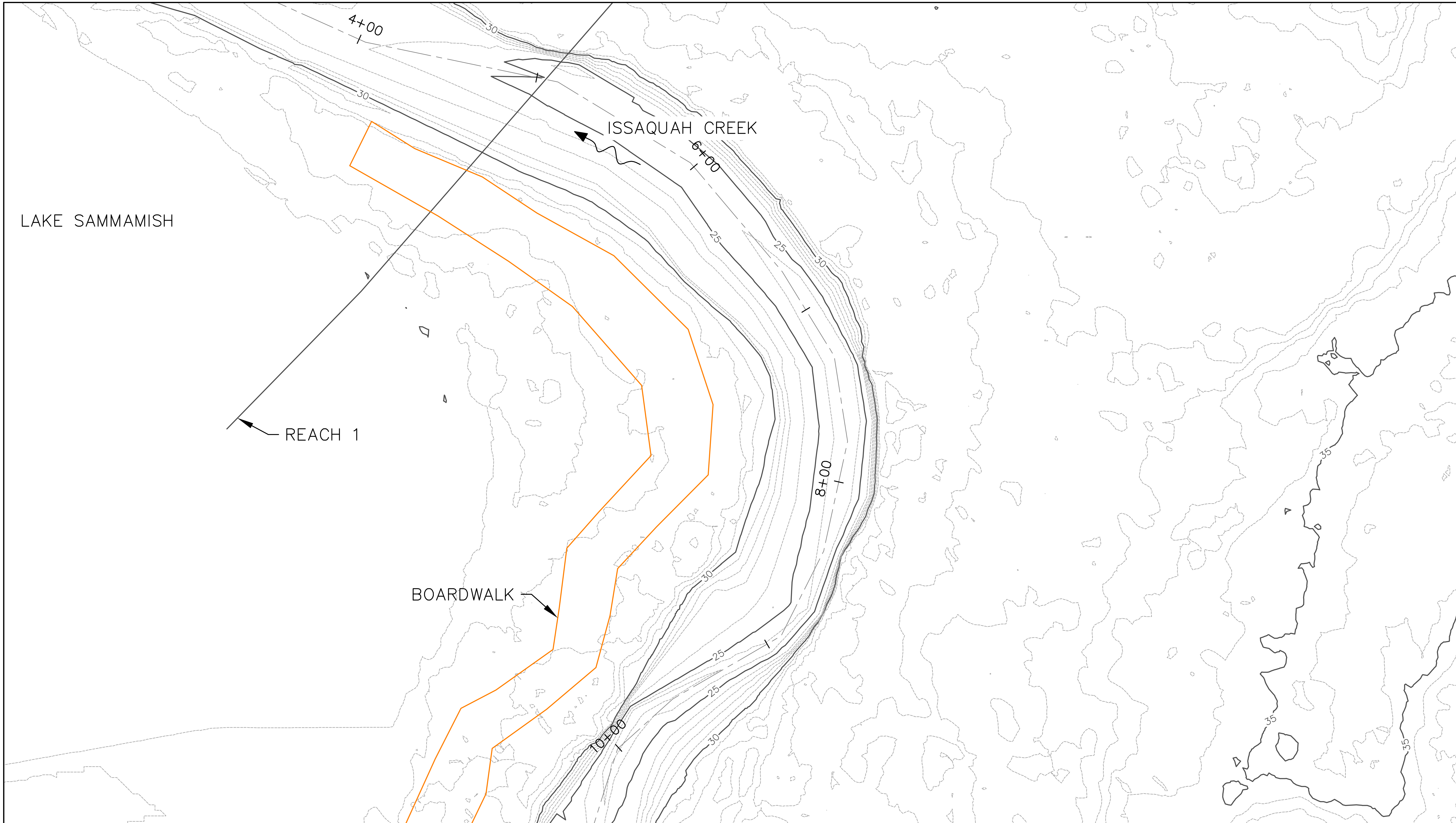
Job: 2003907
Rev:
Drft: MWG
Chkd:
Date: 19Jun20

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reach 1 Overview

Sheet EX-1



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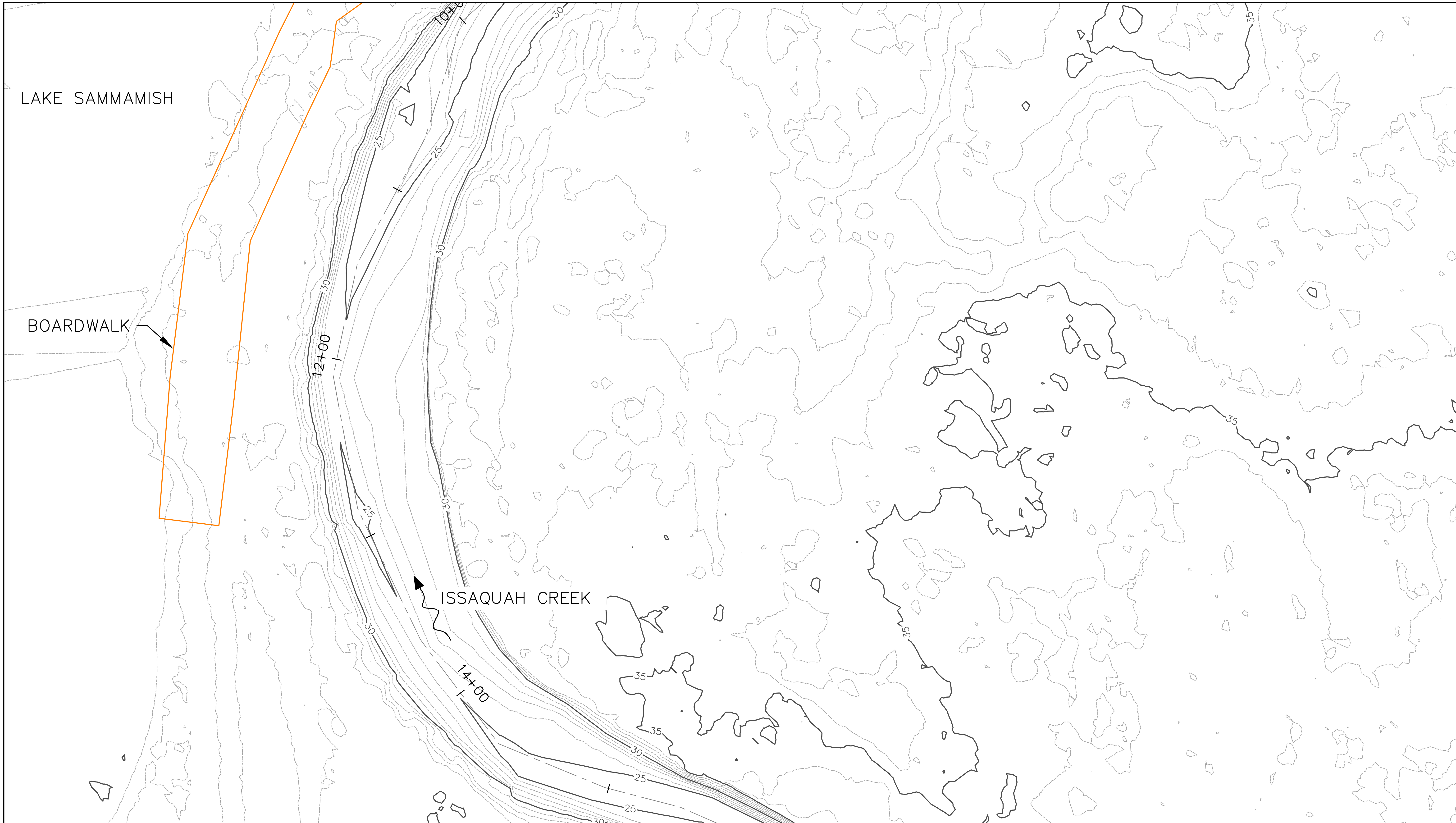
Job:2003907	
Rev:	
Drft: MWG	
Chkd:	
Date:18Jun20	

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reach 1

Sheet EX-2



nhc
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711 capitol way south, suite 607
olympia, washington 98501
phone: (360) 584-9810

N

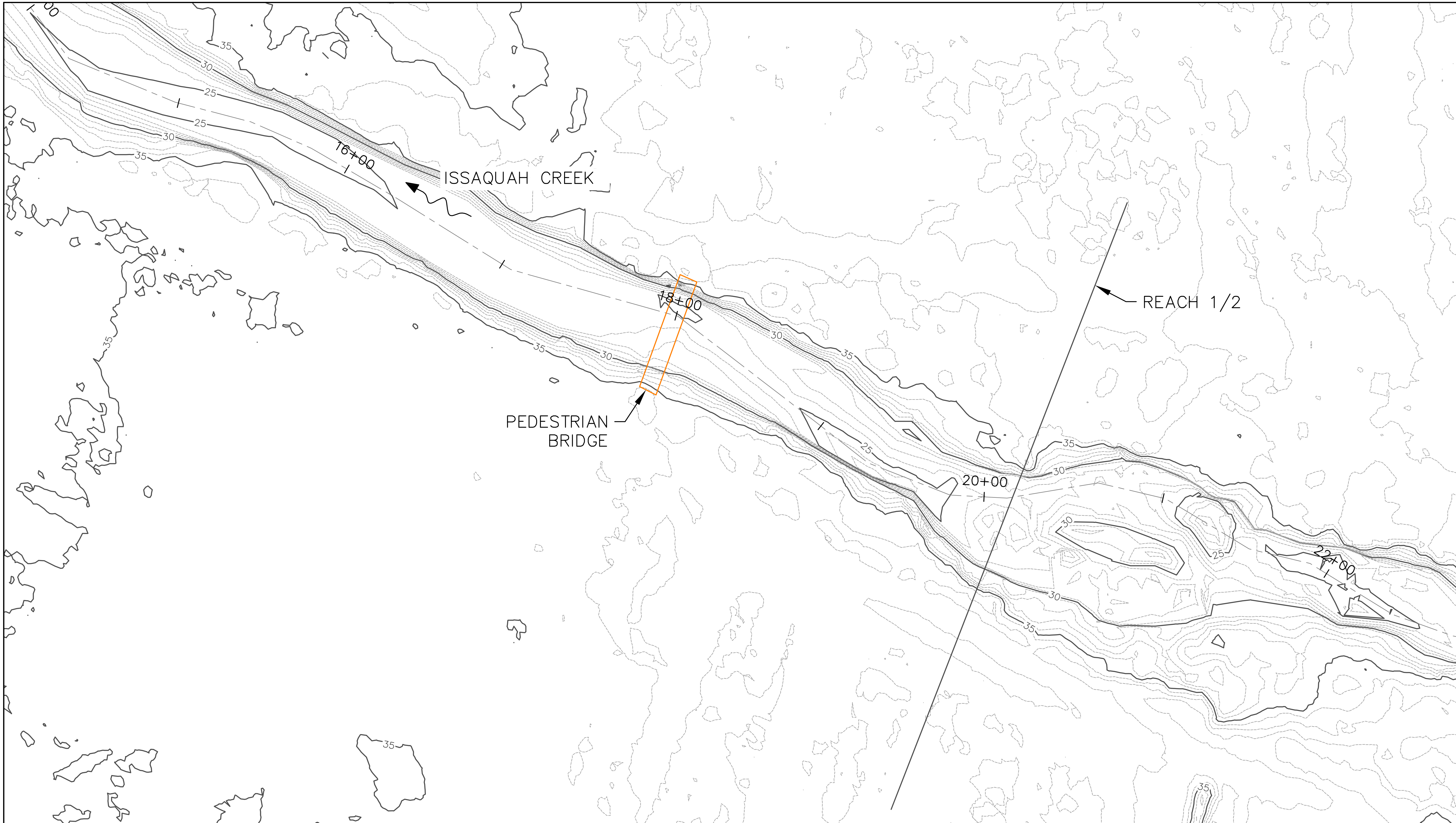
0 50 100
Feet

Job: 2003907	
Rev:	
Drft: MWG	
Chkd:	
Date: 18Jun20	

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reach 1

Sheet EX-3



nhc
northwest hydraulic consultants
711 capitol way south, suite 607
olympia, washington 98501
phone: (360) 584-9810

N

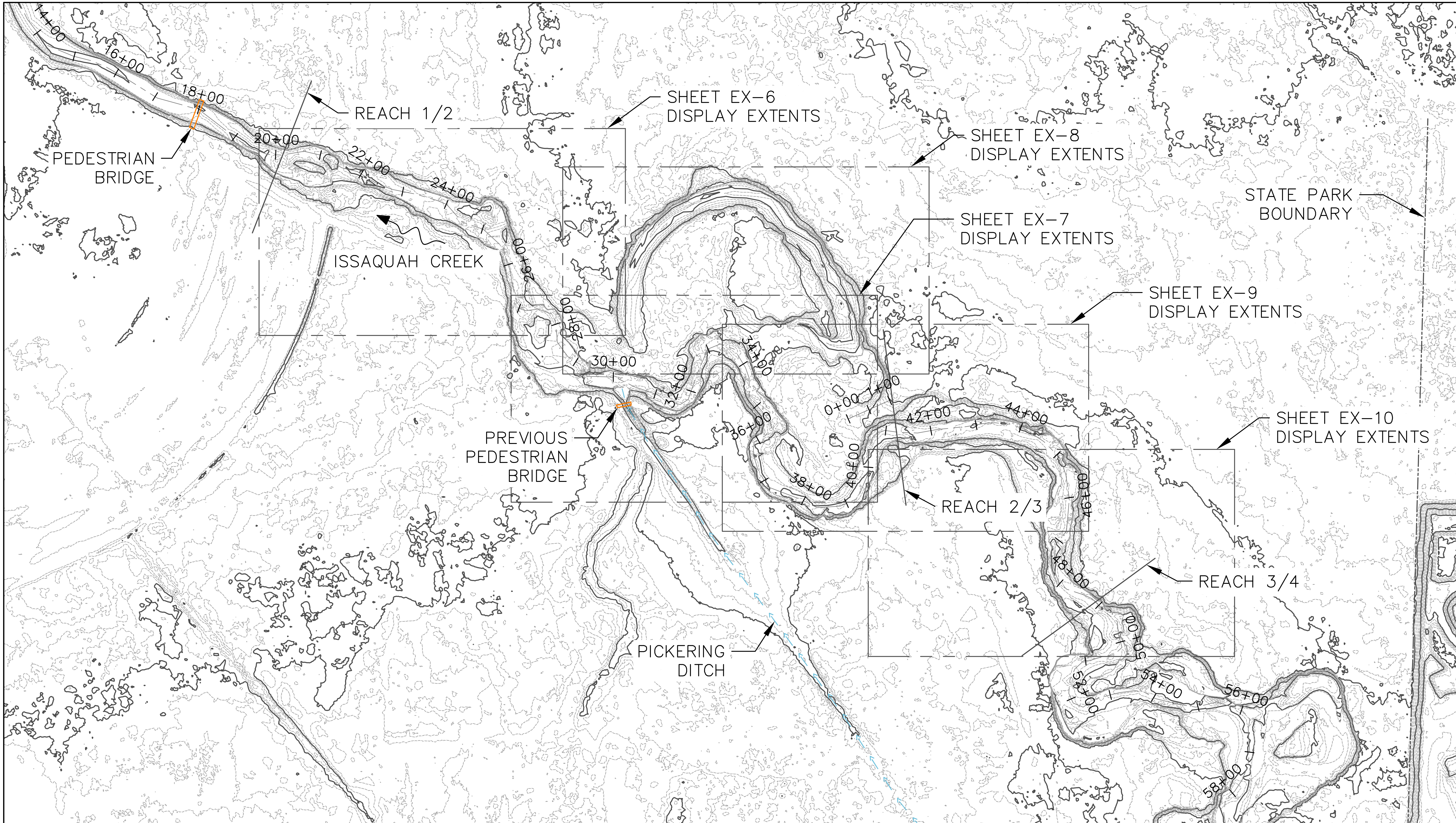
0 50 100
Feet

Job: 2003907	
Rev:	
Drft: MWG	
Chkd:	
Date: 18Jun20	

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reach 1

Sheet EX-4



MOUNTAINS to Sound GREENWAY

WASHINGTON STATE PARKS

nhc
northwest hydraulic consultants
711 capitol way south, suite 607
olympia, washington 98501
phone: (360) 584-9810

N

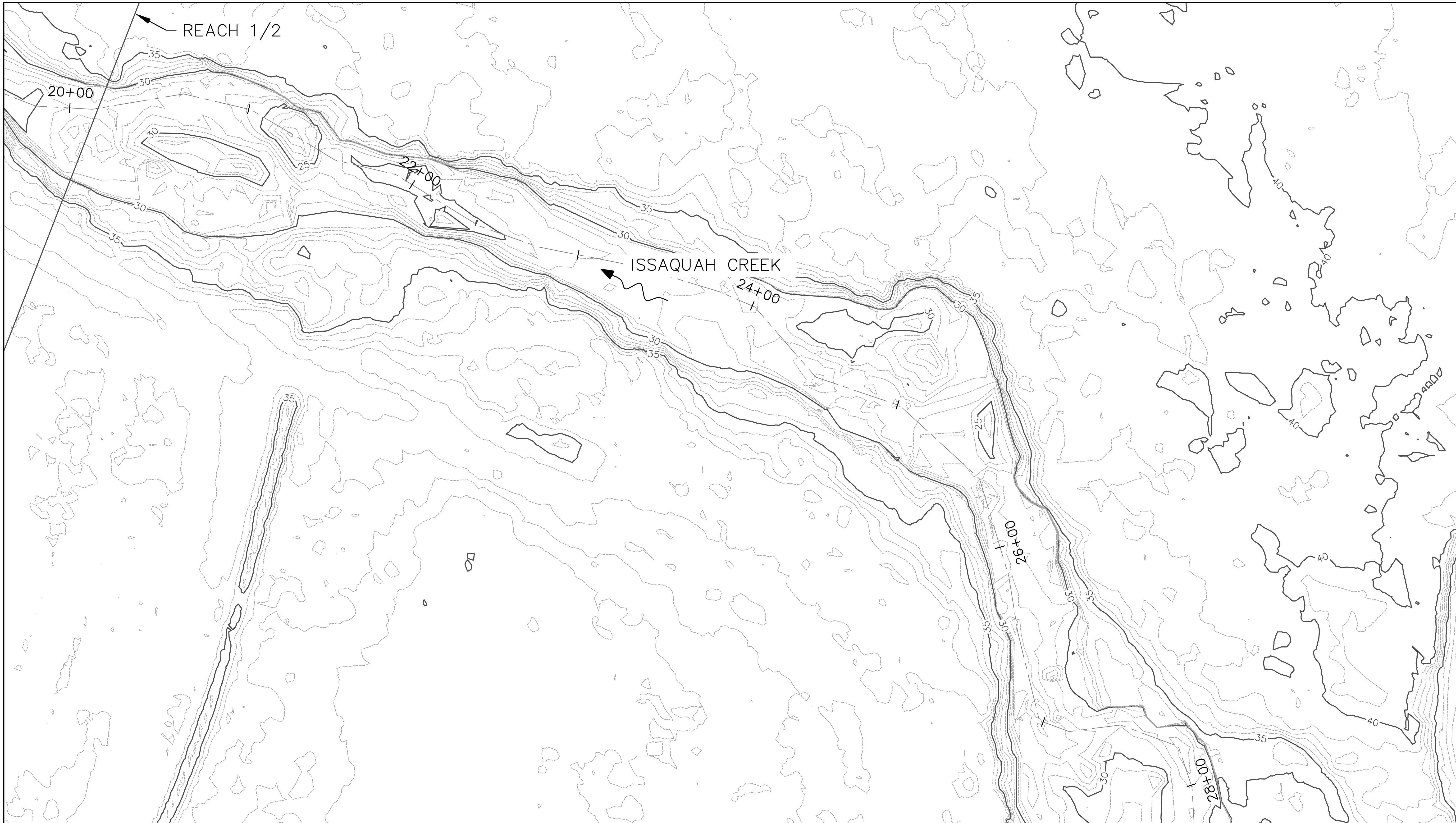
0 200 400 Feet

Job: 2003907
Rev:
Drft: MWG
Chkd:
Date: 18Jun20

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reaches 2 and 3 Overview

Sheet EX-5



MOUNTAINS to Sound GREENWAY

WASHINGTON STATE PARKS

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olympia, washington 98501
phone: (360) 584-9810

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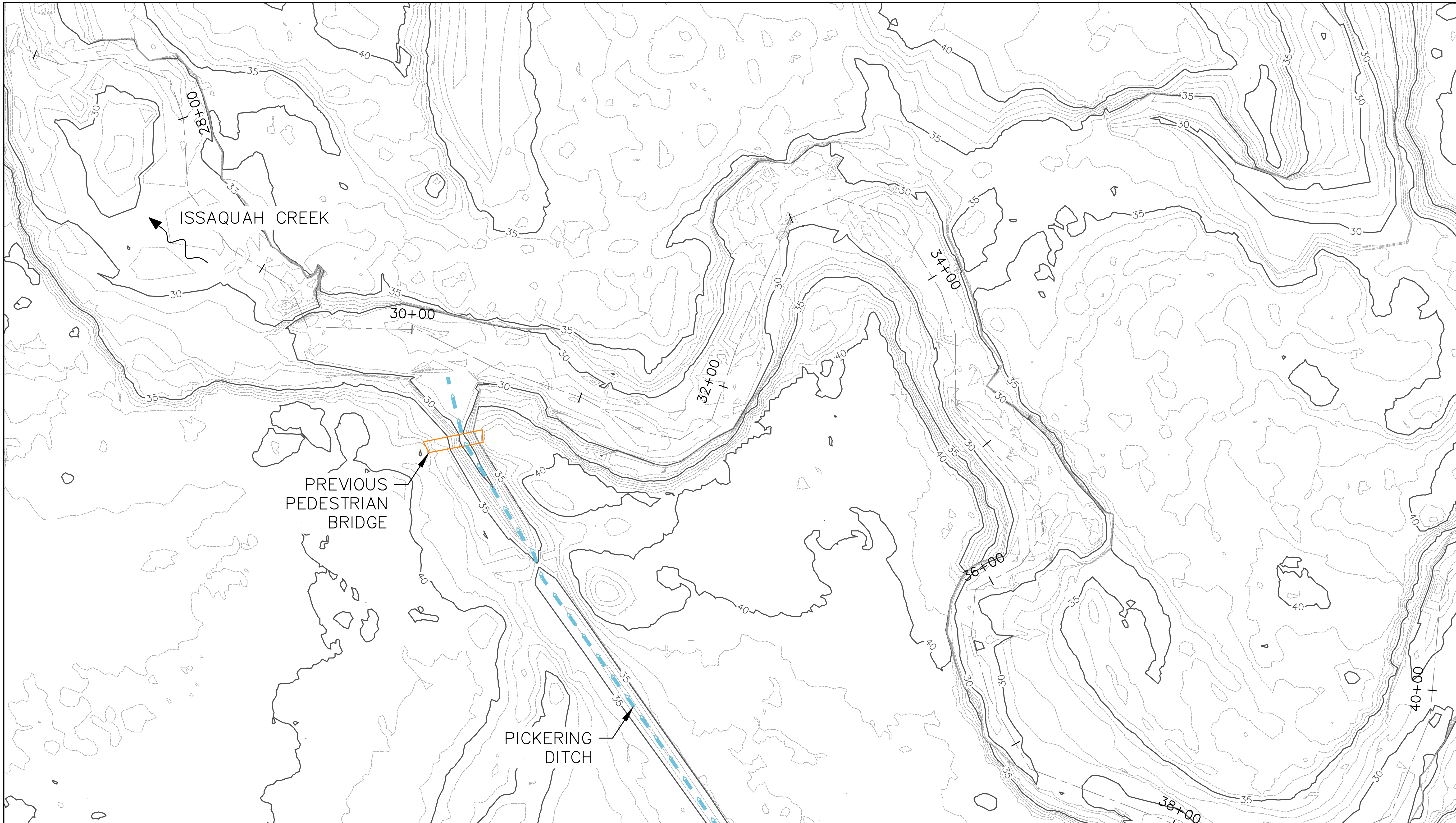
Job: 2003907	
Rev:	
Drft: MWG	
Chkd:	
Date: 18Jun20	

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reach 2

Sheet EX-6



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Lower Issaquah Creek Restoration
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Existing Site Plan - Reach 2

Sheet EX-7

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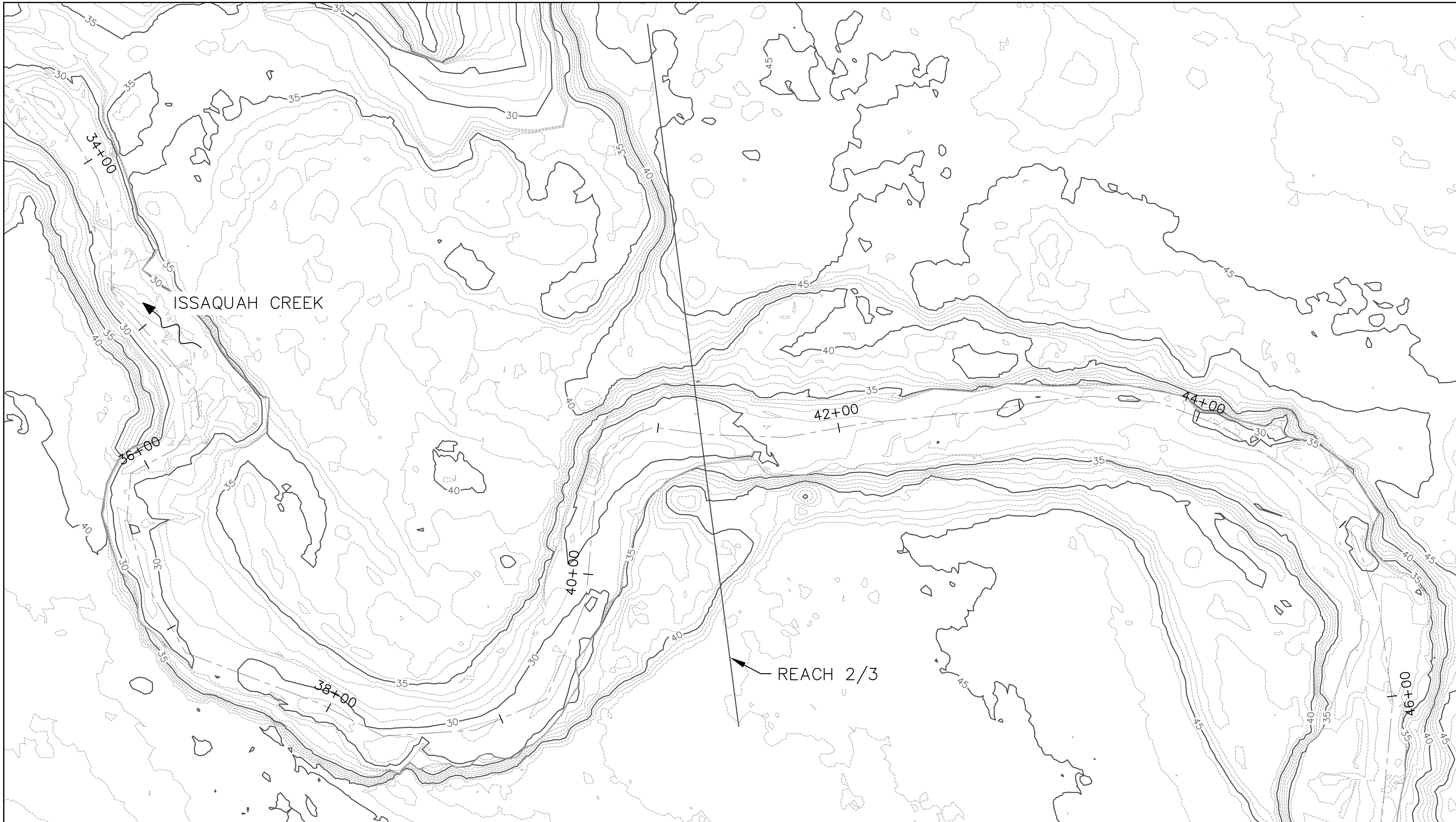
Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reach 2

Sheet EX-8



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Chkd:	
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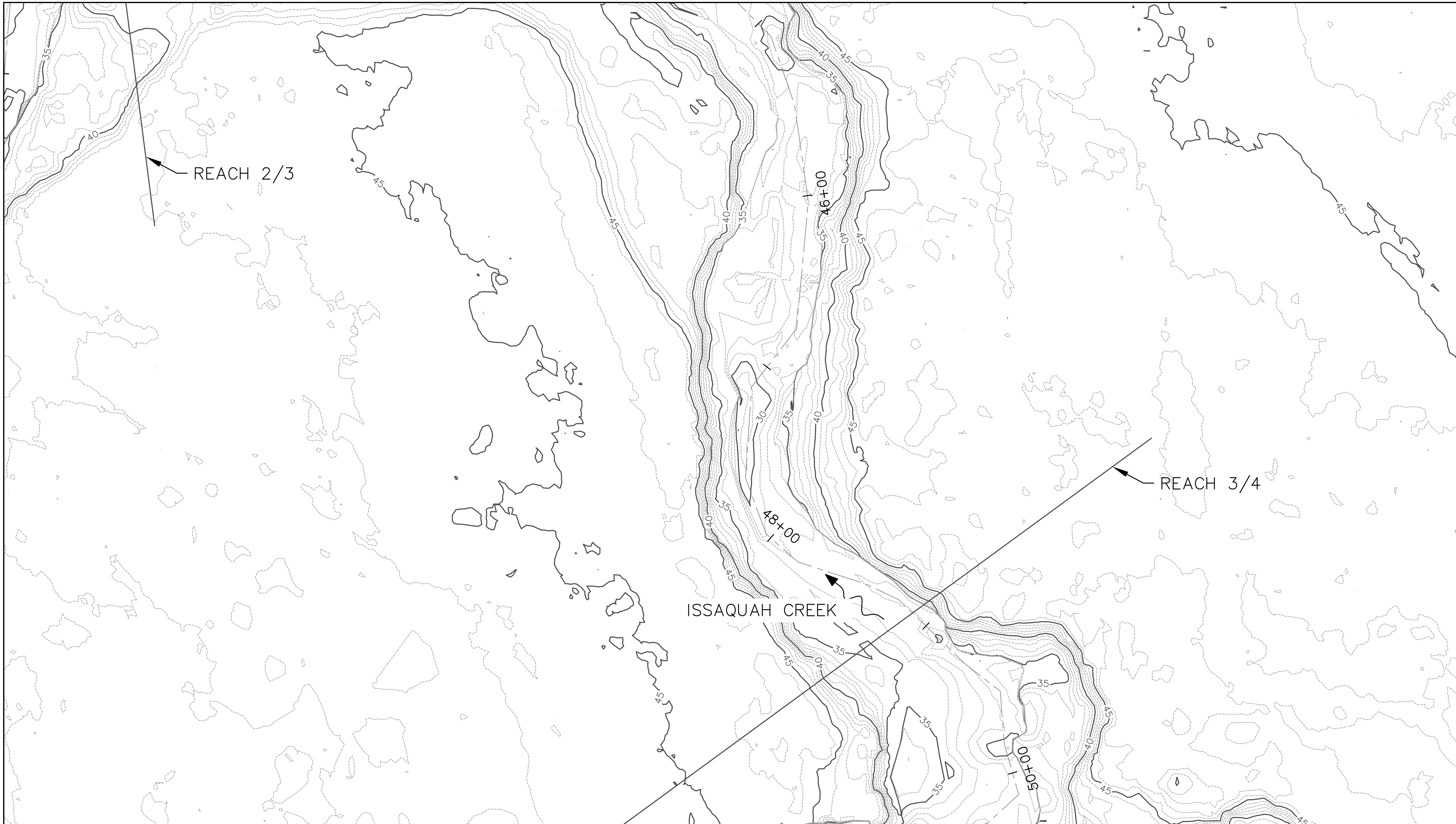
at Lake Sammamish State Park

Existing Site Plan - Reaches 2 and 3

Sheet EX-9



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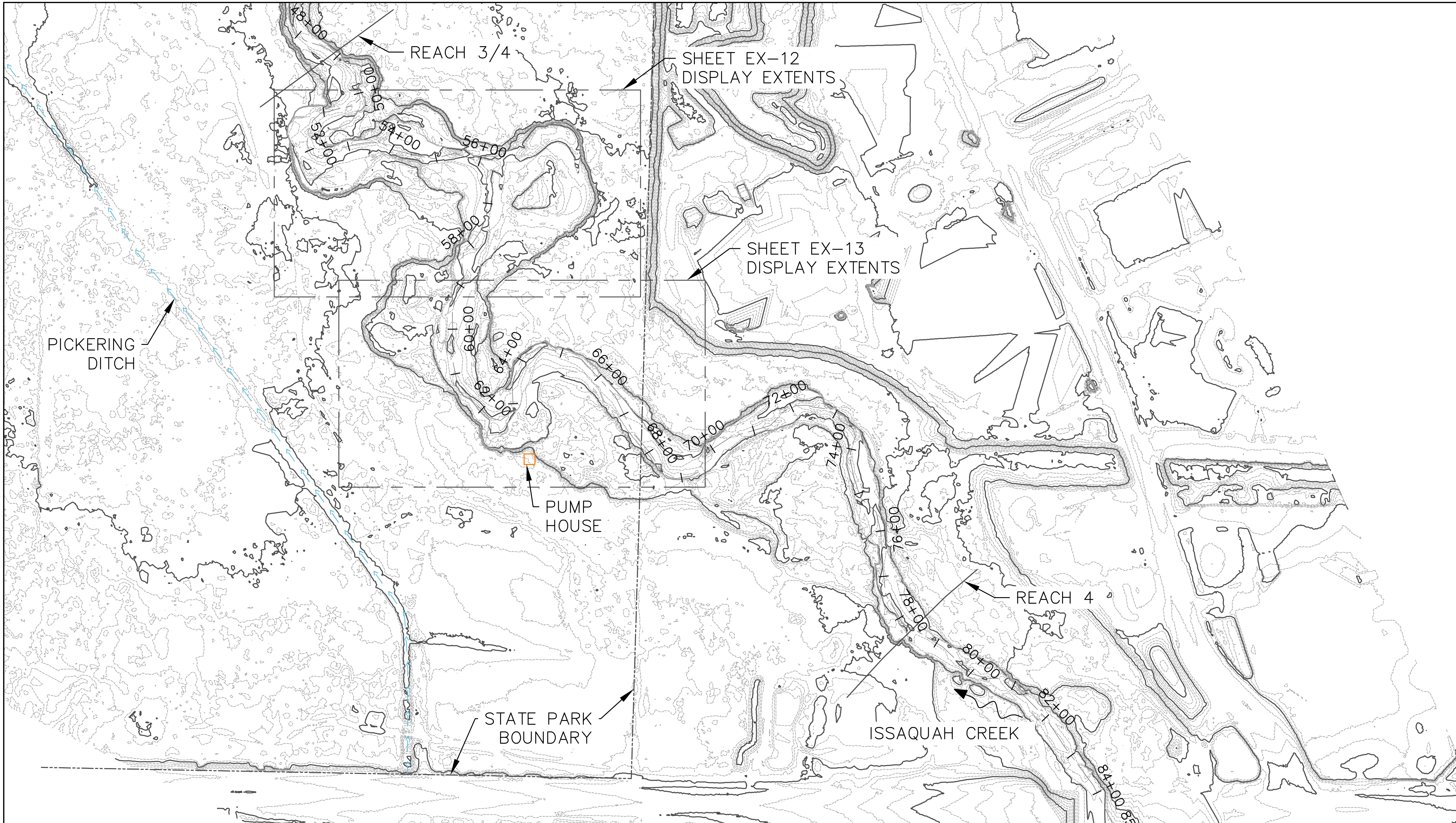
Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reach 3

Sheet EX-10



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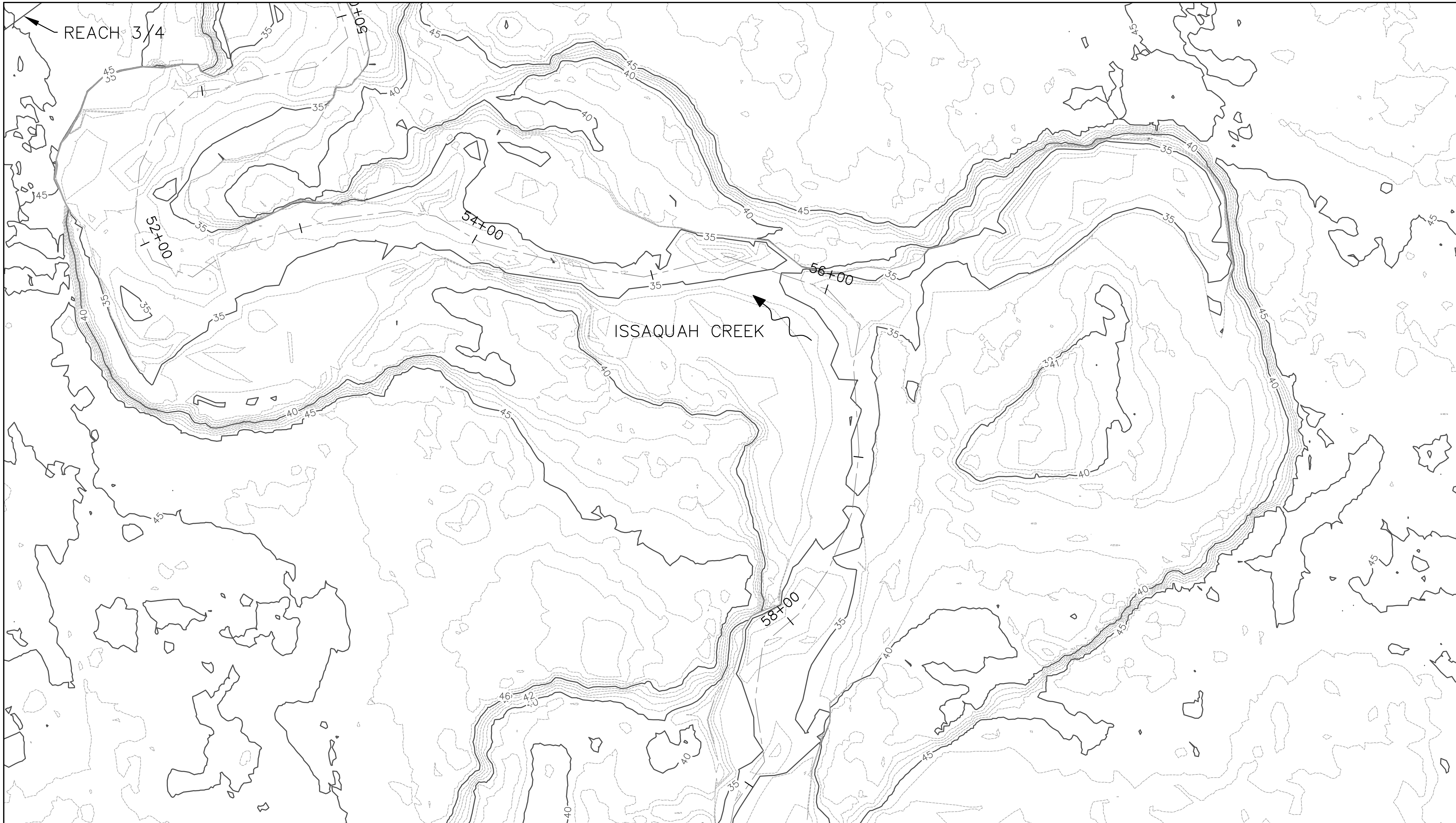
Chkd:	
Date: 18Jun20	

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reach 4 Overview

Sheet EX-11



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Job: 2003907	
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Chkd:	
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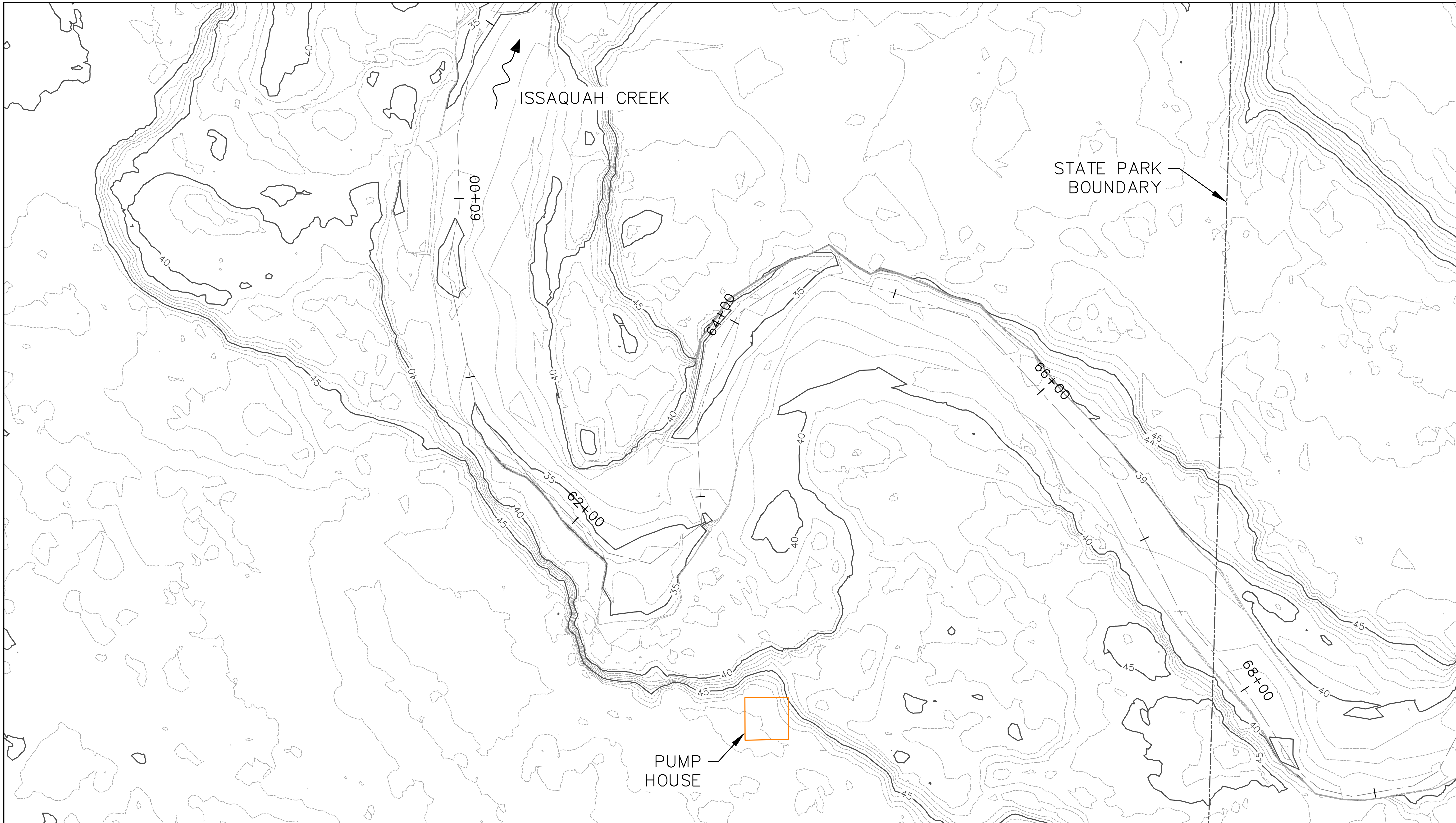
Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Existing Site Plan - Reach 4

Sheet EX-12



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Existing Site Plan - Reach 4

Sheet EX-13

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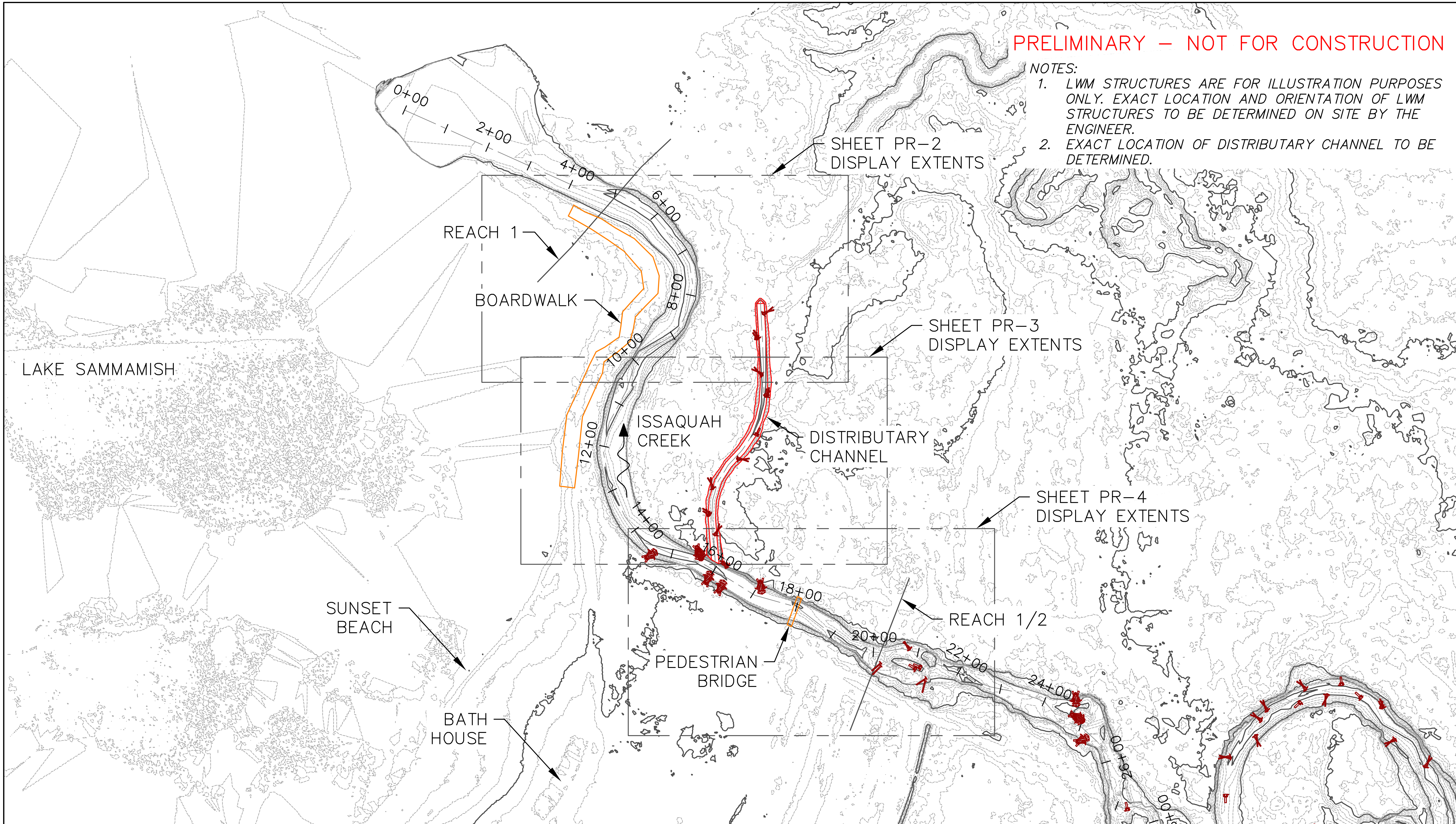
NOTES:

1. LWM STRUCTURES ARE FOR ILLUSTRATION PURPOSES ONLY. EXACT LOCATION AND ORIENTATION OF LWM STRUCTURES TO BE DETERMINED ON SITE BY THE ENGINEER.
2. EXACT LOCATION OF DISTRIBUTARY CHANNEL TO BE DETERMINED.



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Date: 18Jun20	

Lower Issaquah Creek Restoration
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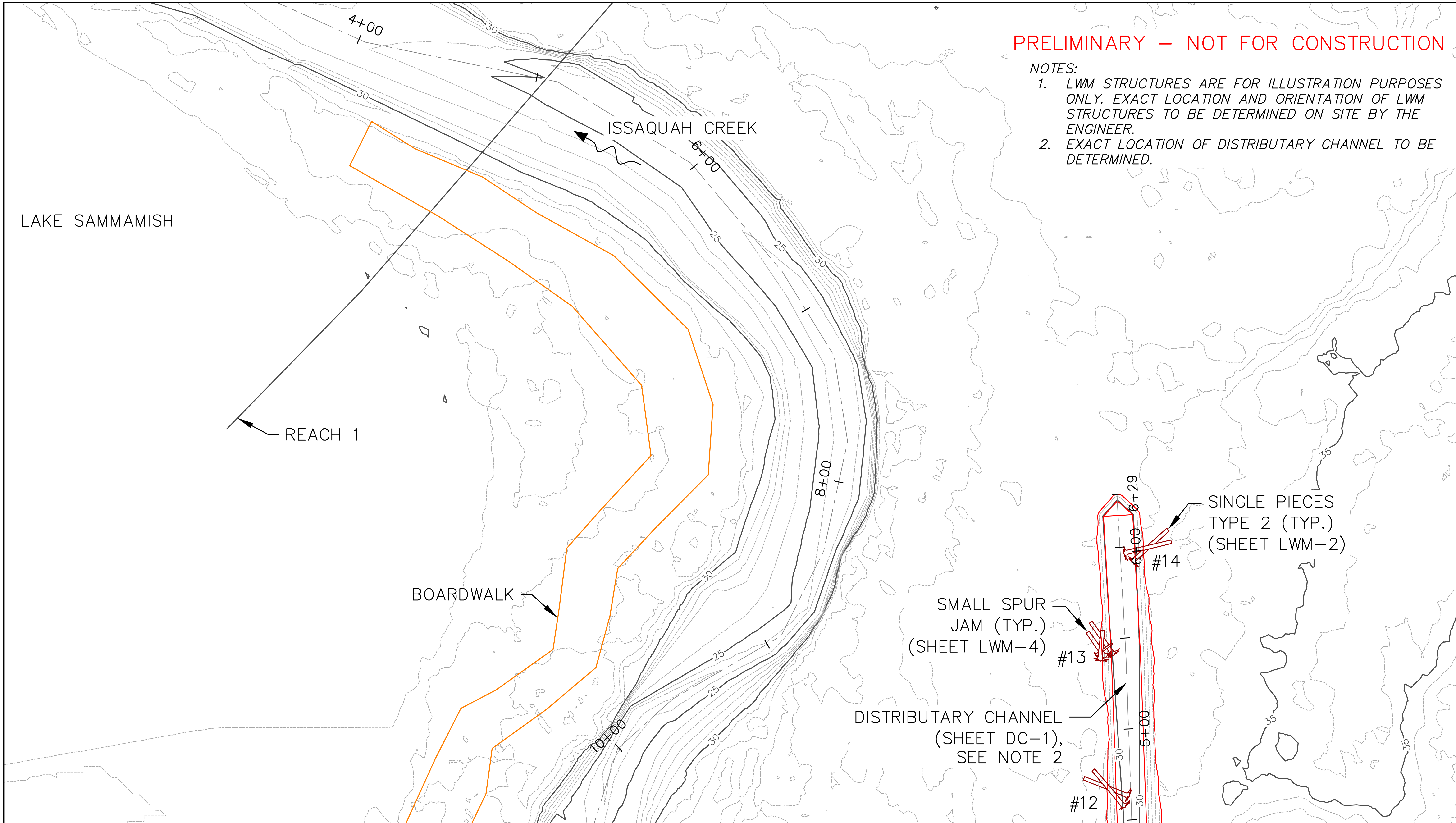
Proposed Site Plan - Reach 1 Overview

Sheet PR-1



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NOTES:

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2. *EXACT LOCATION OF DISTRIBUTARY CHANNEL TO BE DETERMINED.*

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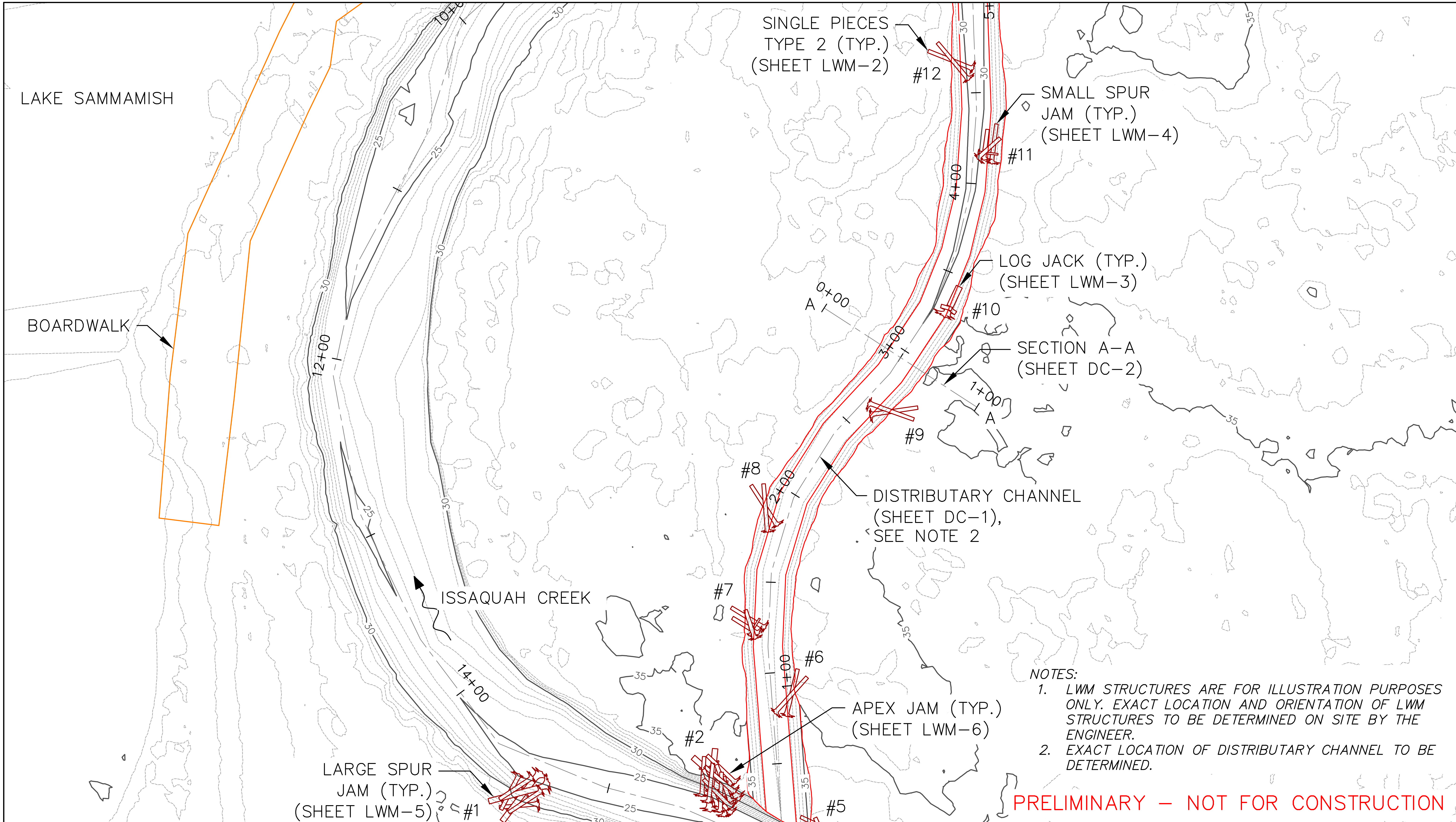
Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Proposed Site Plan - Reach 1

Sheet PR-2



NOTES:
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2. *EXACT LOCATION OF DISTRIBUTARY CHANNEL TO BE DETERMINED.*

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Proposed Site Plan - Reach 1

Sheet PR-3

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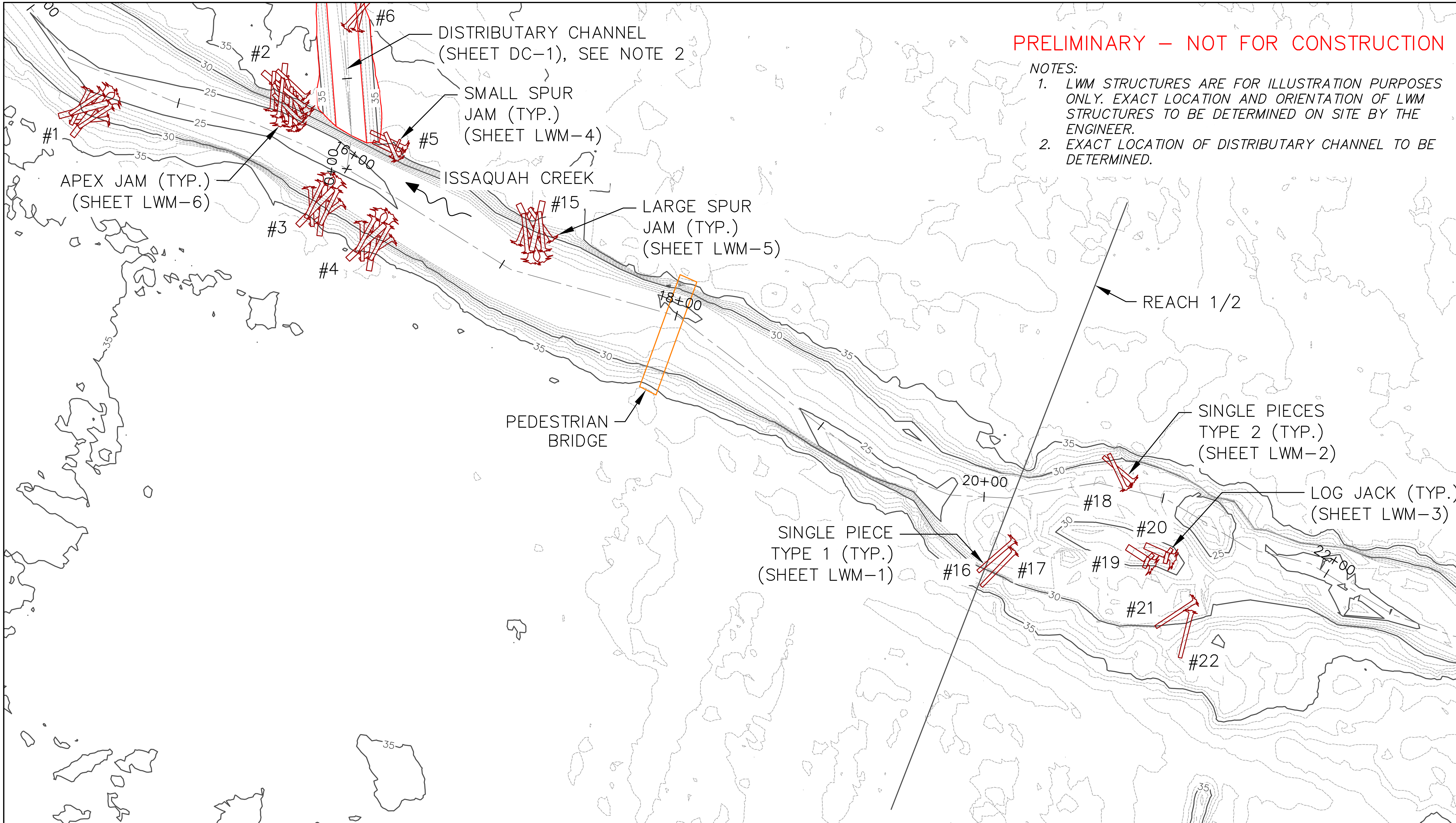
2. *EXACT LOCATION OF DISTRIBUTARY CHANNEL TO BE DETERMINED.*



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Lower Issaquah Creek Restoration
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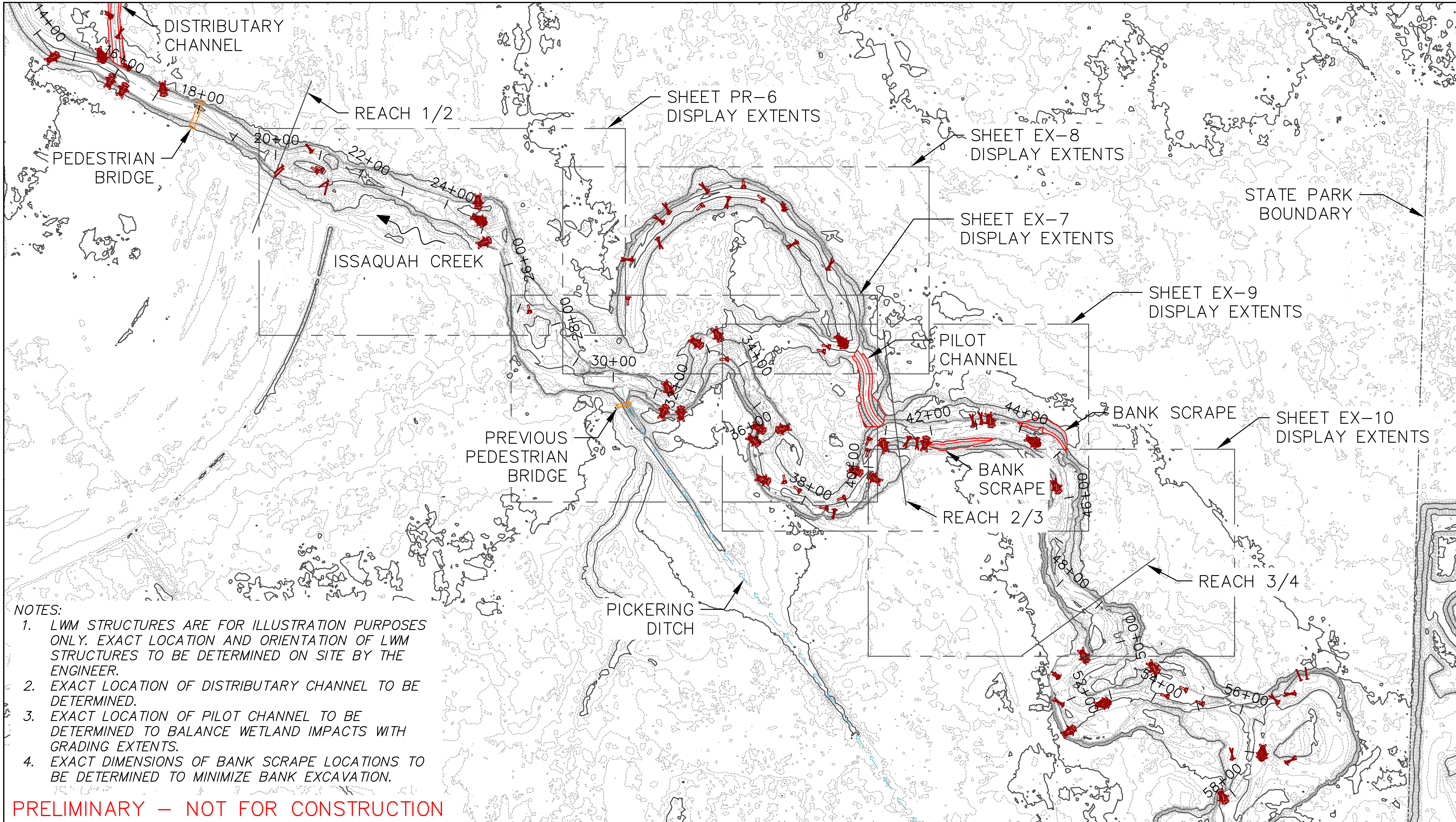
Proposed Site Plan - Reach 1

Sheet PR-4



NOTES:

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2. *EXACT LOCATION OF DISTRIBUTARY CHANNEL TO BE DETERMINED.*
3. *EXACT LOCATION OF PILOT CHANNEL TO BE DETERMINED TO BALANCE WETLAND IMPACTS WITH GRADING EXTENTS.*
4. *EXACT DIMENSIONS OF BANK SCRAPE LOCATIONS TO BE DETERMINED TO MINIMIZE BANK EXCAVATION.*

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Proposed Site Plan - Reaches 2 and 3 Overview

Sheet PR-5

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NOTES:

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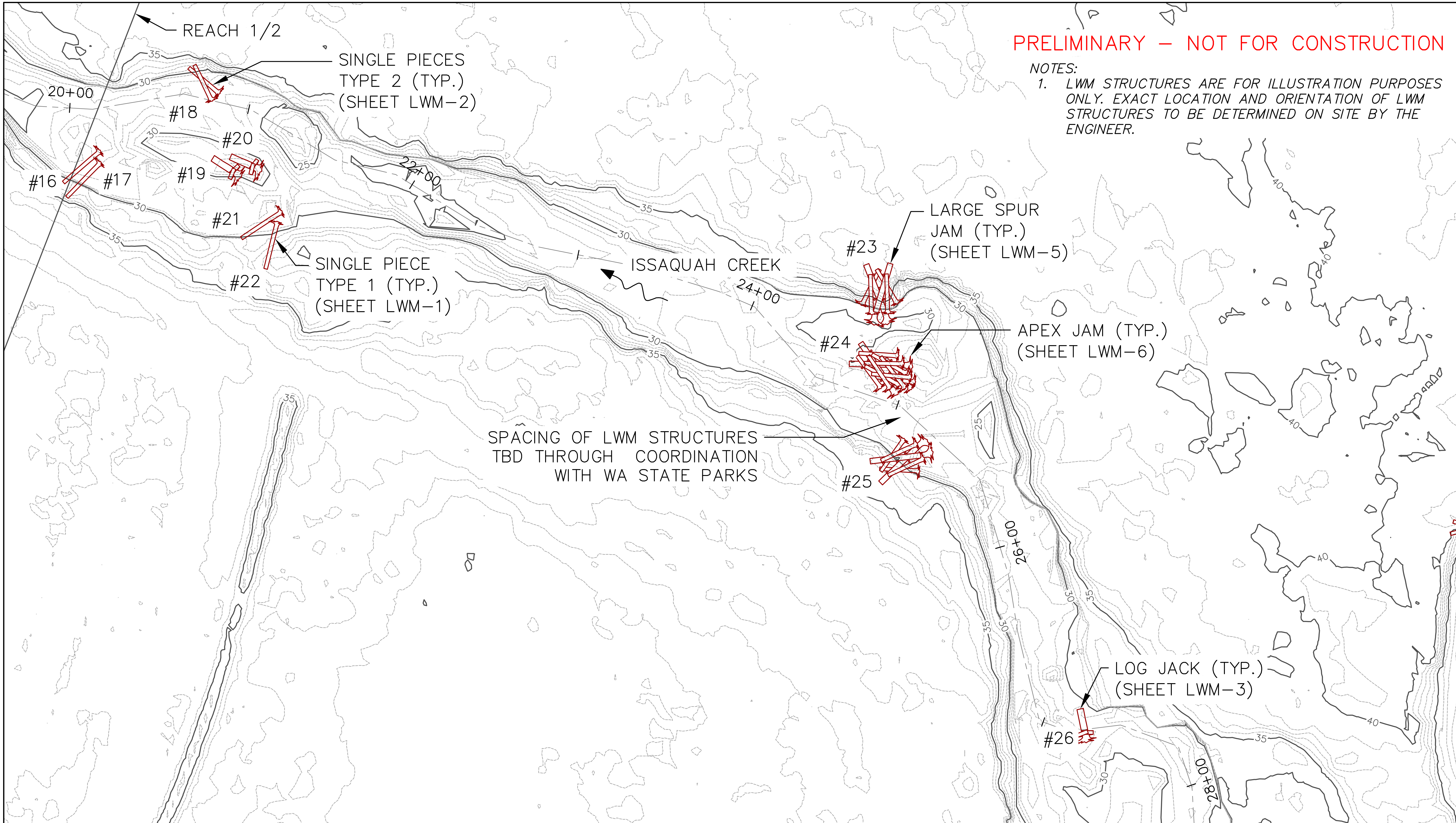

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Job: 2003907	Lower Issaquah Creek Restoration at Lake Sammamish State Park
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Drft: MWG	Proposed Site Plan - Reach 2
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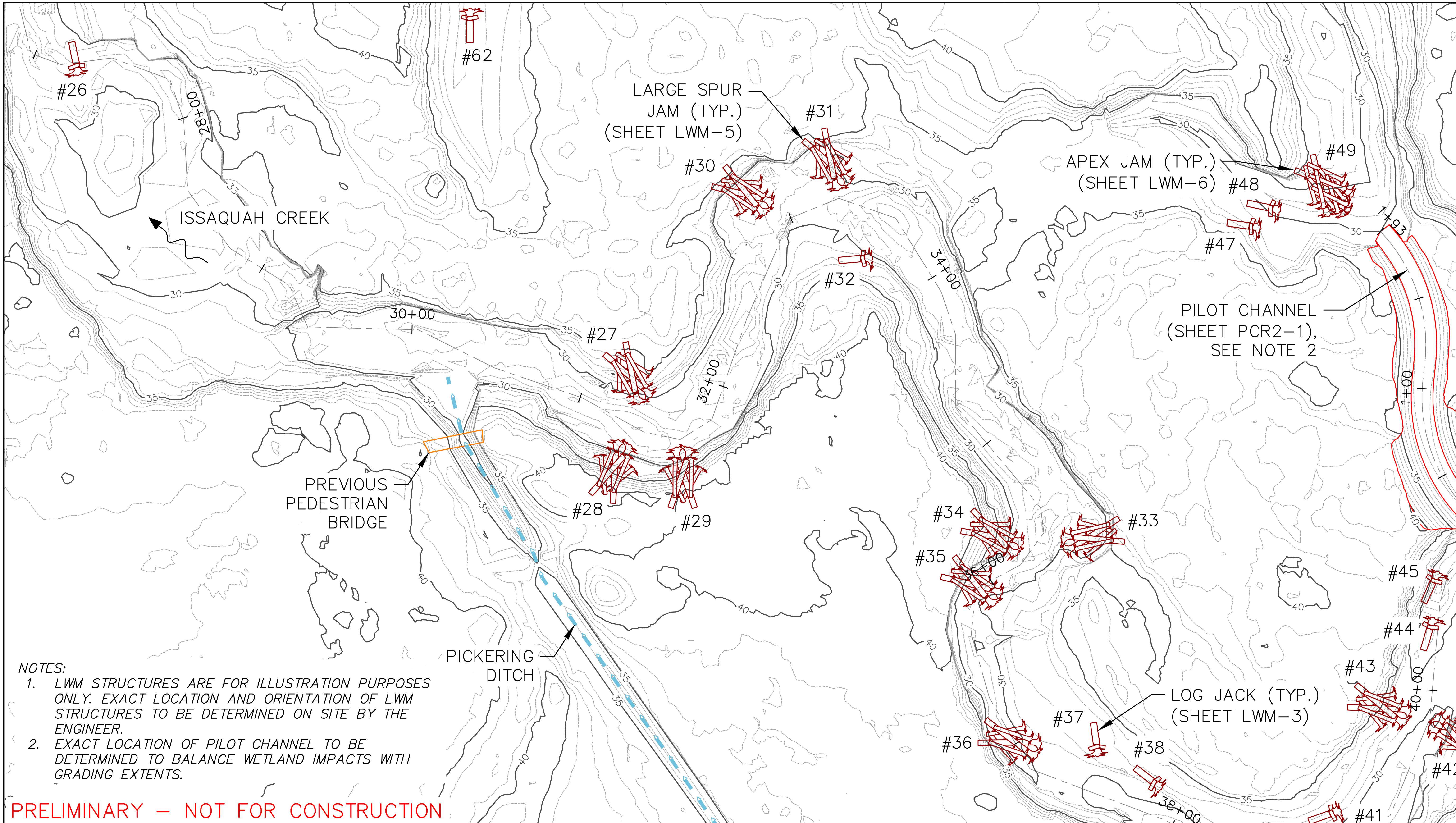
Date: 18Jun20	Sheet PR-6



NOTES:

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Chkd:	
Date: 18Jun20	Sheet PR-7

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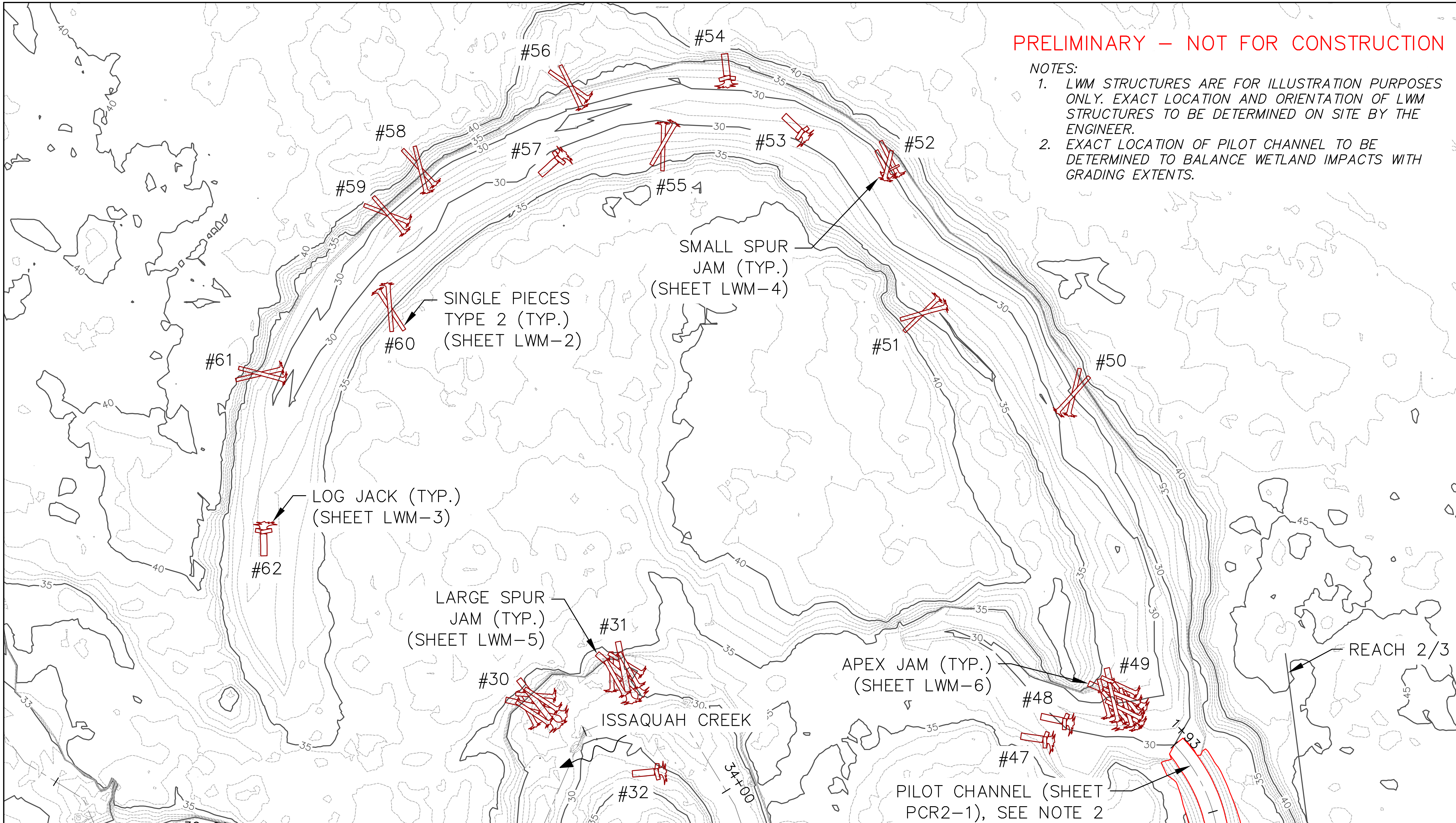

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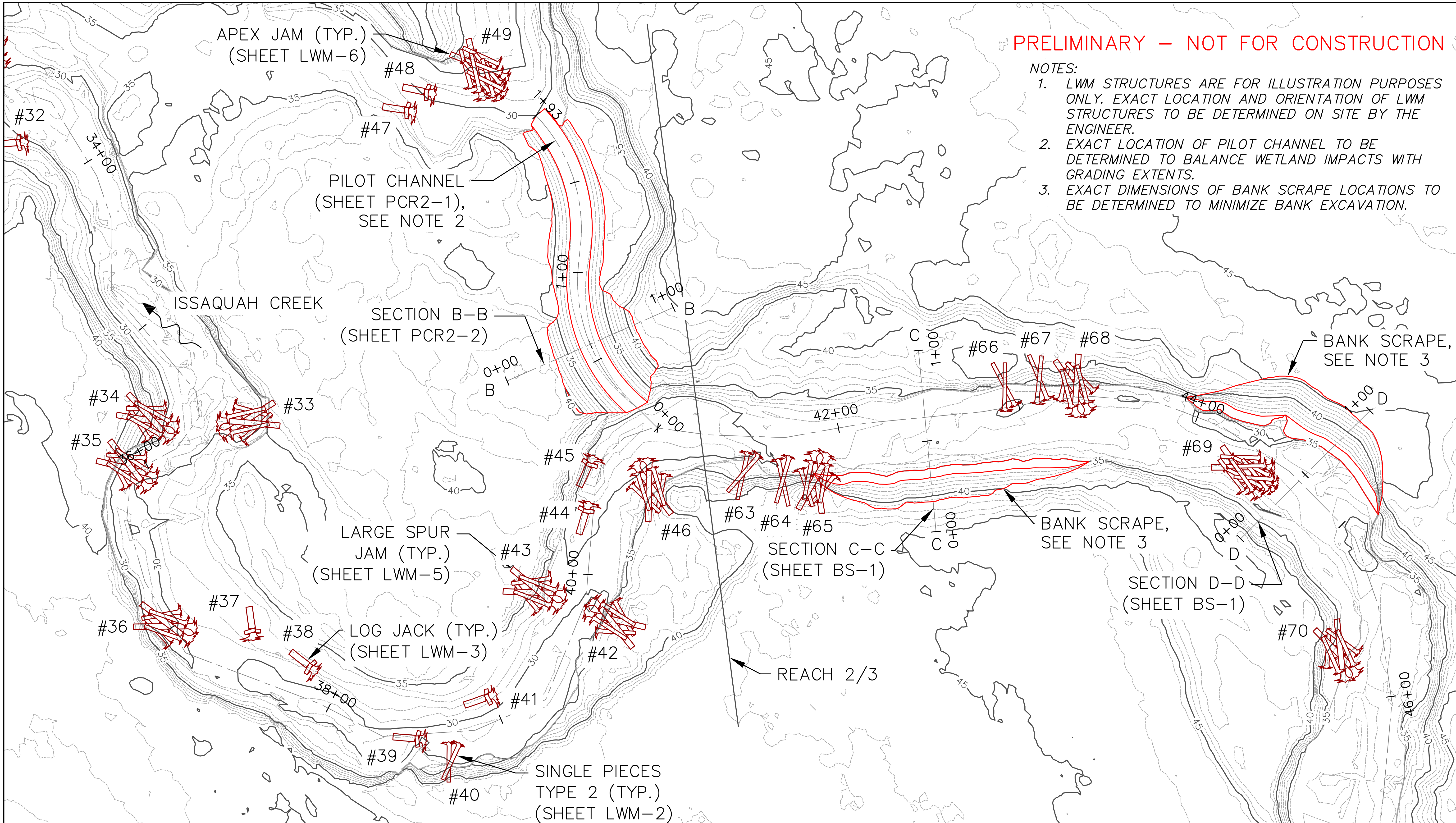
Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Proposed Site Plan - Reach 2

Sheet PR-8



PRELIMINARY – NOT FOR CONSTRUCTION

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3. EXACT DIMENSIONS OF BANK SCRAPE LOCATIONS TO BE DETERMINED TO MINIMIZE BANK EXCAVATION.

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Lower Issaquah Creek Restoration
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Proposed Site Plan - Reaches 2 and 3

Sheet PR-9

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NOTES:

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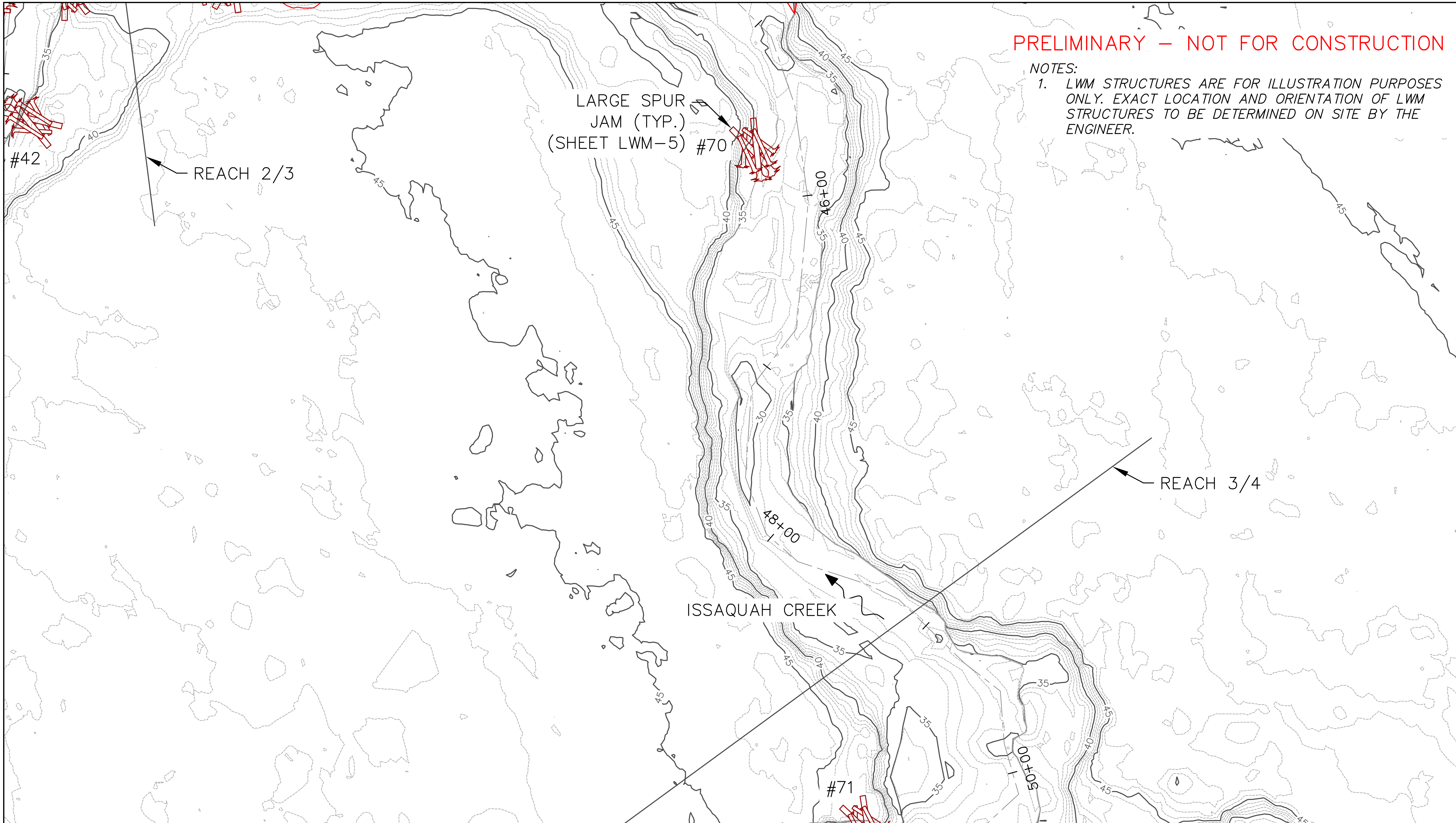

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Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Proposed Site Plan - Reach 3

Sheet PR-10

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NOTES:

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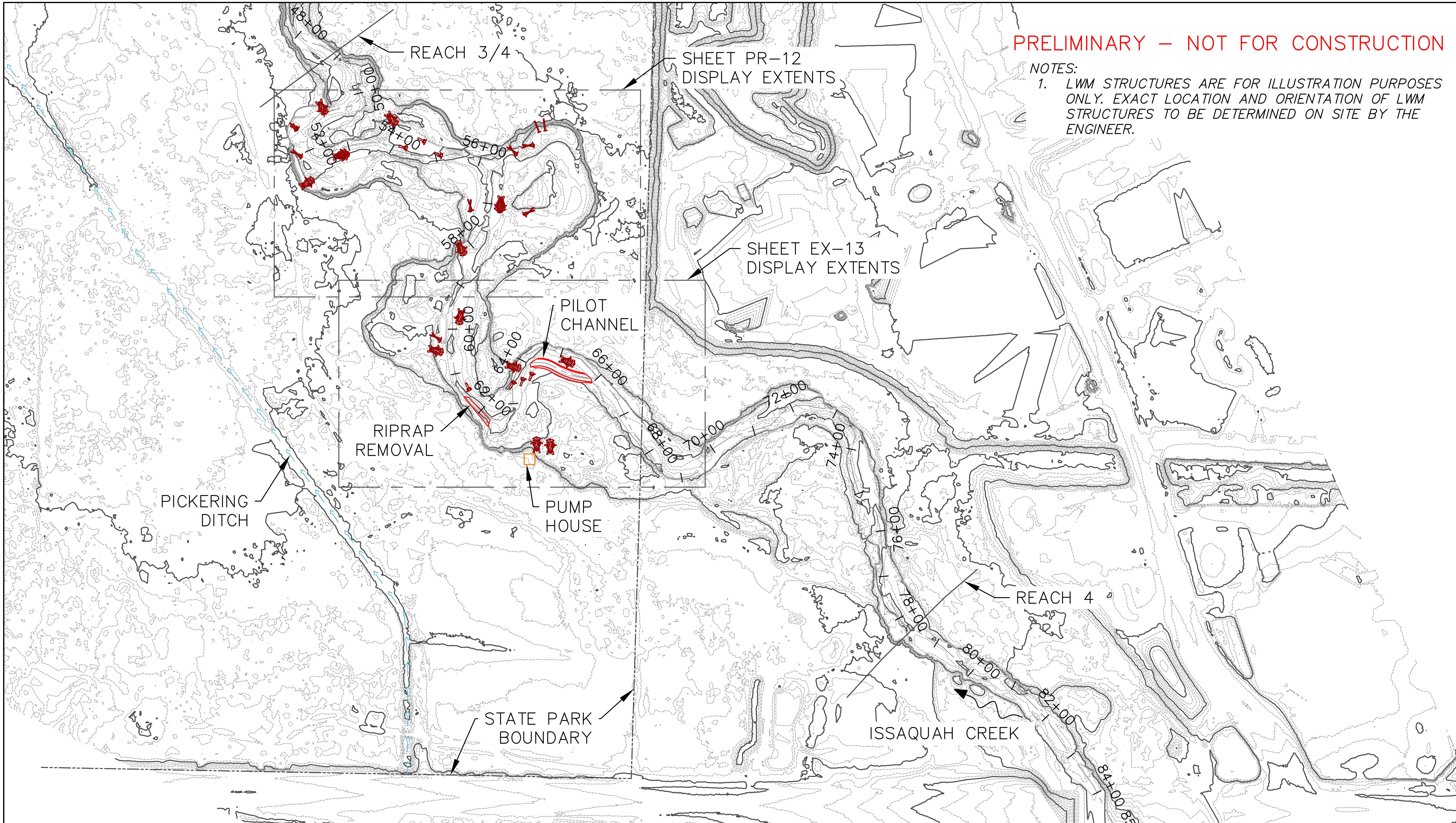

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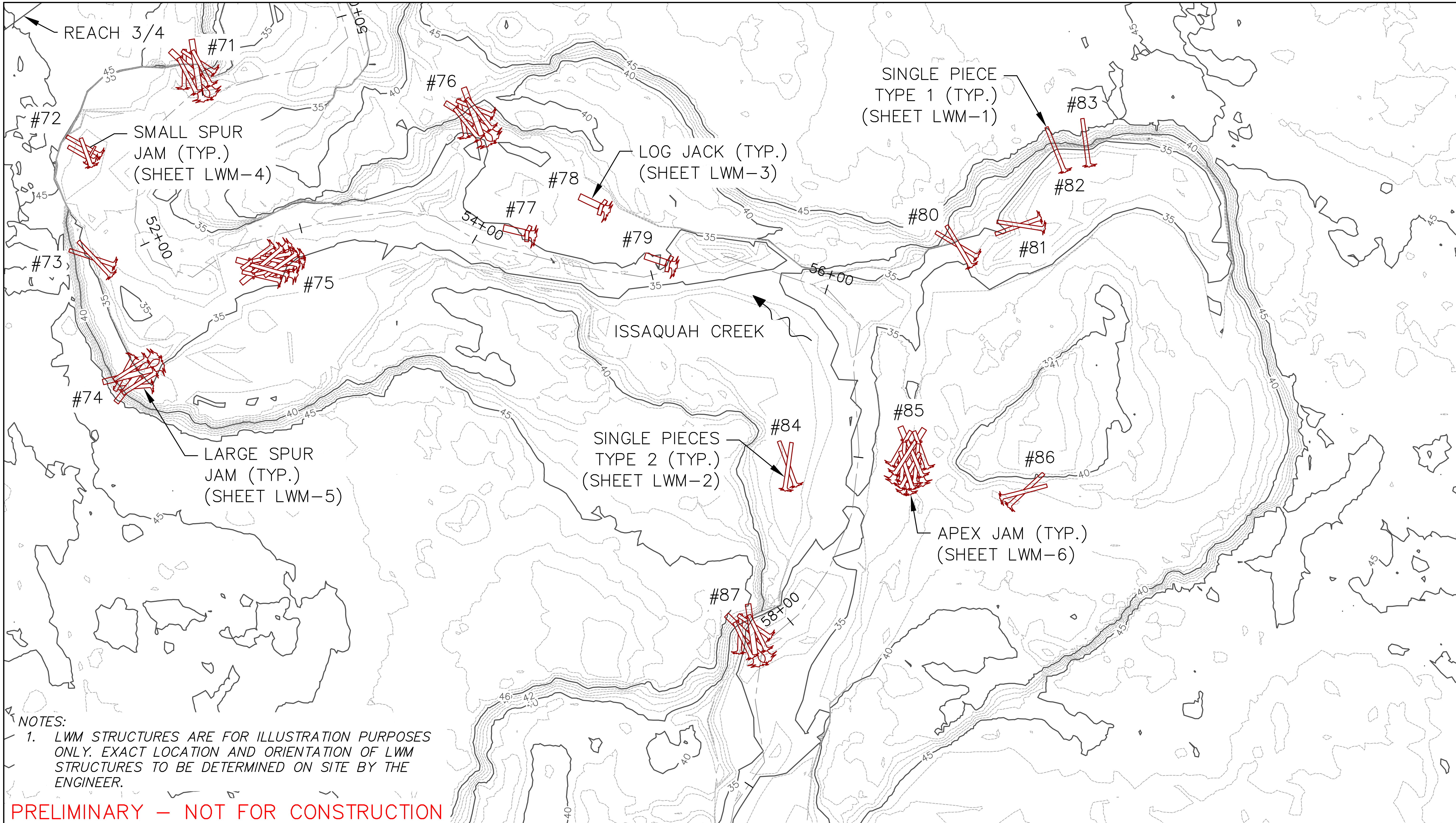
Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Proposed Site Plan - Reach 4 Overview

Sheet PR-11



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Rev:	
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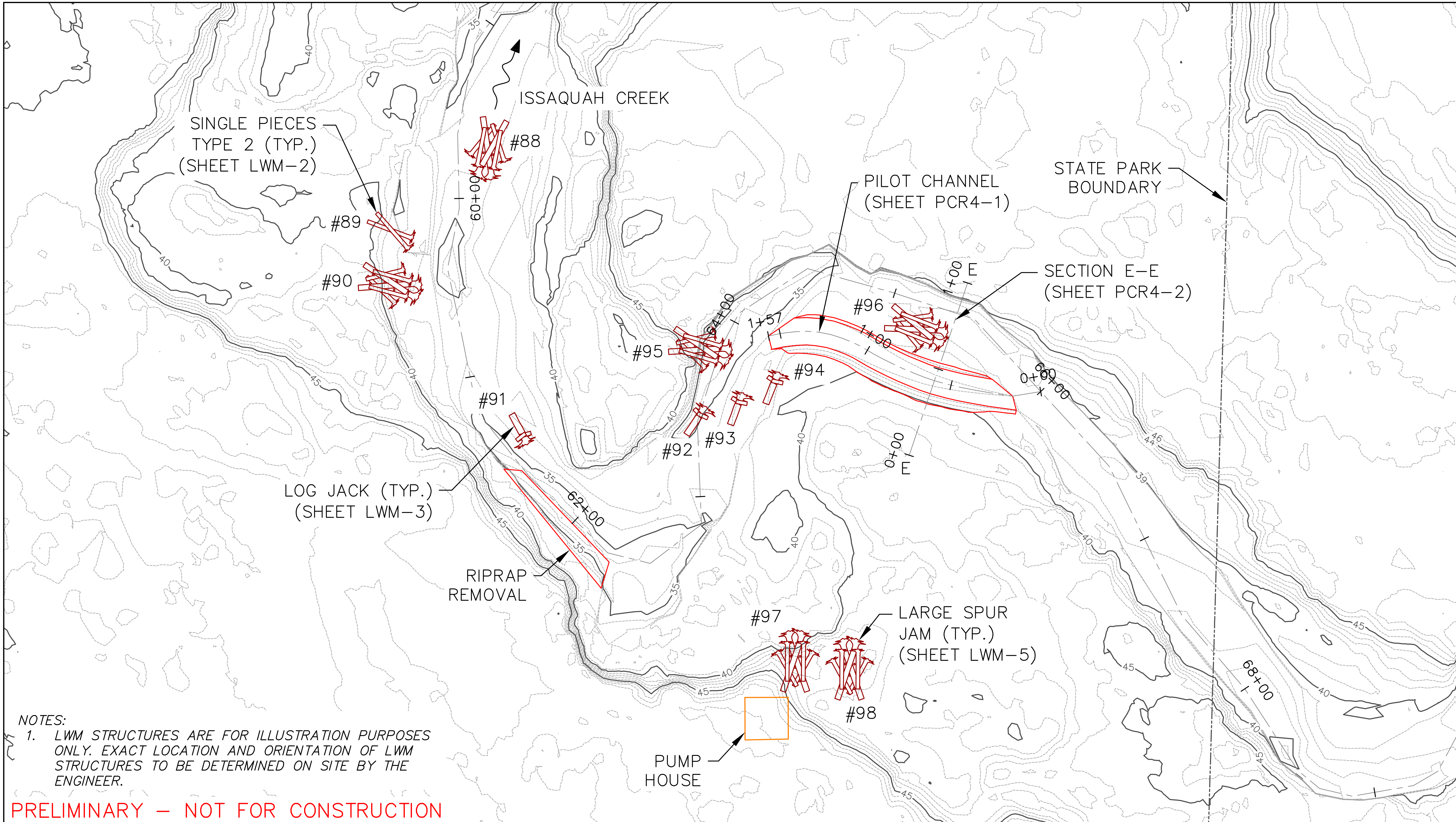

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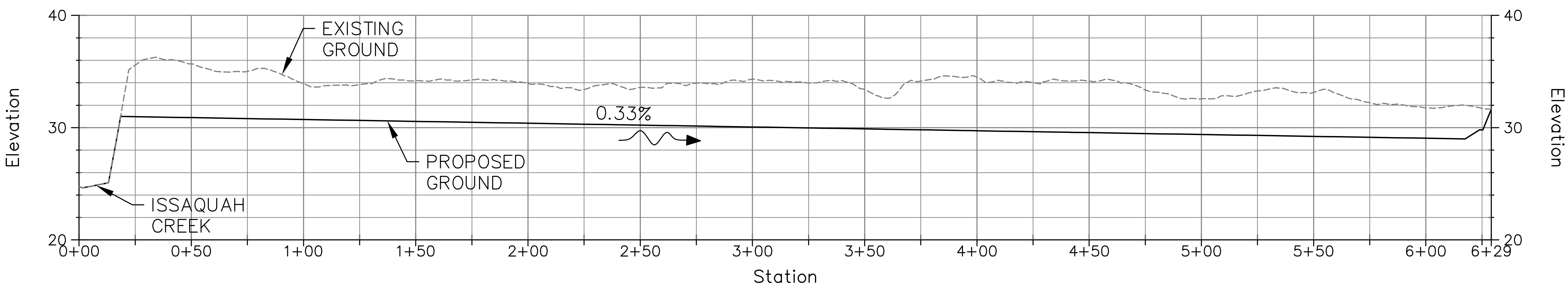
Lower Issaquah Creek Restoration at Lake Sammamish State Park

Proposed Site Plan - Reach 4

Sheet PR-13

PRELIMINARY – NOT FOR CONSTRUCTION

DISTRIBUTARY CHANNEL PROFILE



NOTES:
1. *5X VERTICAL EXAGGERATION FOR PROFILE*
2. *TYPICAL SECTION DETAIL ON SHEET DC–2*
3. *EXACT LOCATION OF DISTRIBUTARY CHANNEL TO BE DETERMINED.*

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Lower Issaquah Creek Restoration
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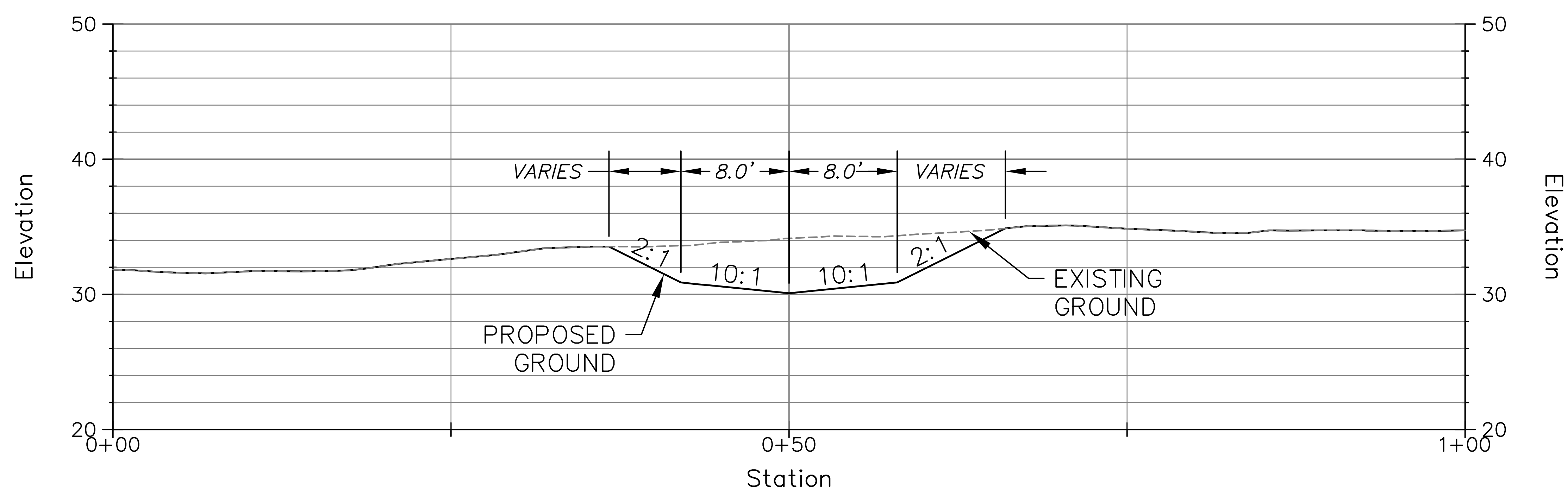
Distributary Channel - Reach 1

Sheet DC-1

PRELIMINARY — NOT FOR CONSTRUCTION

DISTRIBUTARY CHANNEL SECTION A-A



NOTES:
1. *CROSS SECTION LOOKING DOWNSTREAM*
2. *PROFILE ON SHEET DC–1*
3. *EXACT LOCATION OF DISTRIBUTARY CHANNEL TO BE DETERMINED.*

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Lower Issaquah Creek Restoration
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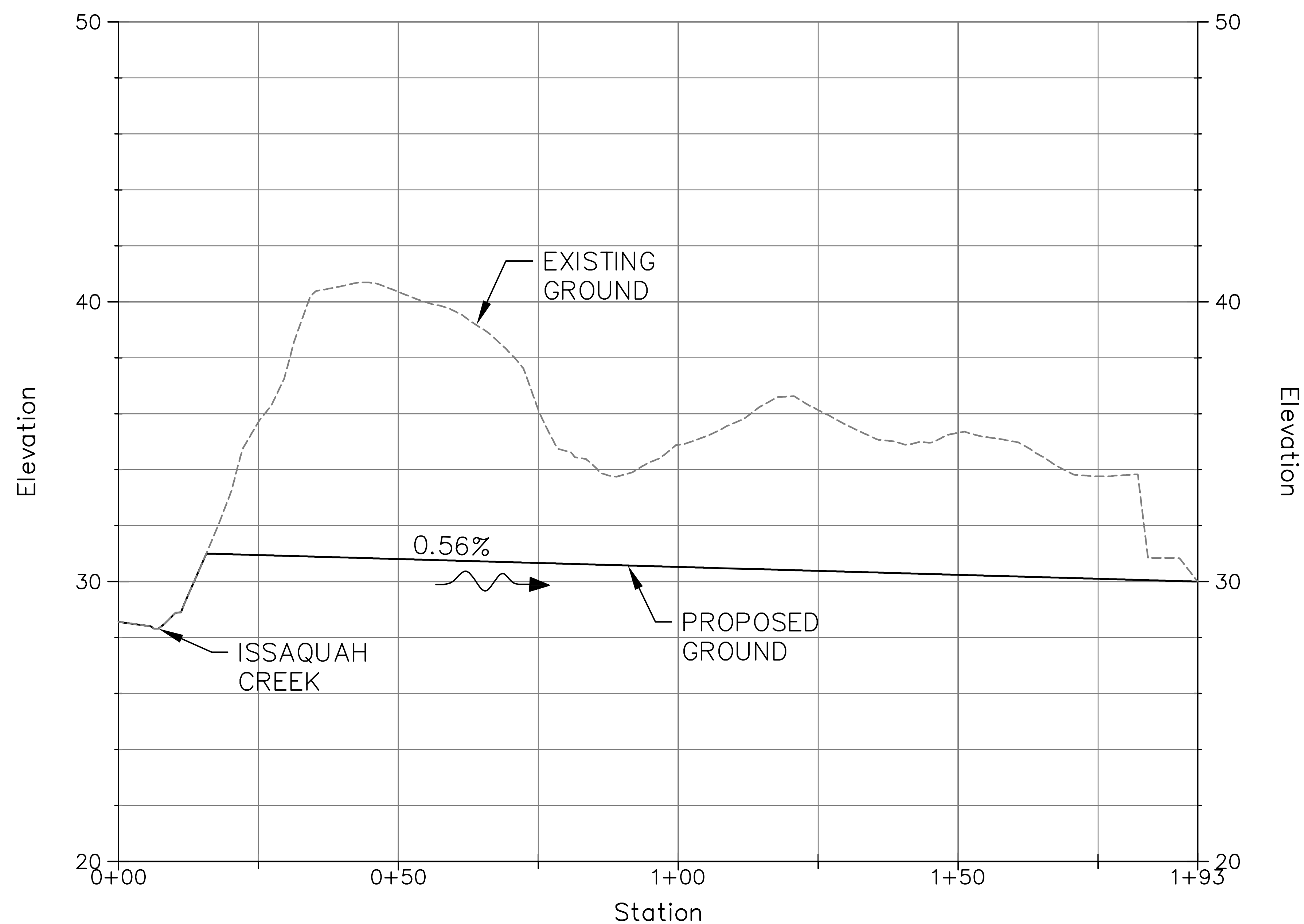
Distributary Channel - Reach 1

Sheet DC-2

PRELIMINARY — NOT FOR CONSTRUCTION

PILOT CHANNEL (REACH 2) PROFILE



NOTES:
1. *5X VERTICAL EXAGGERATION FOR PROFILE*
2. *TYPICAL SECTION DETAIL ON SHEET PCR2–2*
3. *EXACT LOCATION OF PILOT CHANNEL TO BE DETERMINED TO BALANCE WETLAND IMPACTS WITH GRADING EXTENTS.*

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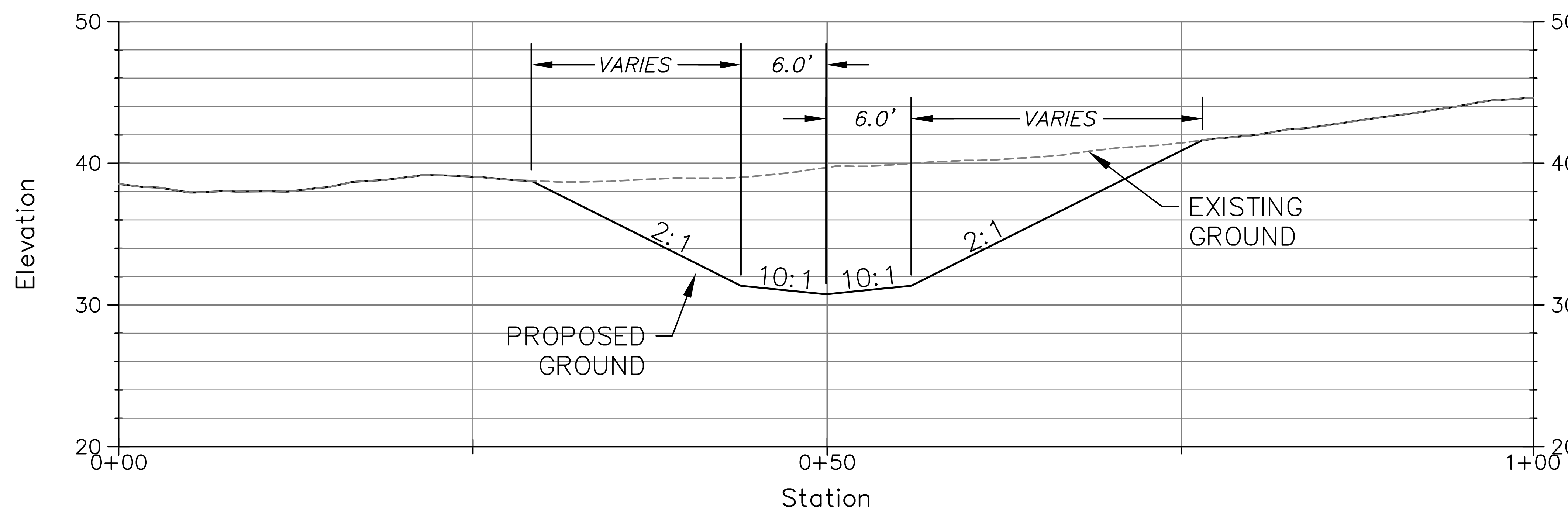
Rev:	
Drft: MWG	Pilot Channel - Reach 2
Chkd:	
Date:18Jun20	Sheet PCR2-1

PRELIMINARY – NOT FOR CONSTRUCTION

PILOT CHANNEL (REACH 2) SECTION B-B



NOTES:
1. *CROSS SECTION LOOKING DOWNSTREAM*
2. *PROFILE ON SHEET PCR2-1*
3. *EXACT LOCATION OF PILOT CHANNEL TO BE DETERMINED TO BALANCE WETLAND IMPACTS WITH GRADING EXTENTS.*

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Lower Issaquah Creek Restoration
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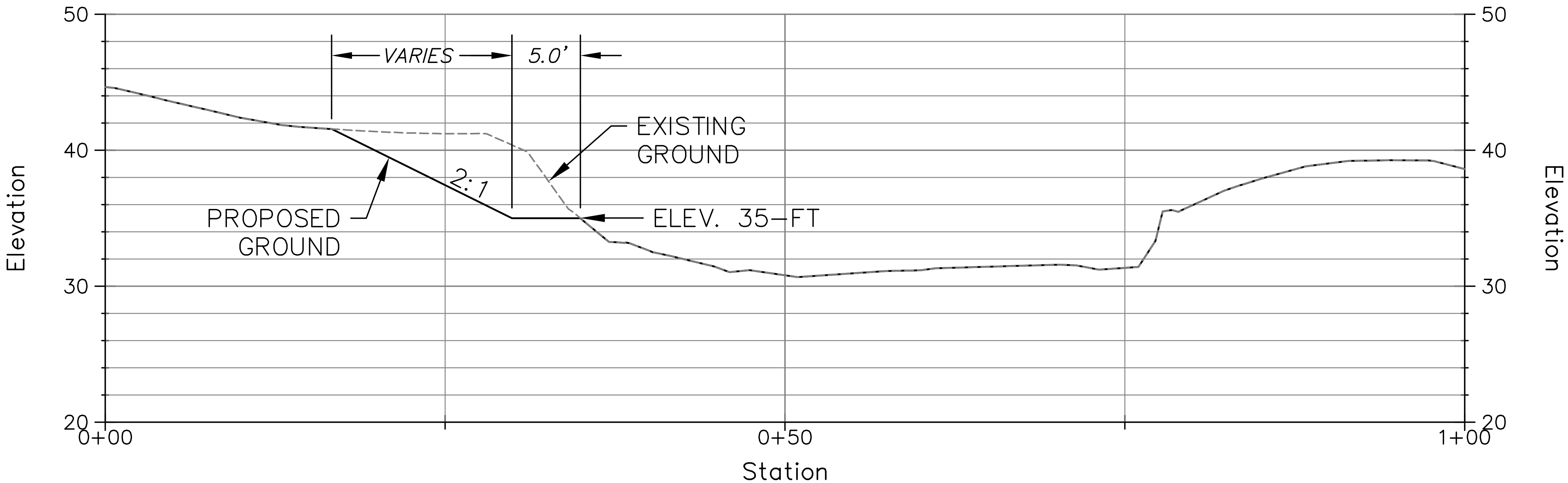
Pilot Channel - Reach 2

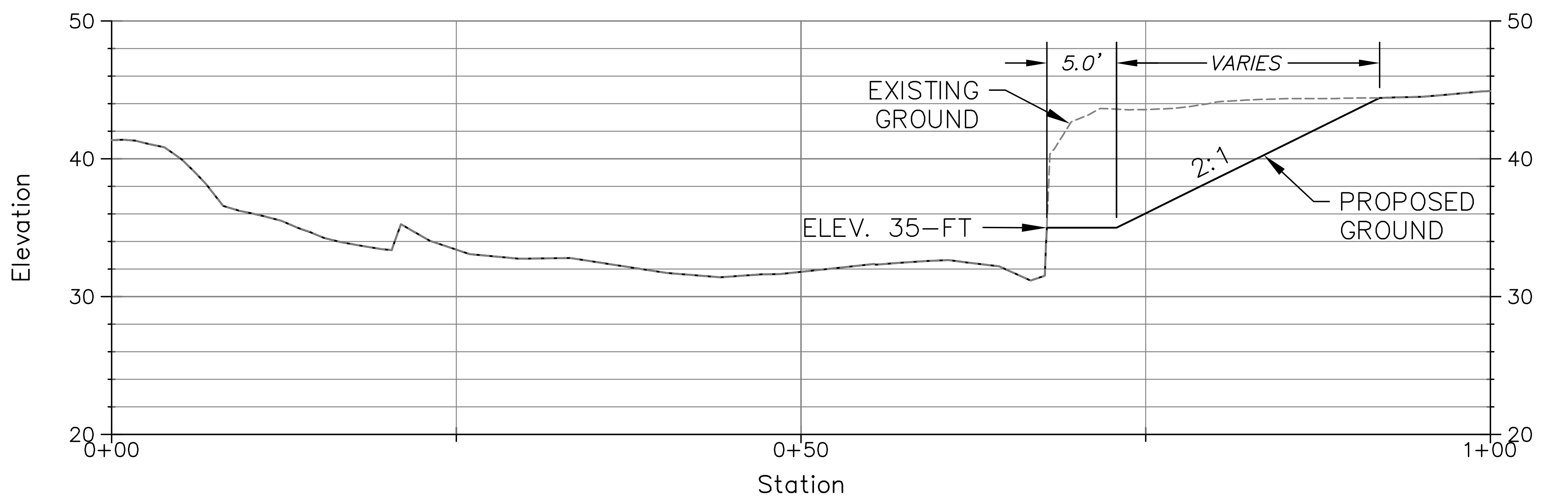
Sheet PCR2-2

PRELIMINARY – NOT FOR CONSTRUCTION

BANK SCRAPE SECTION C-C



BANK SCRAPE SECTION D-D



NOTES:

1. *CROSS SECTIONS LOOKING DOWNSTREAM*
2. *EXACT DIMENSIONS OF BANK SCRAPE LOCATIONS TO BE DETERMINED TO MINIMIZE BANK EXCAVATION.*

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Lower Issaquah Creek Restoration
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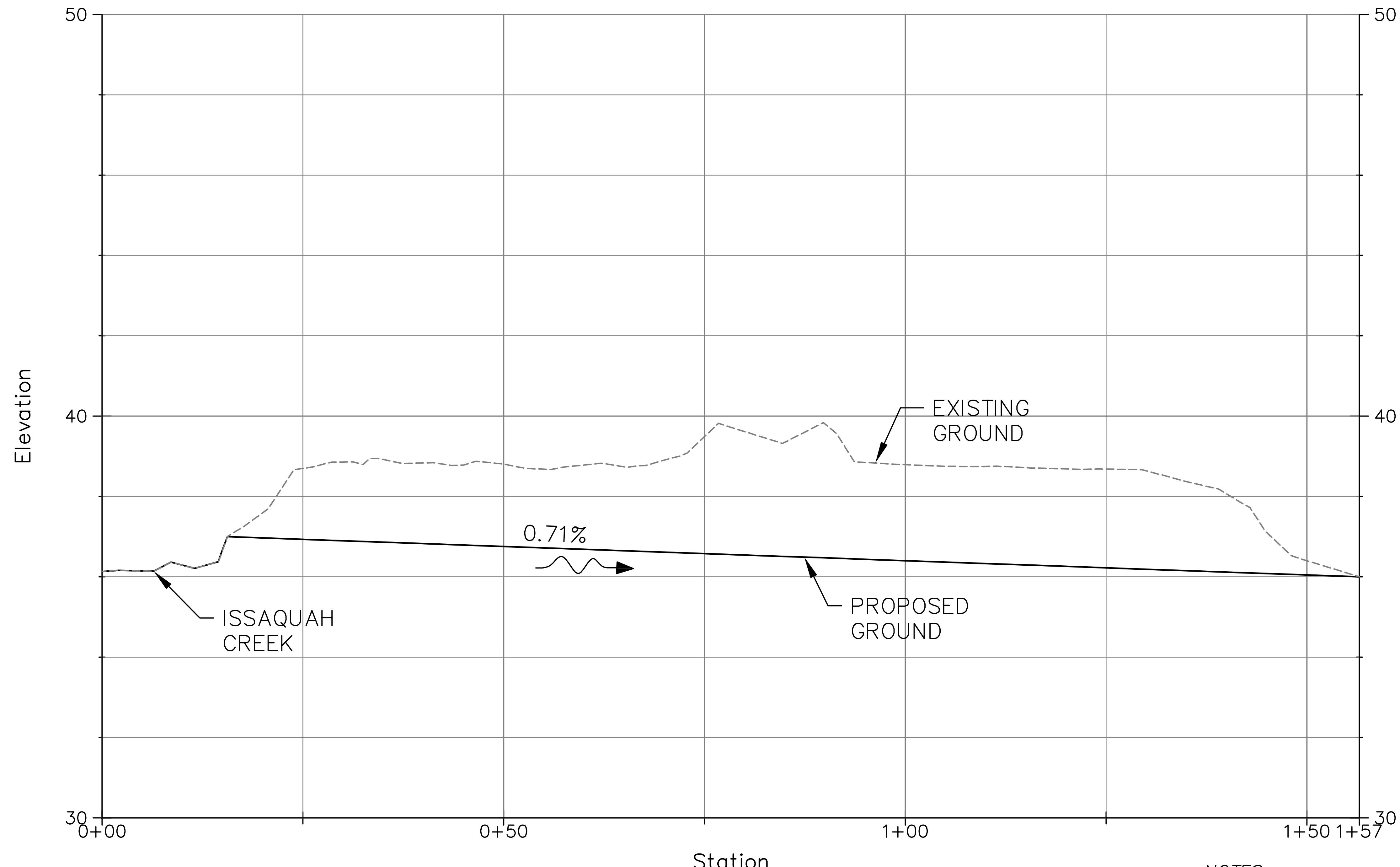
Bank Scrapes - Reach 3

Sheet BS-1

PILOT CHANNEL (REACH 4) PROFILE

PRELIMINARY – NOT FOR CONSTRUCTION



NOTES:
1. 5X VERTICAL EXAGGERATION FOR PROFILE
2. TYPICAL SECTION DETAIL ON SHEET PCR4–2

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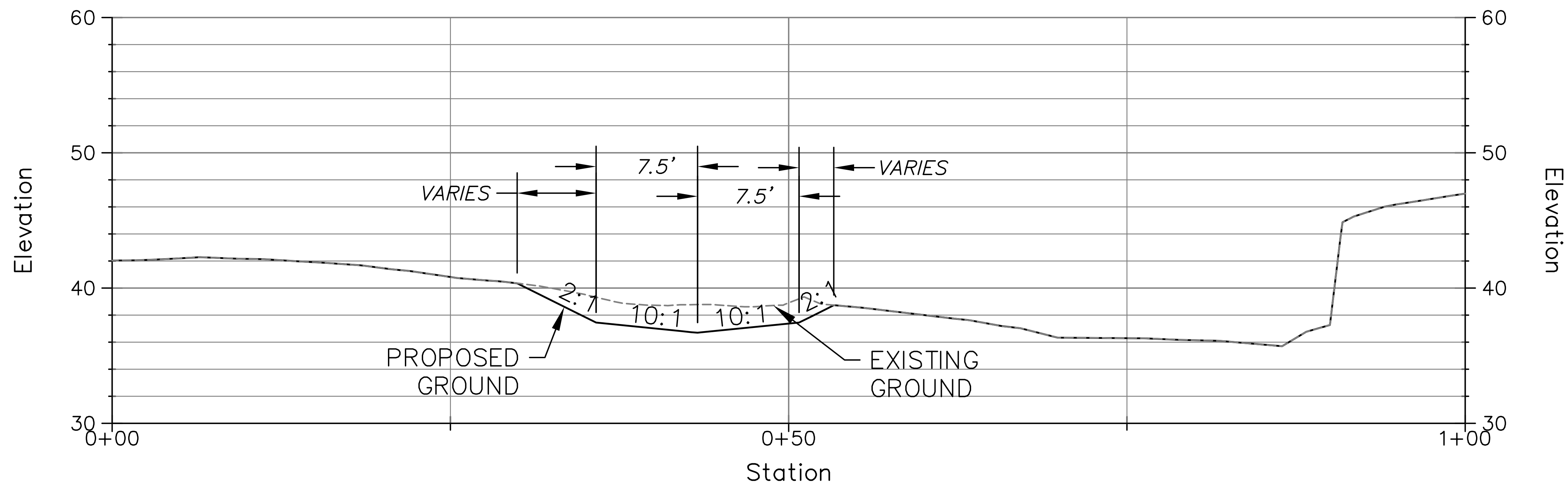
Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Pilot Channel - Reach 4

Sheet PCR4-1

PRELIMINARY – NOT FOR CONSTRUCTION

PILOT CHANNEL (REACH 4) SECTION E-E



NOTES:
1. *CROSS SECTION LOOKING DOWNSTREAM*
2. *PROFILE ON SHEET PCR4–1*

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at Lake Sammamish State Park

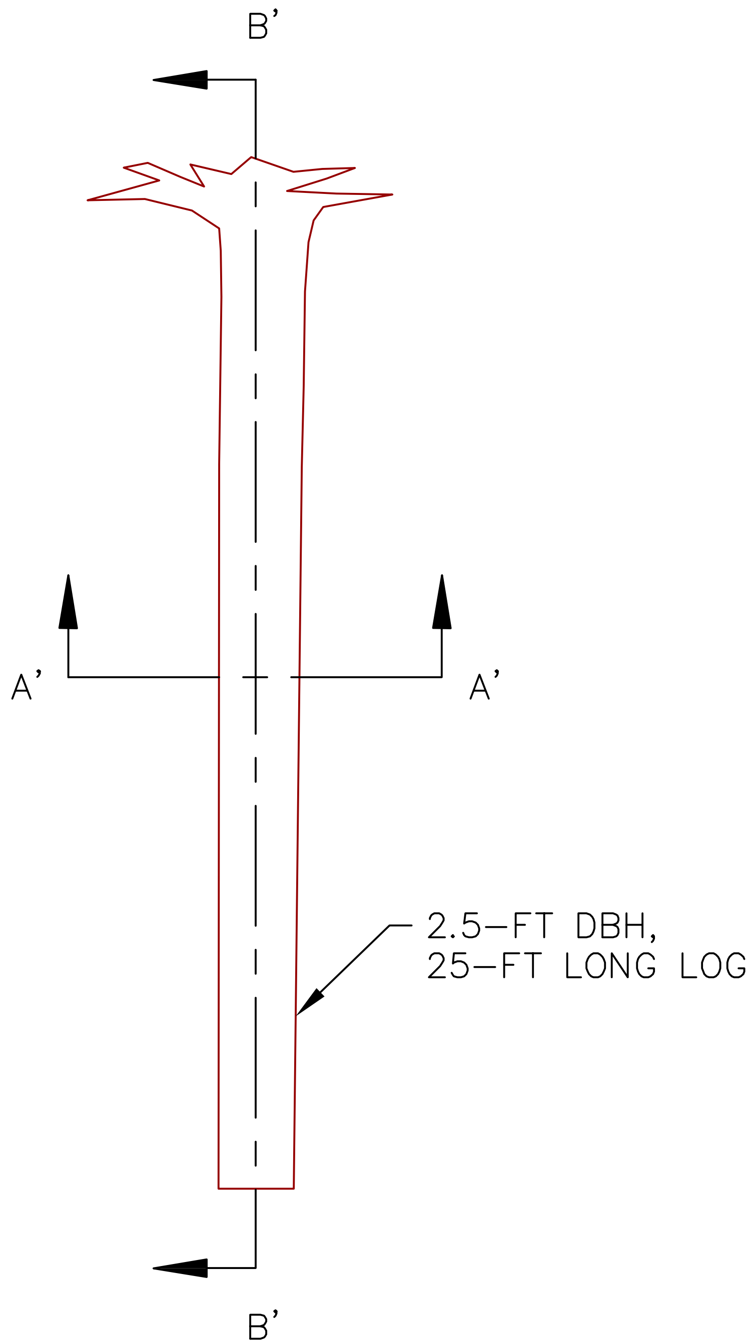
Pilot Channel - Reach 4

Sheet PCR4-2

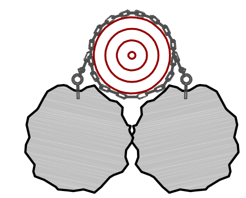
PRELIMINARY – NOT FOR CONSTRUCTION

NOTES:

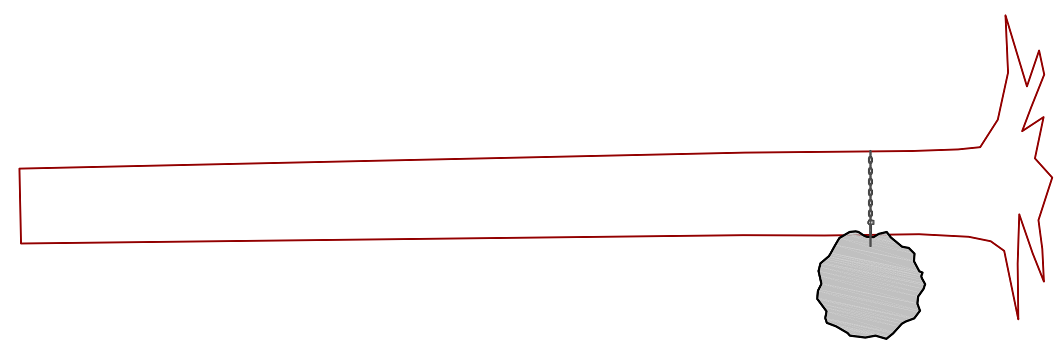
1. *LWM STRUCTURES ARE FOR ILLUSTRATION PURPOSES ONLY. EXACT LOCATION AND ORIENTATION OF LWM STRUCTURES TO BE DETERMINED ON SITE BY THE ENGINEER.*
2. *ANCHORING TO BE DETERMINED AT LATER STAGES OF DESIGN.*



PLAN VIEW



SECTION A'–A'



SECTION B'–B'

MOUNTAINS to Sound GREENWAY

WASHINGTON STATE PARKS

nhc
northwest hydraulic consultants
711 capitol way south, suite 607
olympia, washington 98501
phone: (360) 584–9810

Job: 2003907	
Rev:	
Drft: MWG	
Chkd:	
Date: 18Jun20	

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Single Piece - Type 1

Sheet LWM-1

PRELIMINARY – NOT FOR CONSTRUCTION

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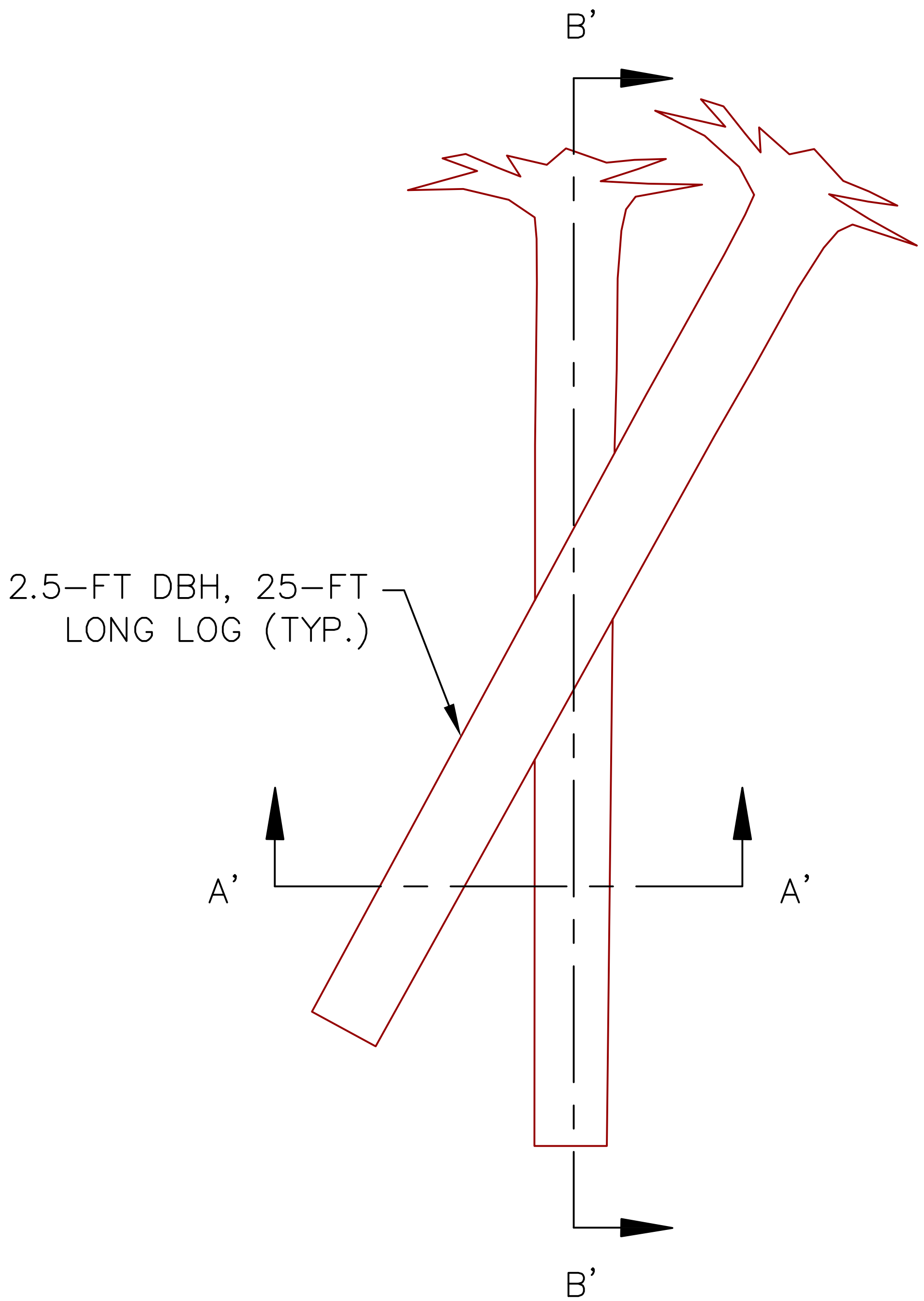

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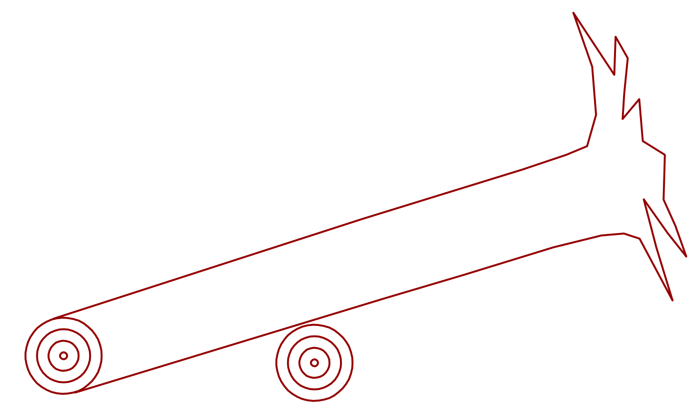

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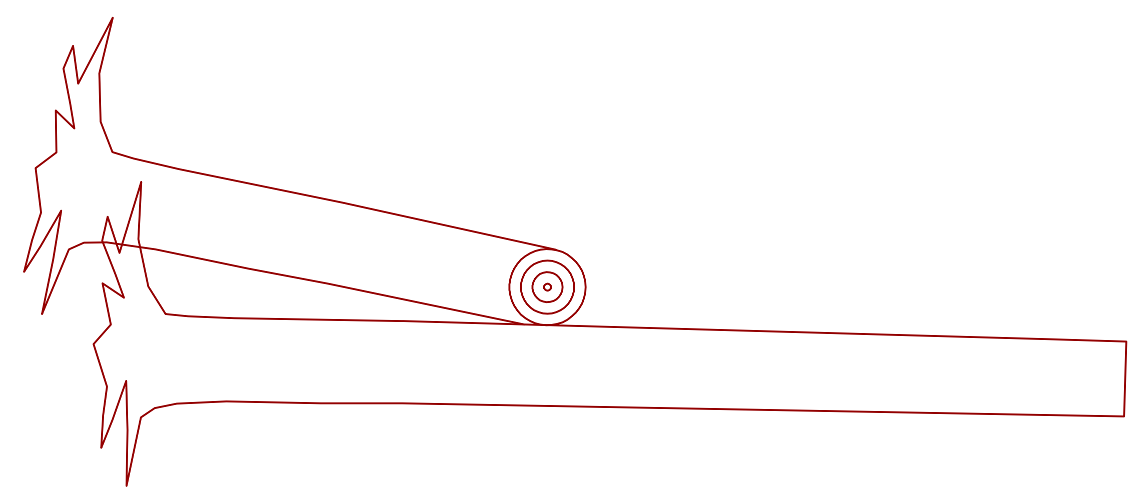

SECTION B'–B'

northwest hydraulic consultants
711 capitol way south, suite 607
olympia, washington 98501
phone: (360) 584–9810

Job: 2003907	
Rev:	
Drft: MWG	
Chkd:	
Date: 18Jun20	

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Single Pieces - Type 2

Sheet LWM-2

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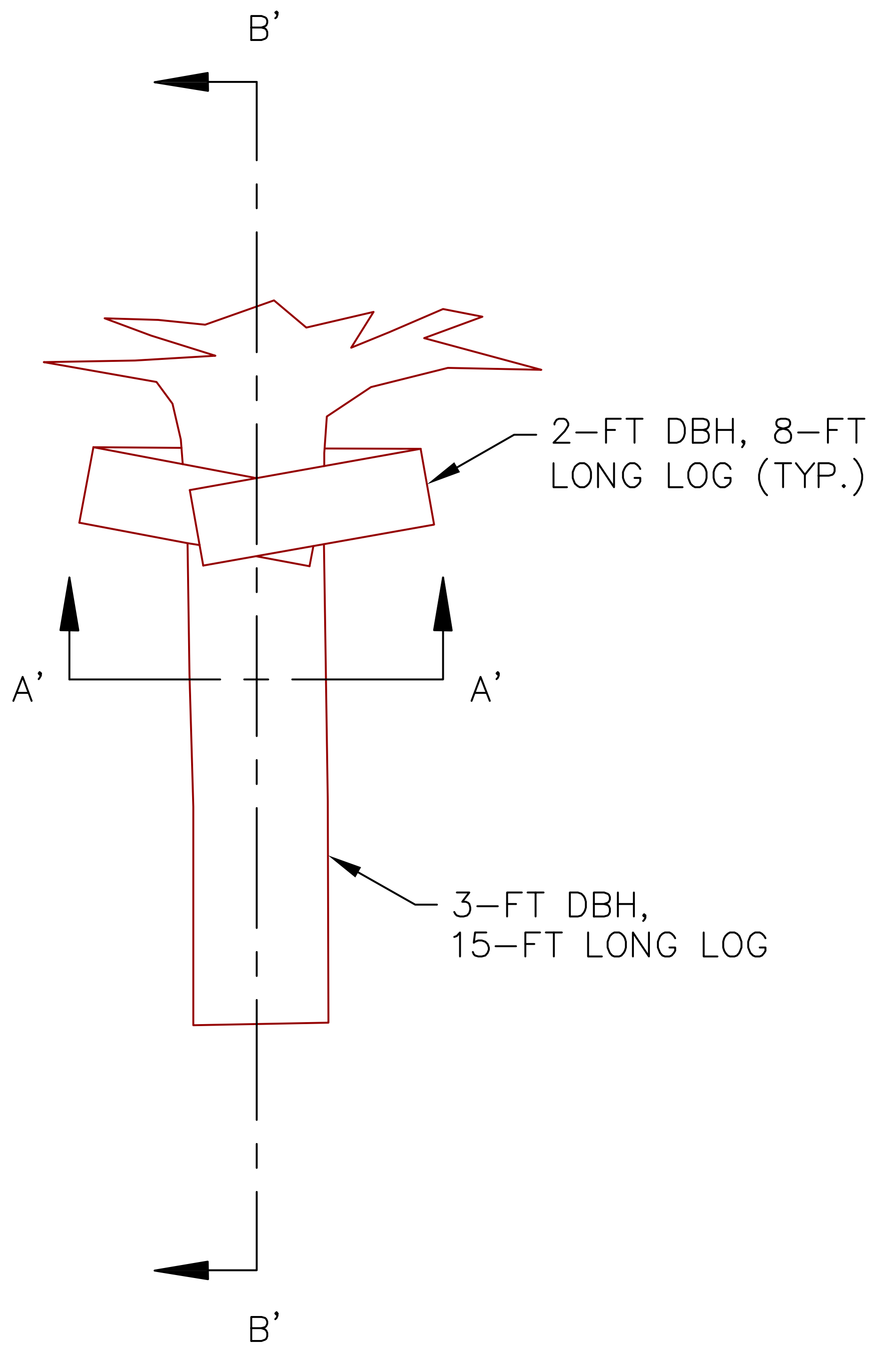

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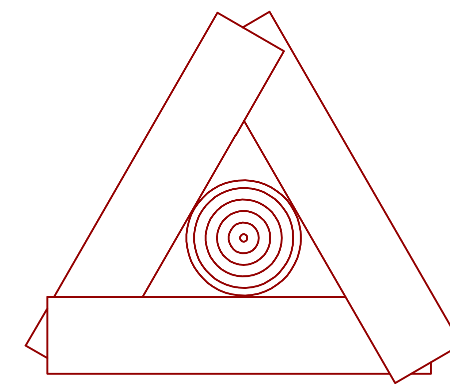

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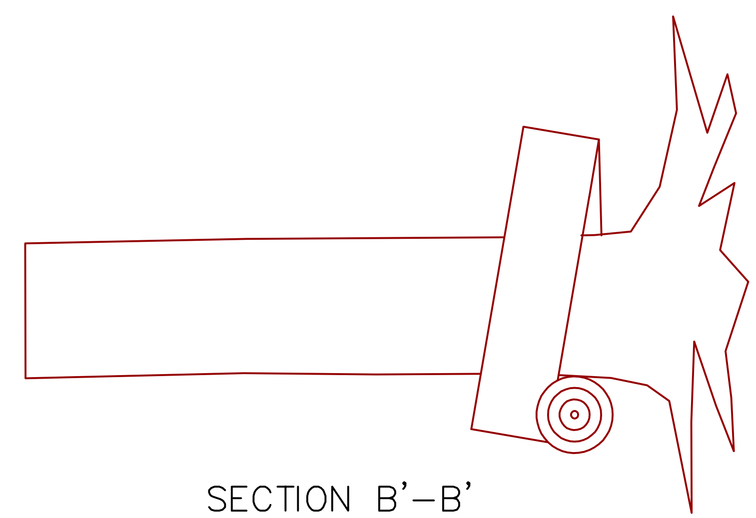

SECTION B'–B'

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olympia, washington 98501
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Chkd:
Date:18Jun20

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Log Jack

Sheet LWM-3

PRELIMINARY – NOT FOR CONSTRUCTION

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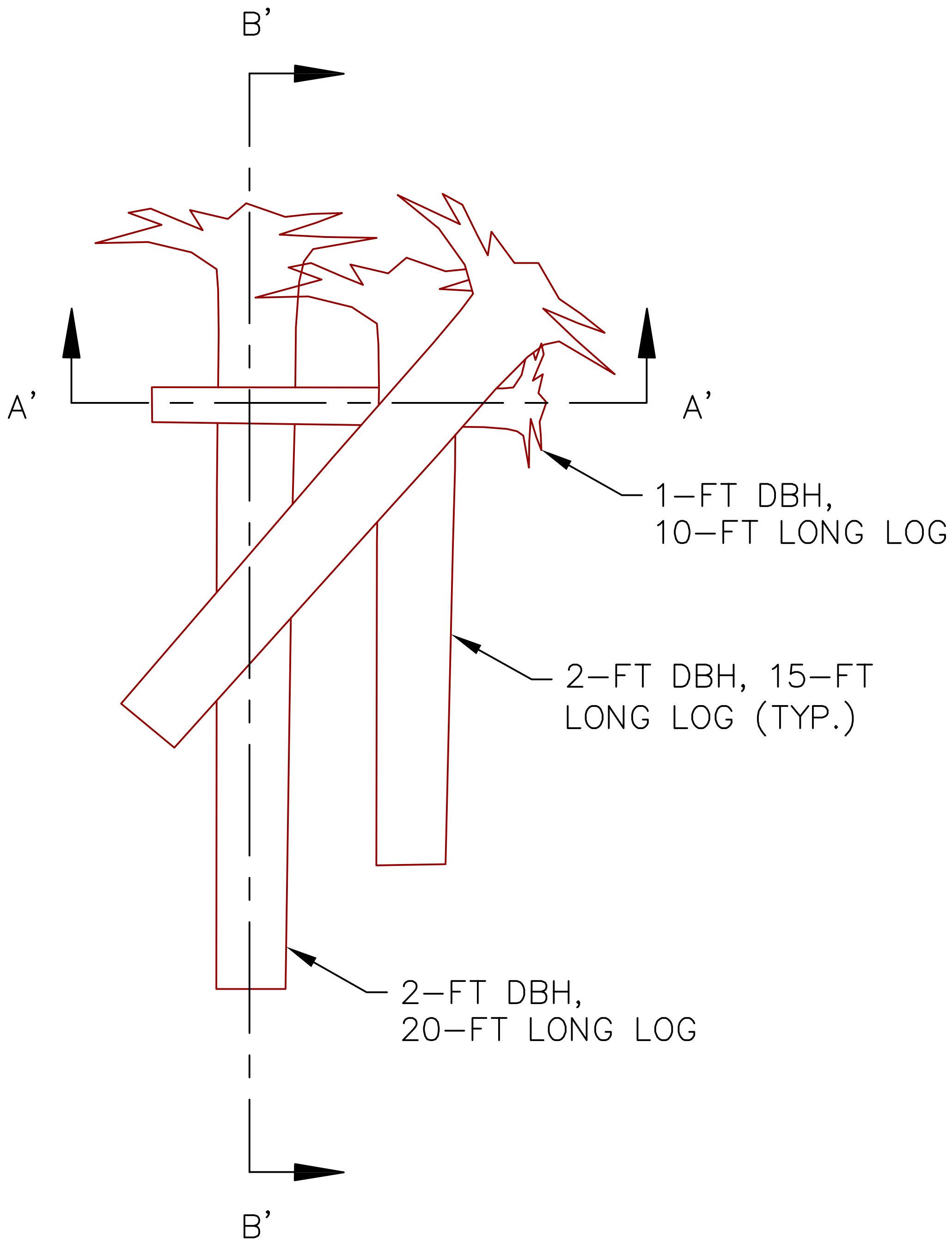

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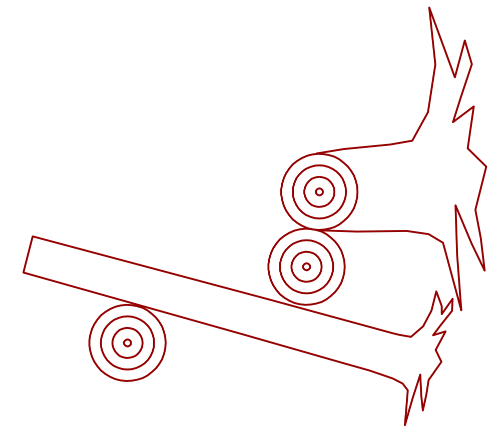

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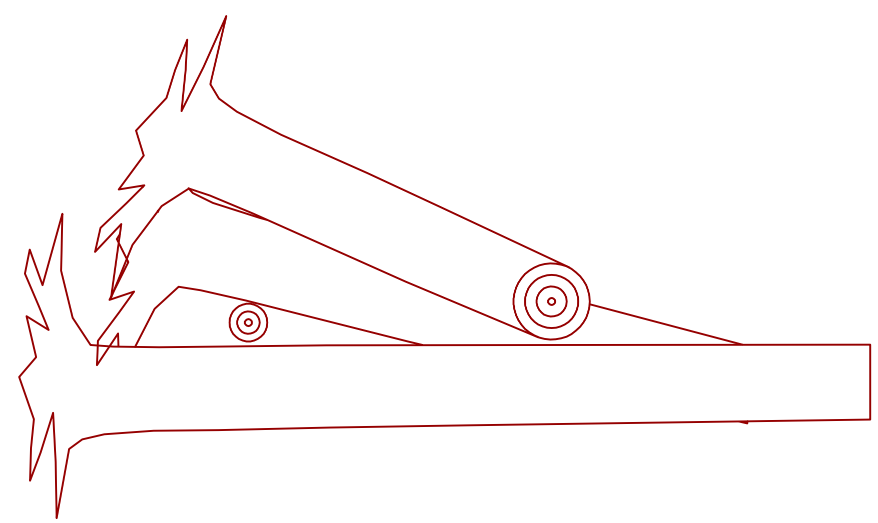

SECTION B'–B'

MOUNTAINS to Sound GREENWAY

WASHINGTON STATE PARKS

nhc
northwest hydraulic consultants
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Job:2003907	
Rev:	
Drft: MWG	
Chkd:	
Date:18Jun20	

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Small Spur Jam

Sheet LWM-4

PRELIMINARY – NOT FOR CONSTRUCTION

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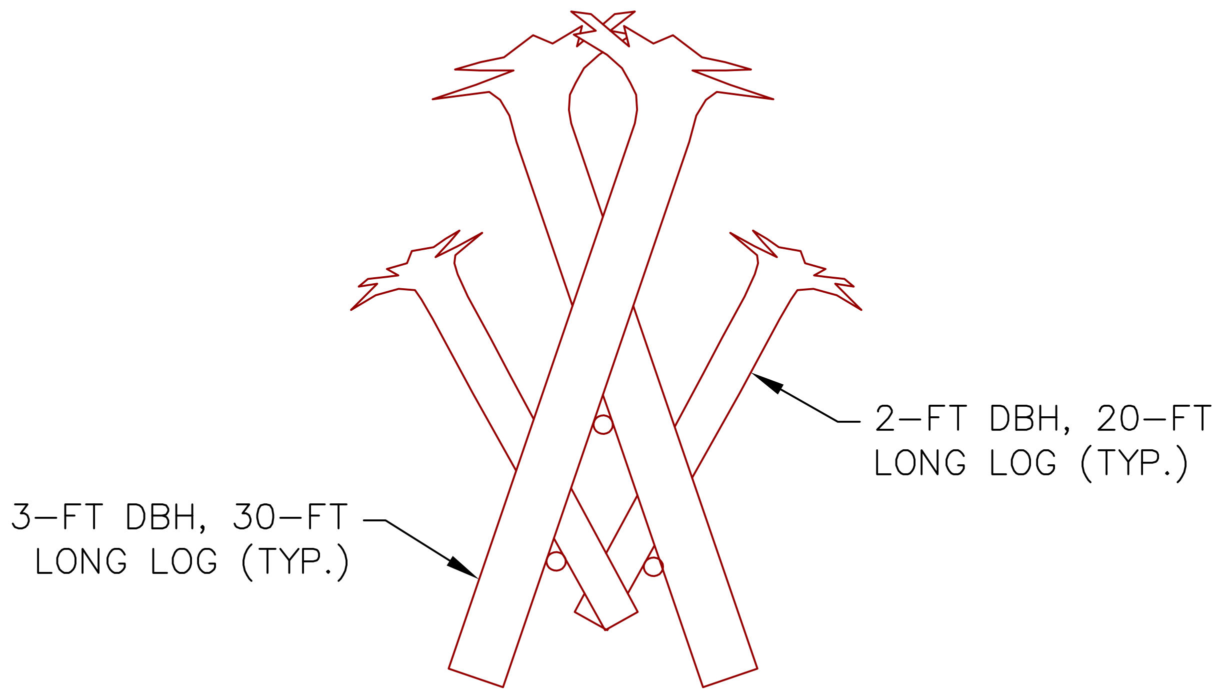
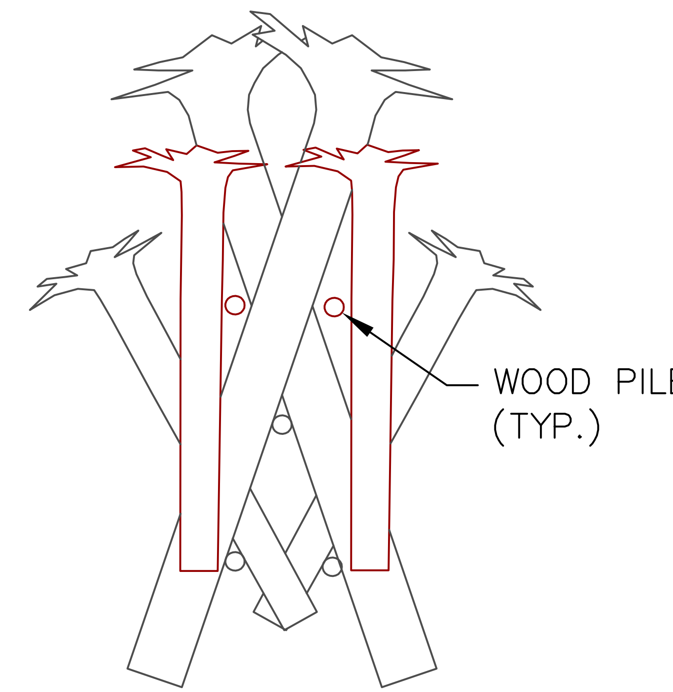


PLAN VIEW,
CONSTRUCTION
LAYER 1



PLAN VIEW,
CONSTRUCTION
LAYER 2

MOUNTAINS to Sound GREENWAY

WASHINGTON STATE PARKS

nhc
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711 capitol way south, suite 607
olympia, washington 98501
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Job: 2003907	
Rev:	
Drft: MWG	
Chkd:	
Date: 19Jun20	

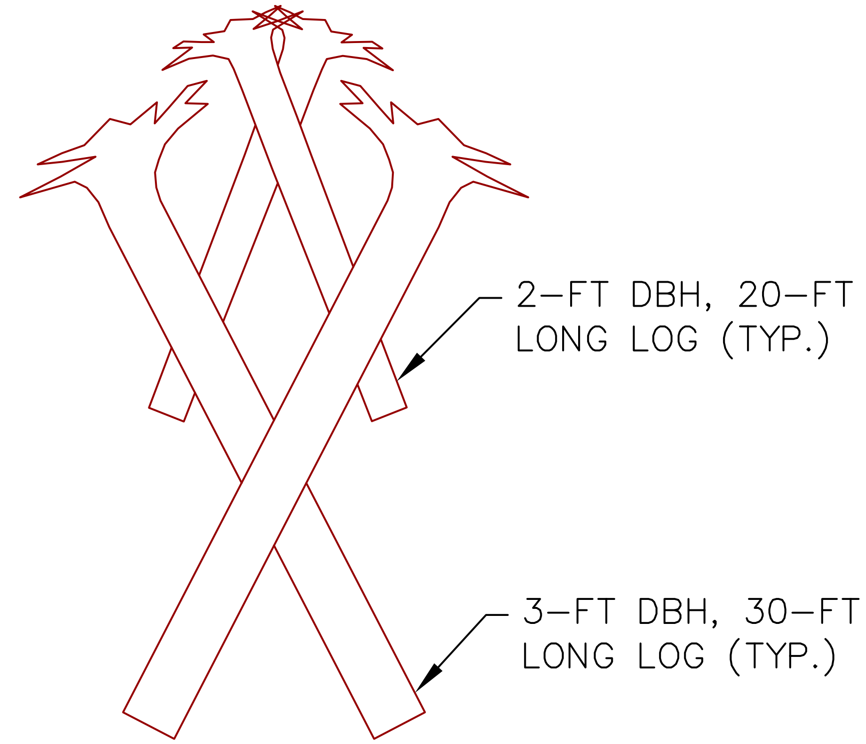
Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Large Spur Jam

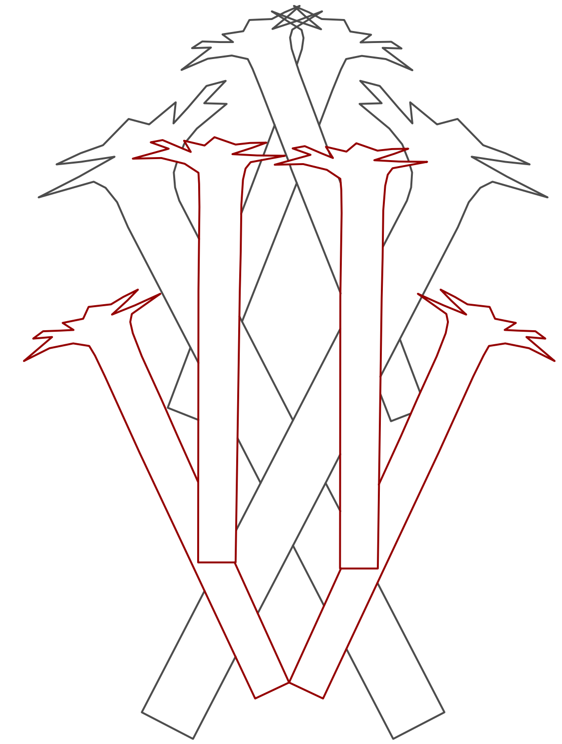
Sheet LWM-5

PRELIMINARY –
NOT FOR CONSTRUCTION

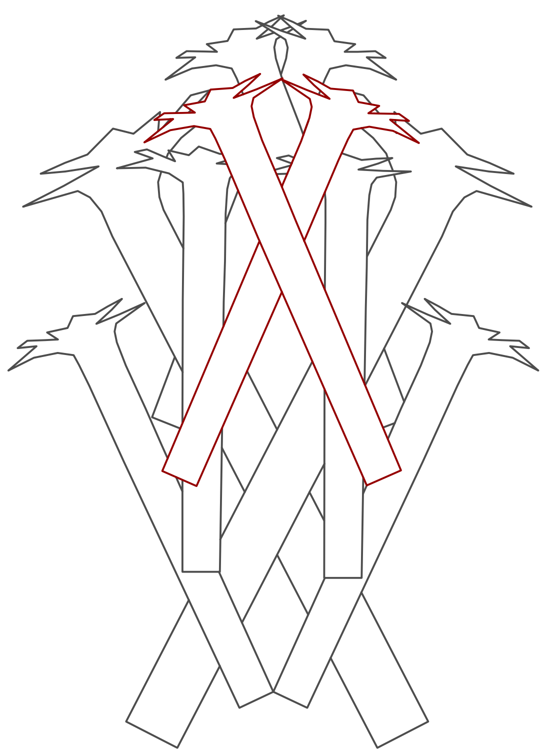
PLAN VIEW,
CONSTRUCTION
LAYER 1



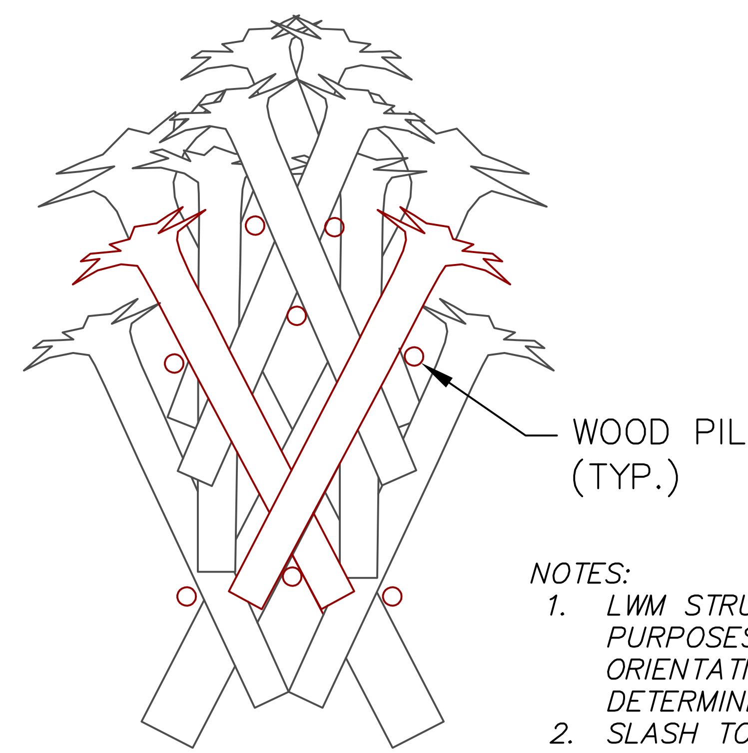
PLAN VIEW,
CONSTRUCTION
LAYER 2



PLAN VIEW,
CONSTRUCTION
LAYER 3



PLAN VIEW,
CONSTRUCTION
LAYER 4



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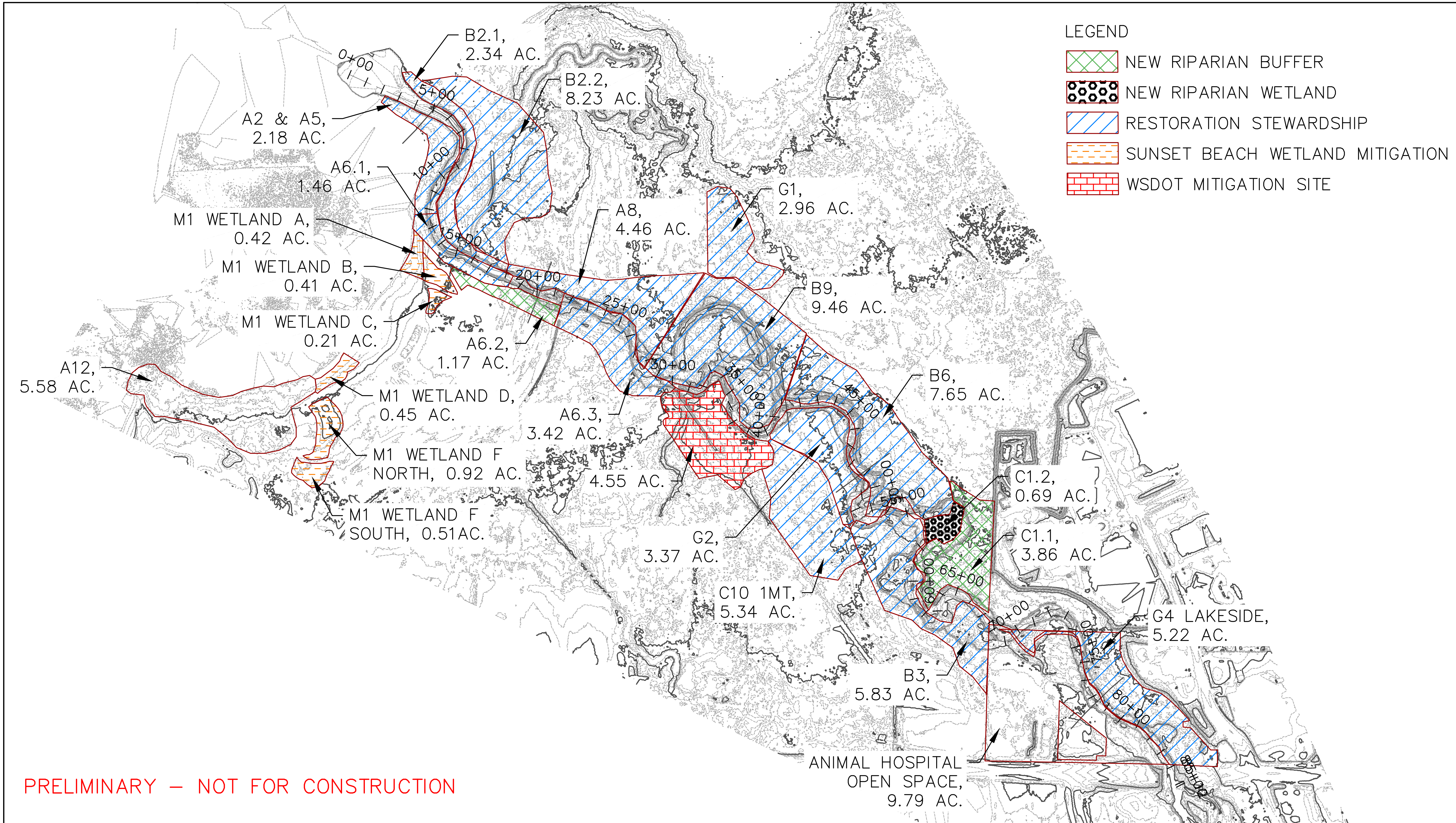
Rev:
Drft: MWG
Chkd:
Date:19Jun20

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Apex Jam

Sheet LWM-6



PRELIMINARY – NOT FOR CONSTRUCTION

MOUNTAINS to Sound GREENWAY

WASHINGTON STATE PARKS

nhc
northwest hydraulic consultants
711 capitol way south, suite 607
olympia, washington 98501
phone: (360) 584–9810

N

0 500 1000 Feet

Job:2003907
Rev:
Drft: MWG
Chkd:
Date:18Jun20

Lower Issaquah Creek Restoration
at Lake Sammamish State Park

Restoration Plan

Sheet RP-1

APPENDIX G: HYDRAULIC ANALYSIS RESULTS – EXISTING CONDITIONS

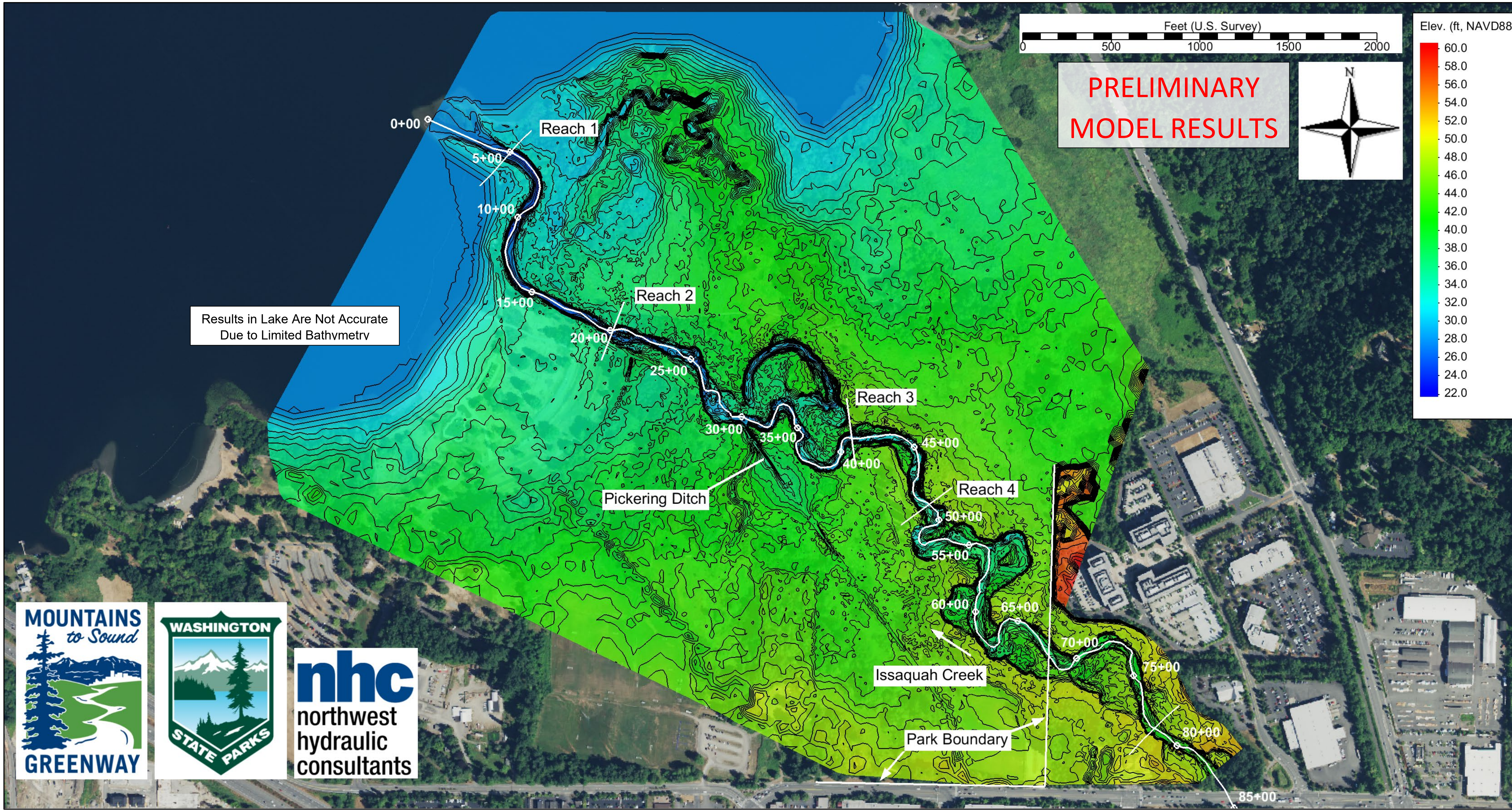


Figure G.1 Lower Issaquah Creek Existing Conditions Model Domain

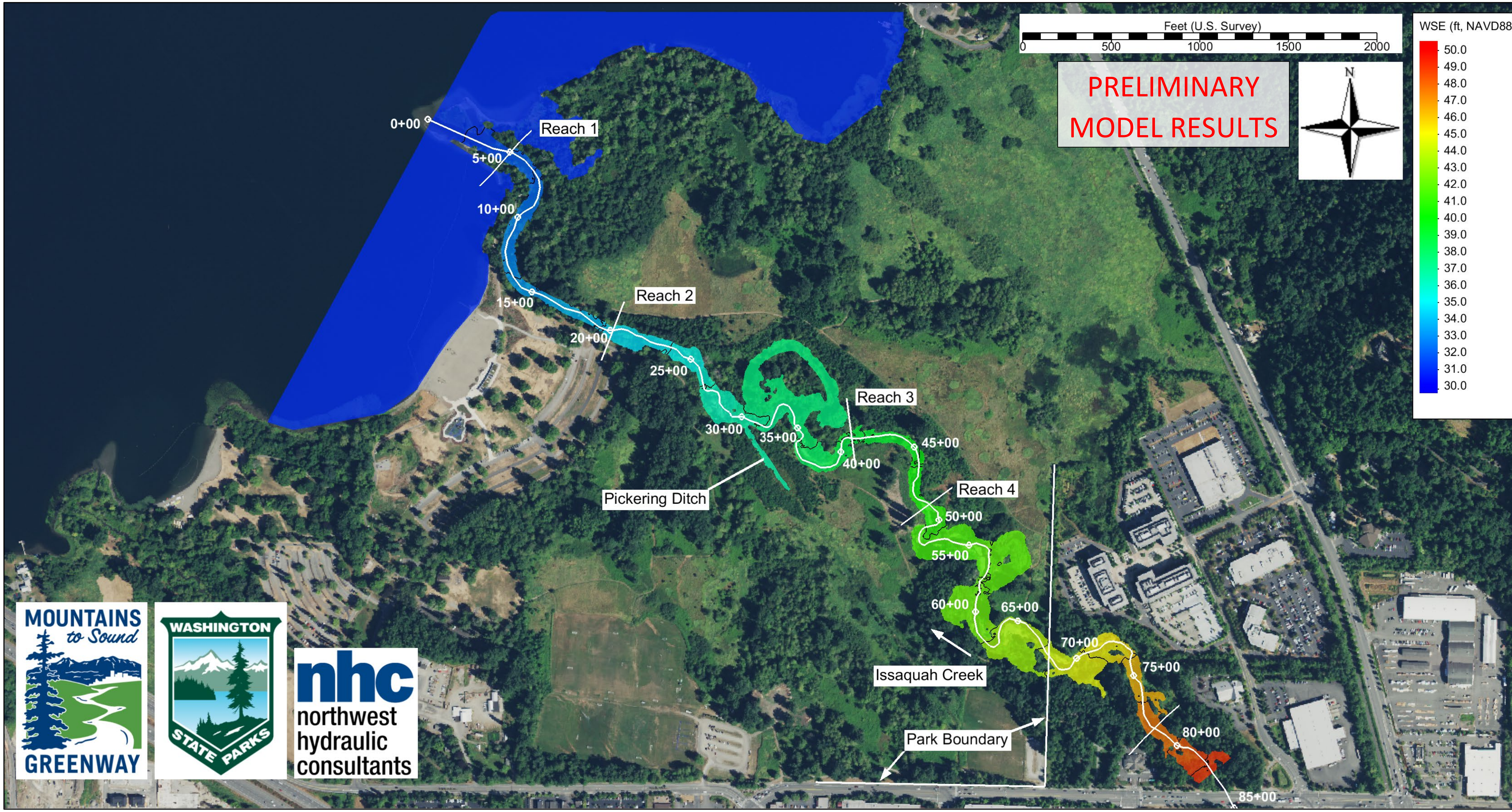


Figure G.2 Lower Issaquah Creek Existing Conditions 2-Year Water Surface Elevation (WSE)

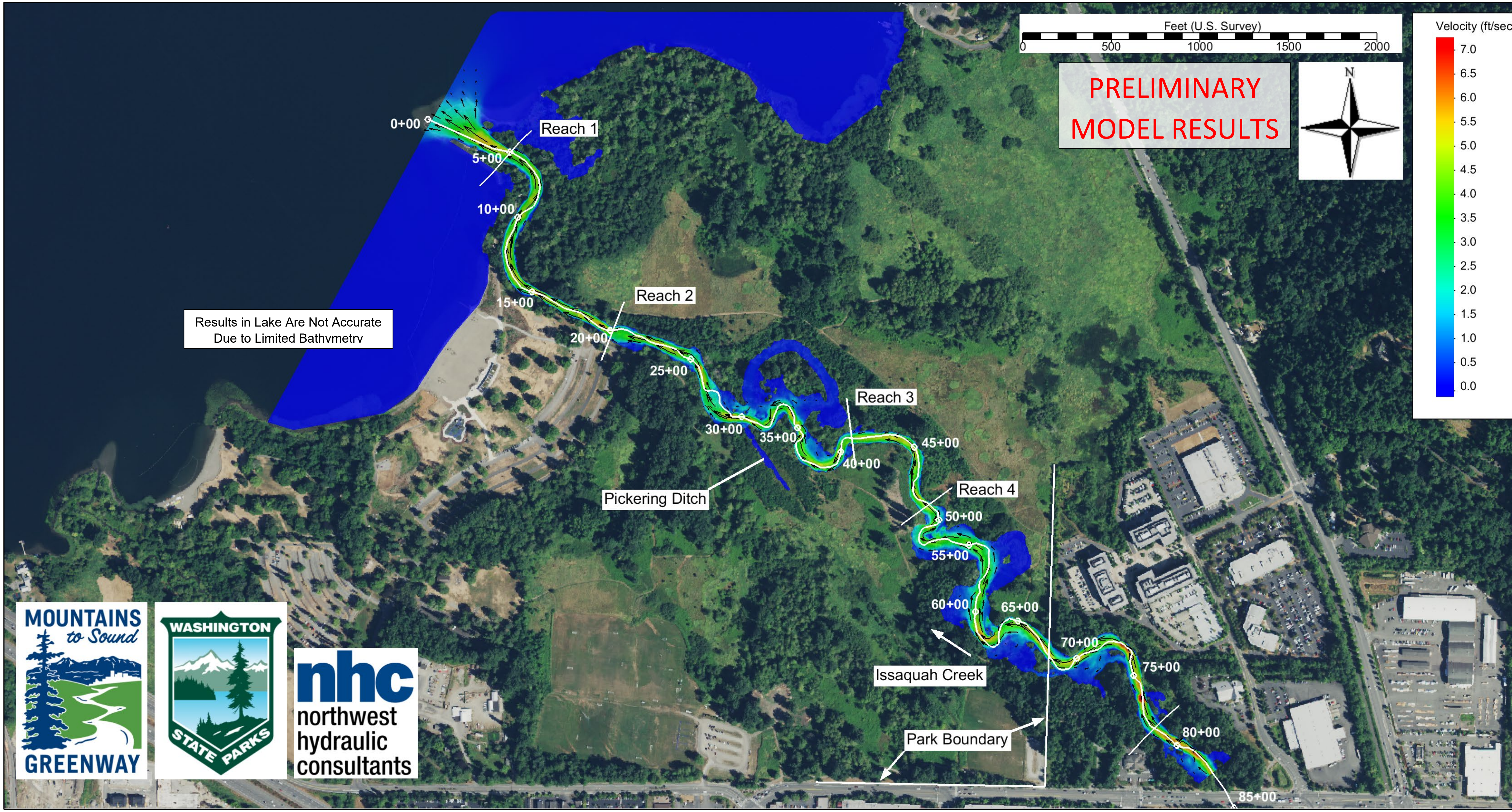


Figure G.3 Lower Issaquah Creek Existing Conditions 2-Year Velocity

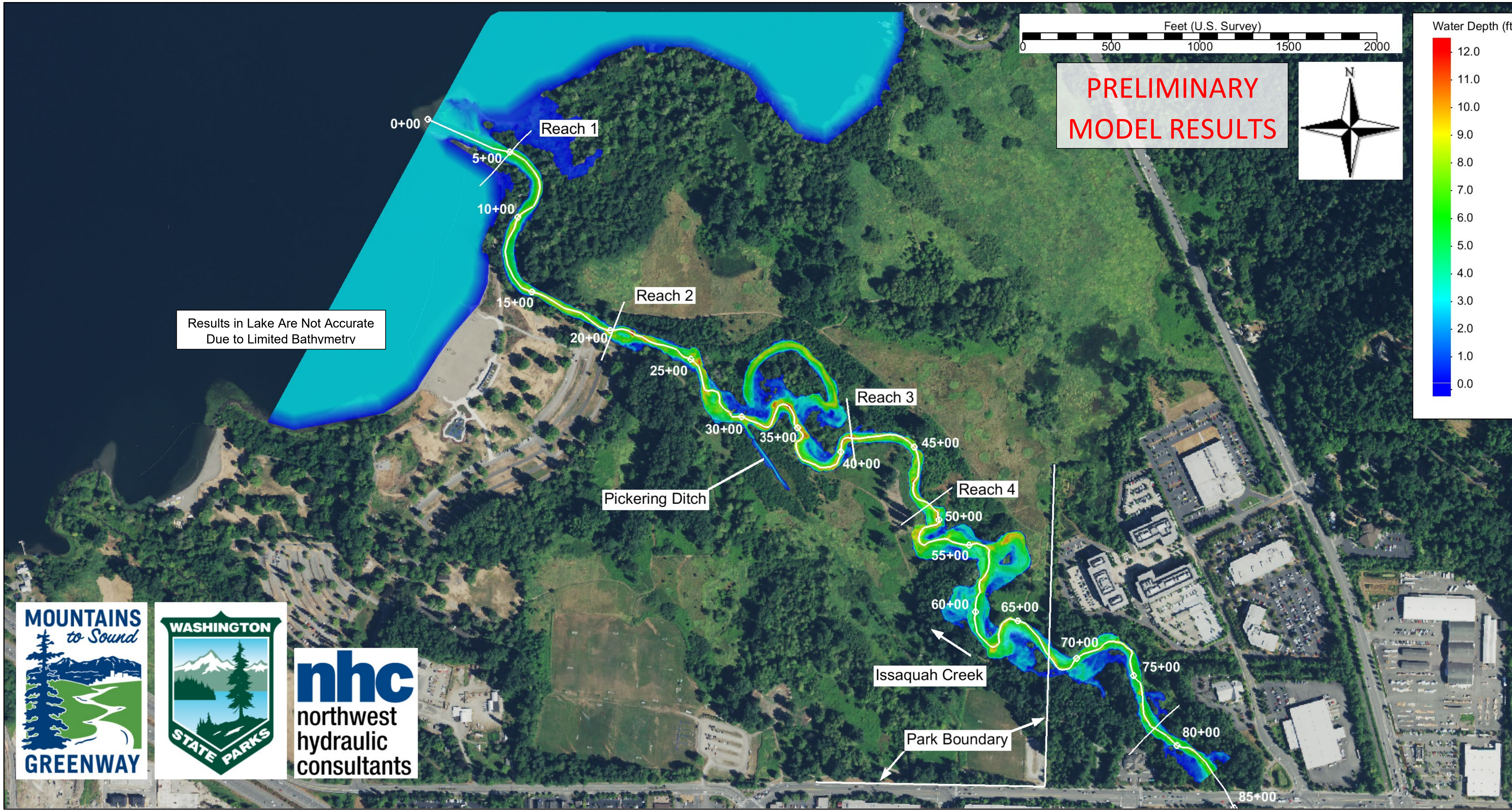


Figure G.4 Lower Issaquah Creek Existing Conditions 2-Year Water Depth

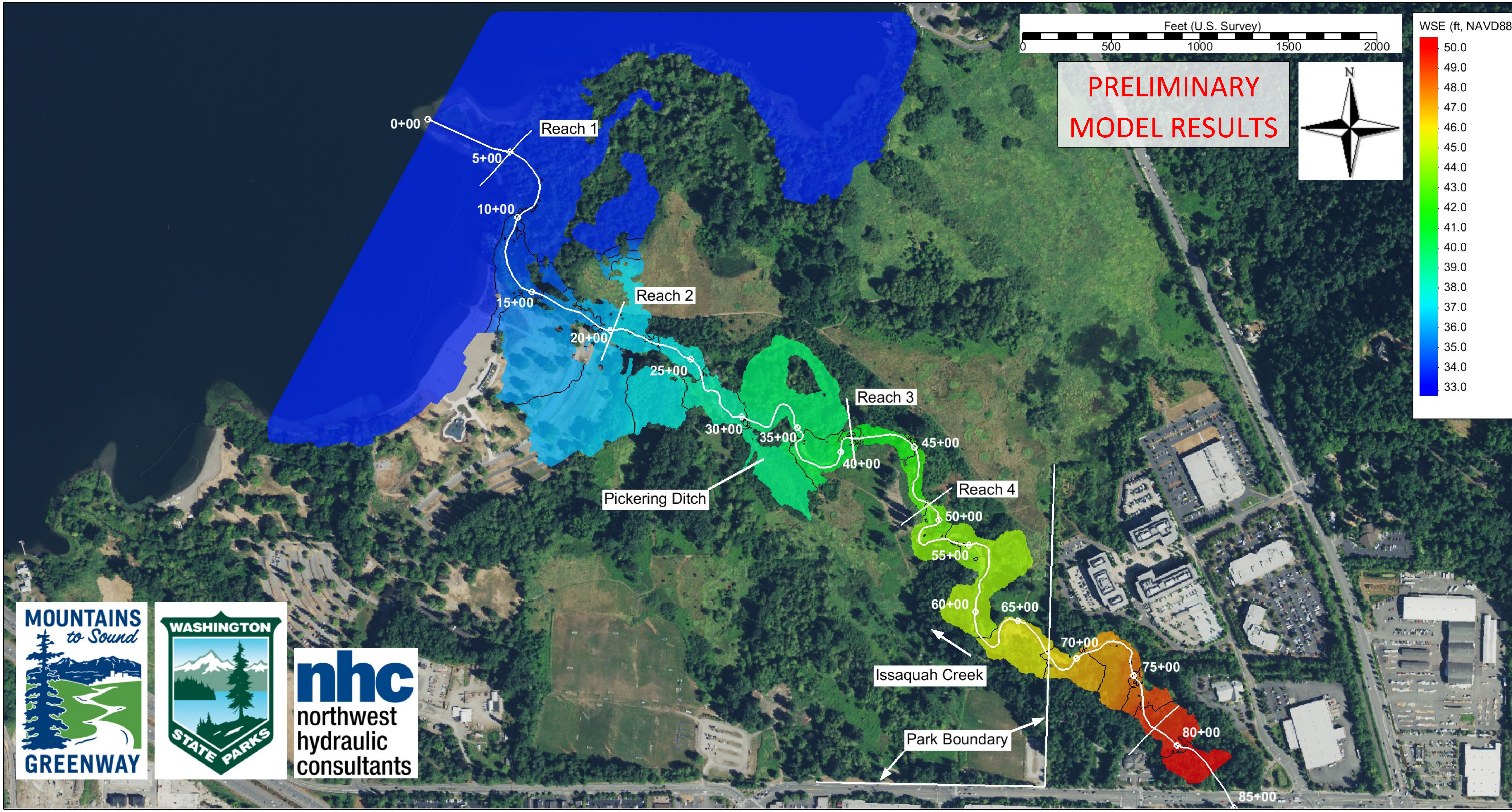


Figure G.5 Lower Issaquah Creek Existing Conditions February 6, 2020 Flood Event Water Surface Elevation (WSE)

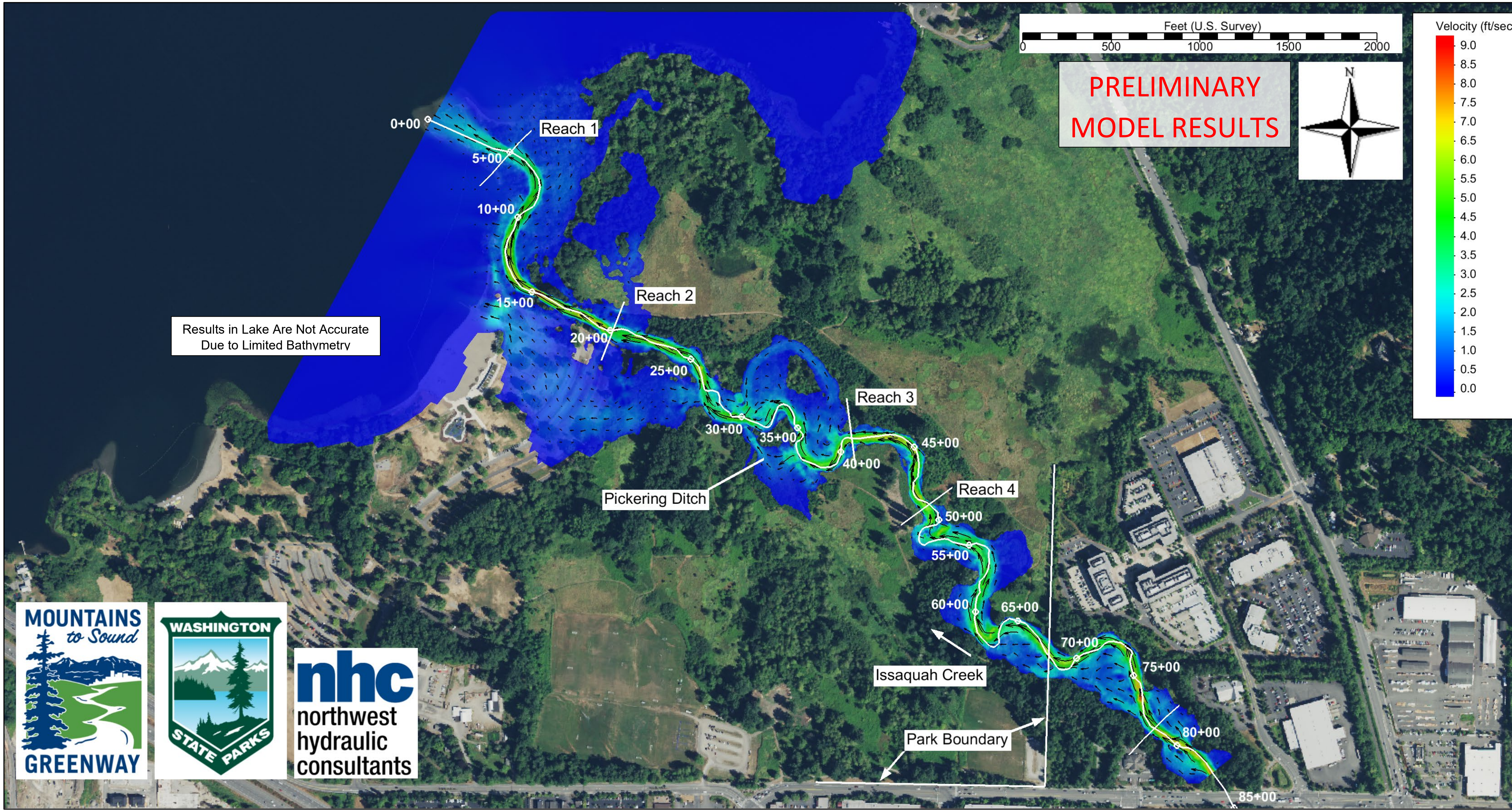


Figure G.6 Lower Issaquah Creek Existing Conditions February 6, 2020 Flood Event Velocity

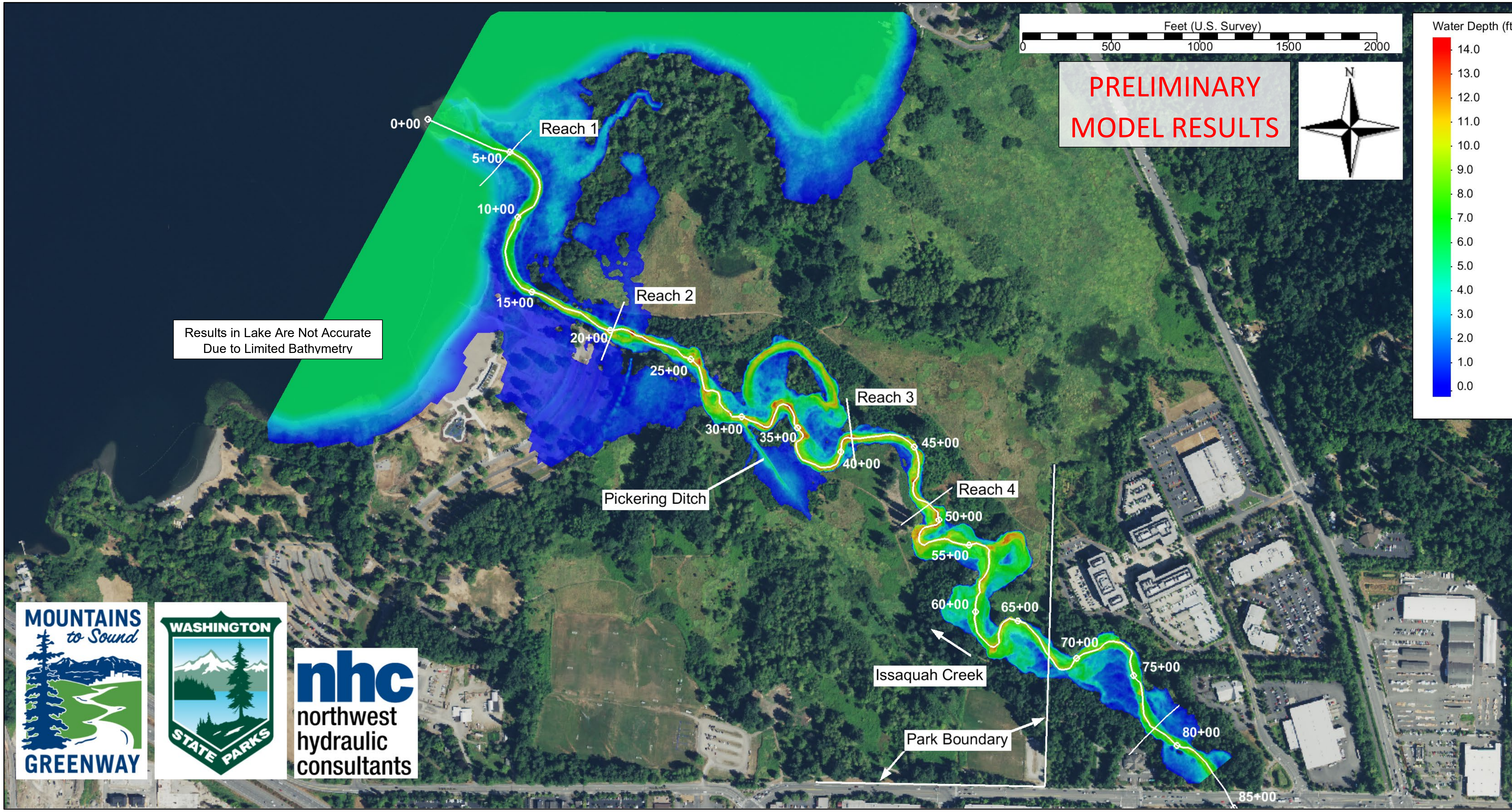


Figure G.7 Lower Issaquah Creek Existing Conditions February 6, 2020 Flood Event Water Depth

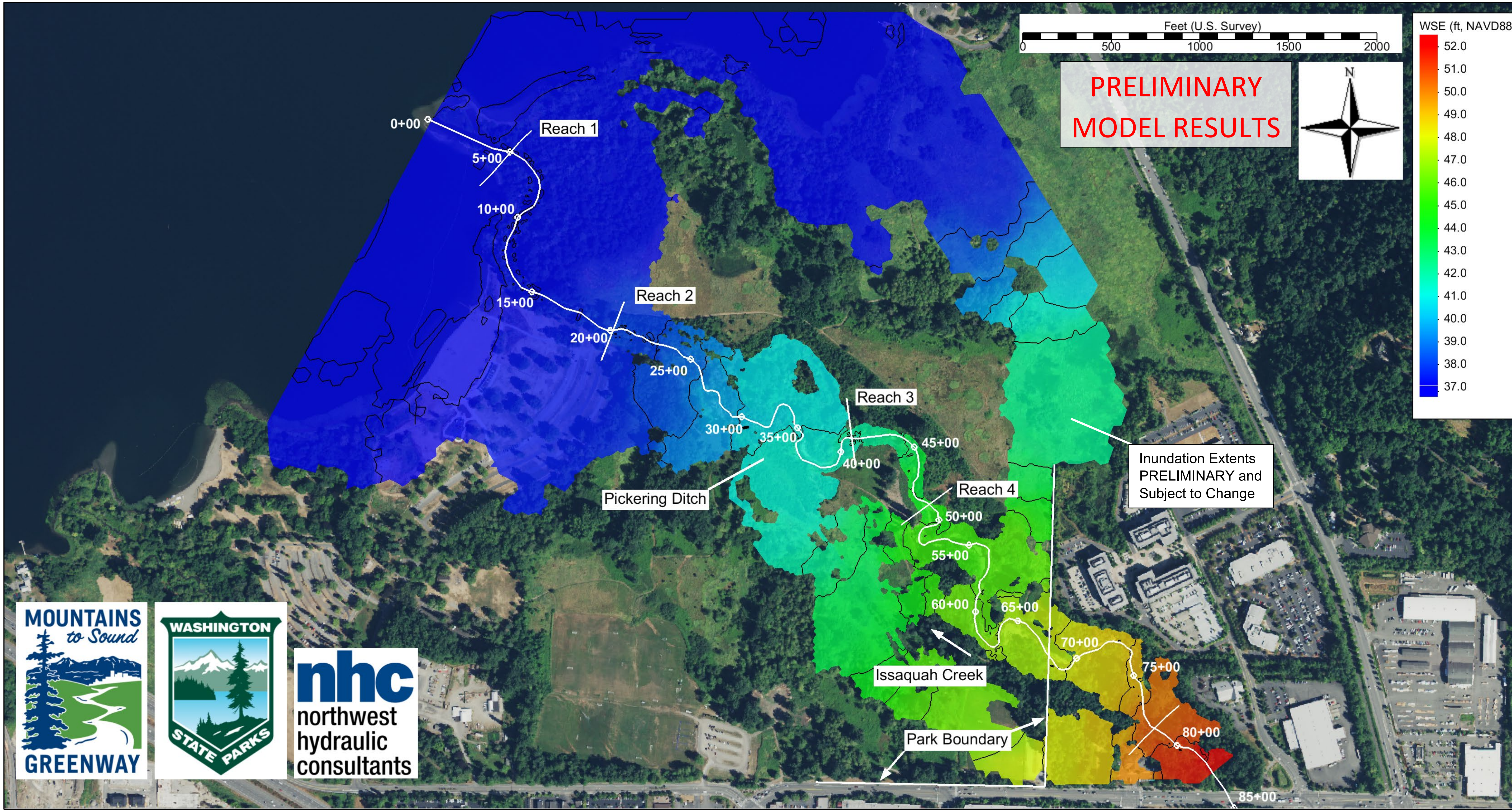


Figure G.8 Lower Issaquah Creek Existing Conditions 100-Year Water Surface Elevation (WSE)

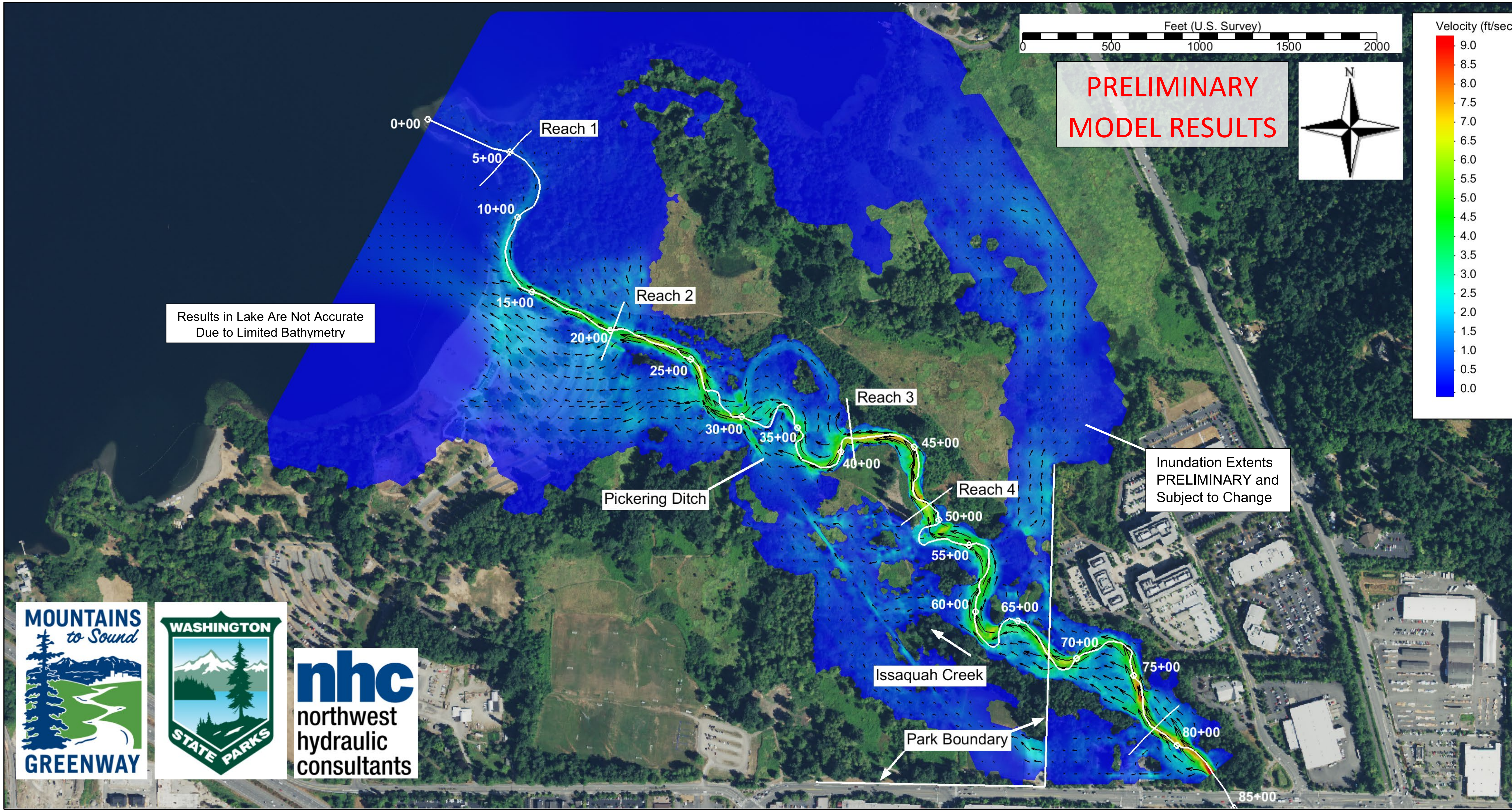


Figure G.9 Lower Issaquah Creek Existing Conditions 100-Year Velocity

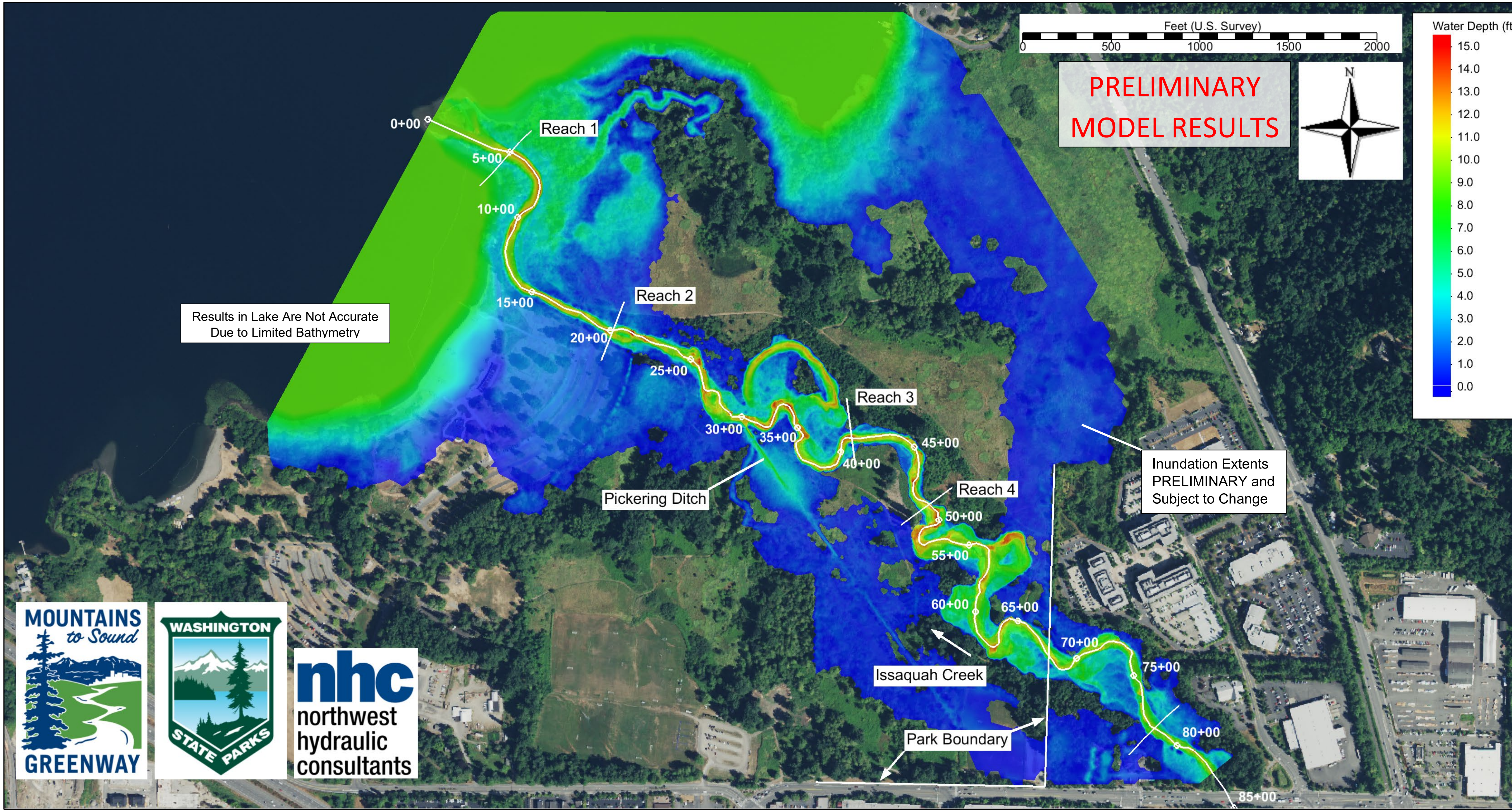


Figure G.10 Lower Issaquah Creek Existing Conditions 100-Year Water Depth

APPENDIX H: HYDRAULIC ANALYSIS RESULTS – PROPOSED CONDITIONS

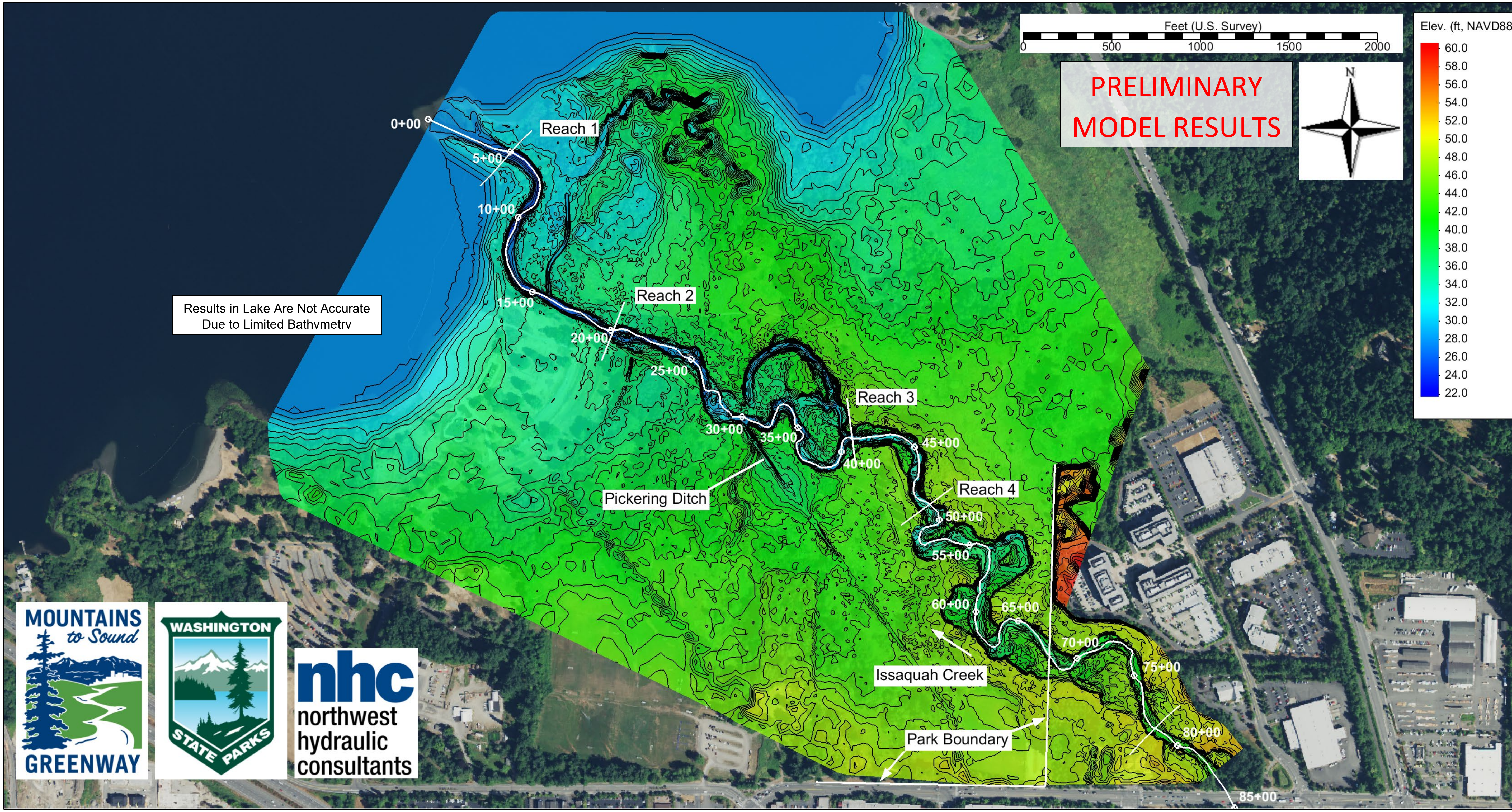


Figure H.1 Lower Issaquah Creek Proposed Conditions Model Domain

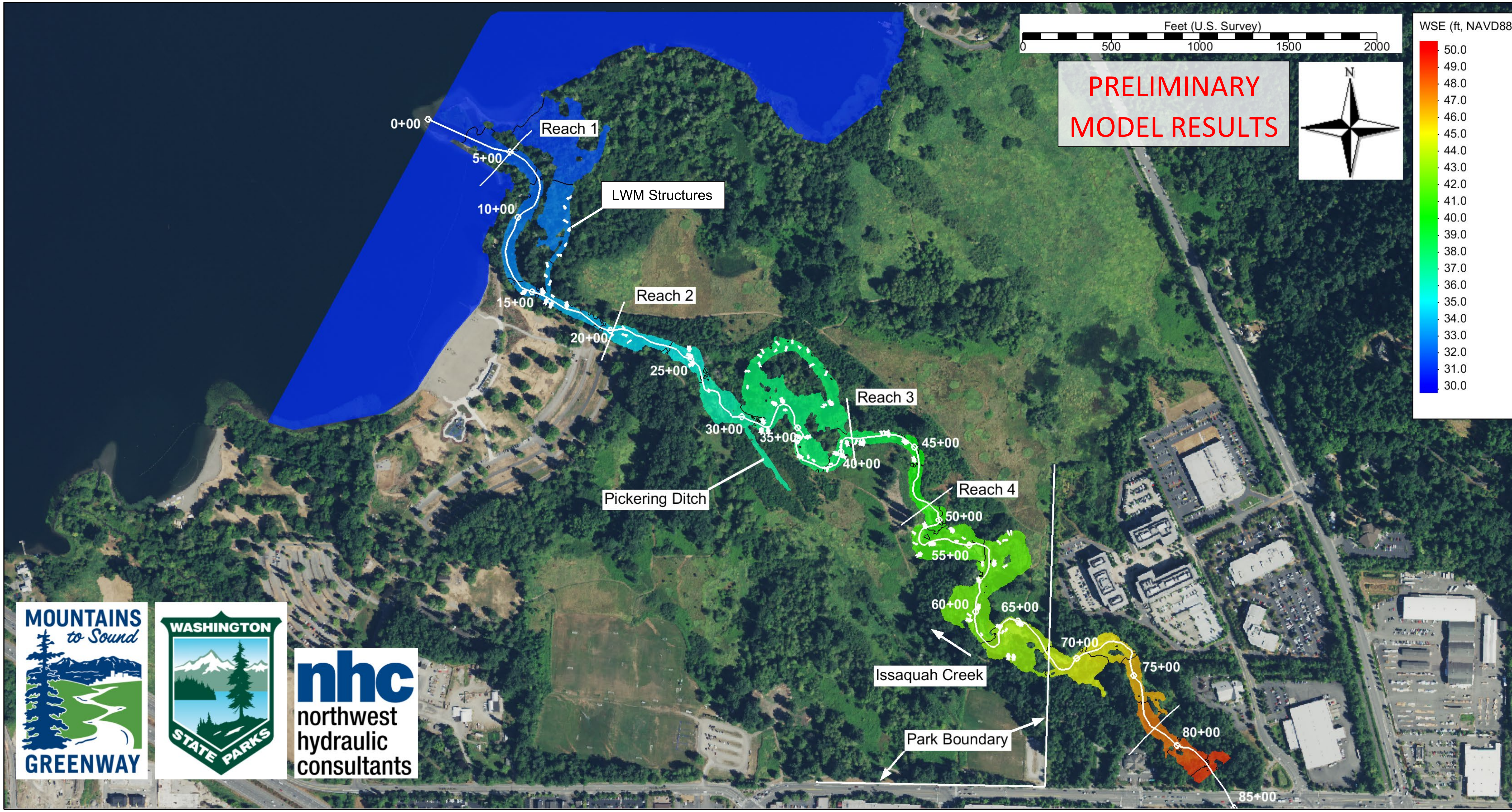


Figure H.2 Lower Issaquah Creek Proposed Conditions 2-Year Water Surface Elevation (WSE)

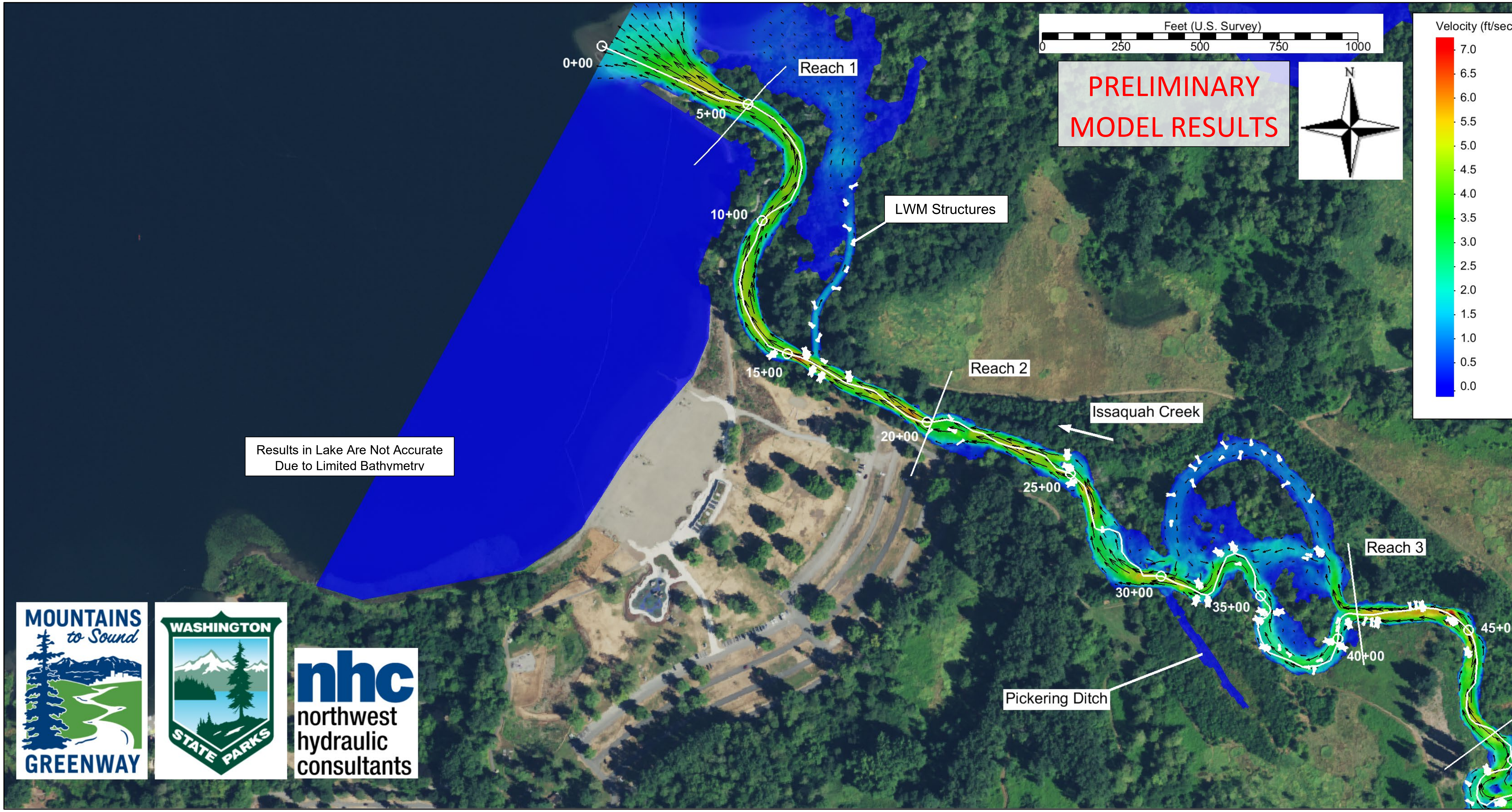


Figure H.3 Lower Issaquah Creek Proposed Conditions 2-Year Velocity (Reaches 1 and 2)

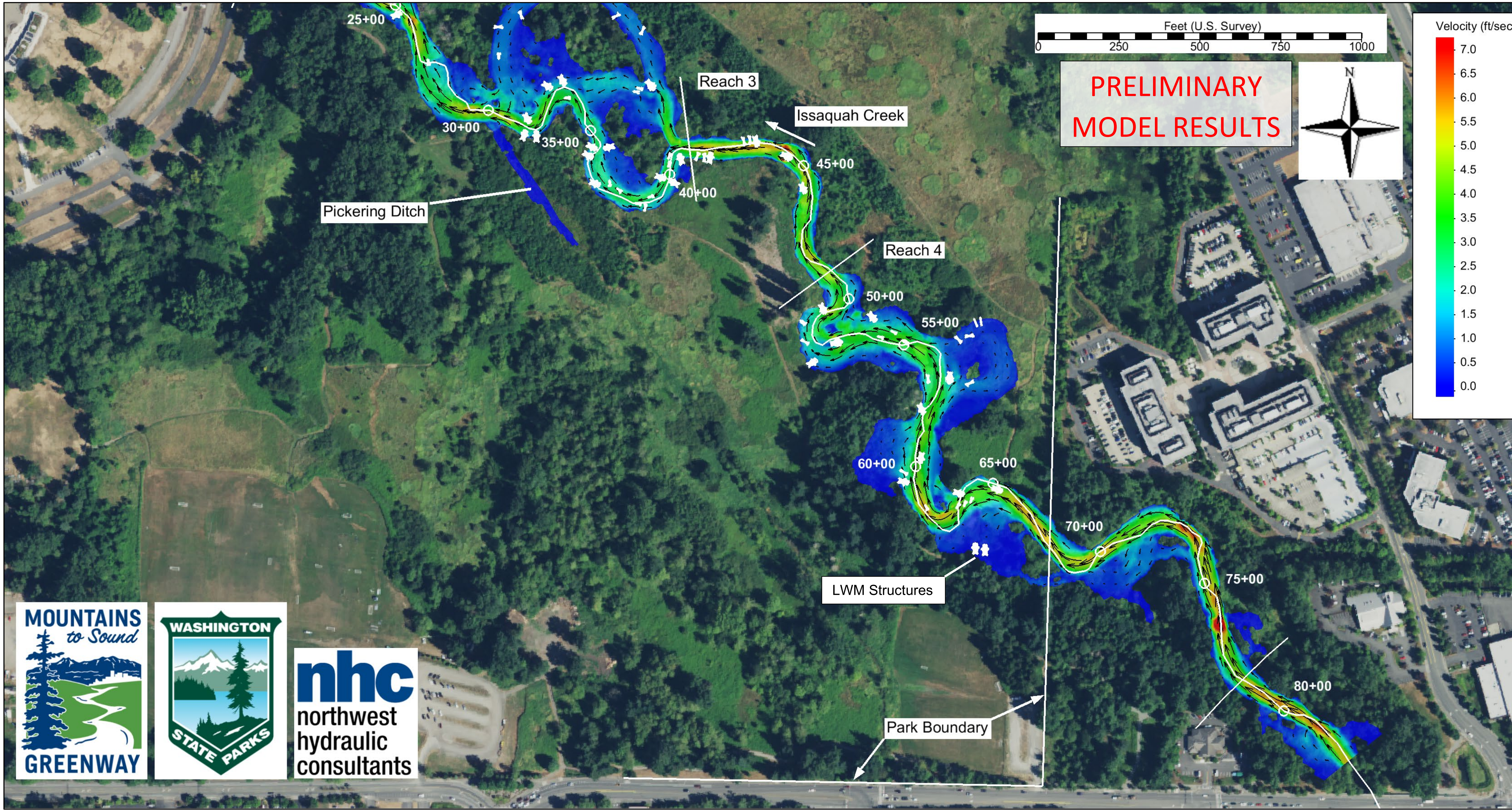


Figure H.4 Lower Issaquah Creek Proposed Conditions 2-Year Velocity (Reaches 3 and 4)

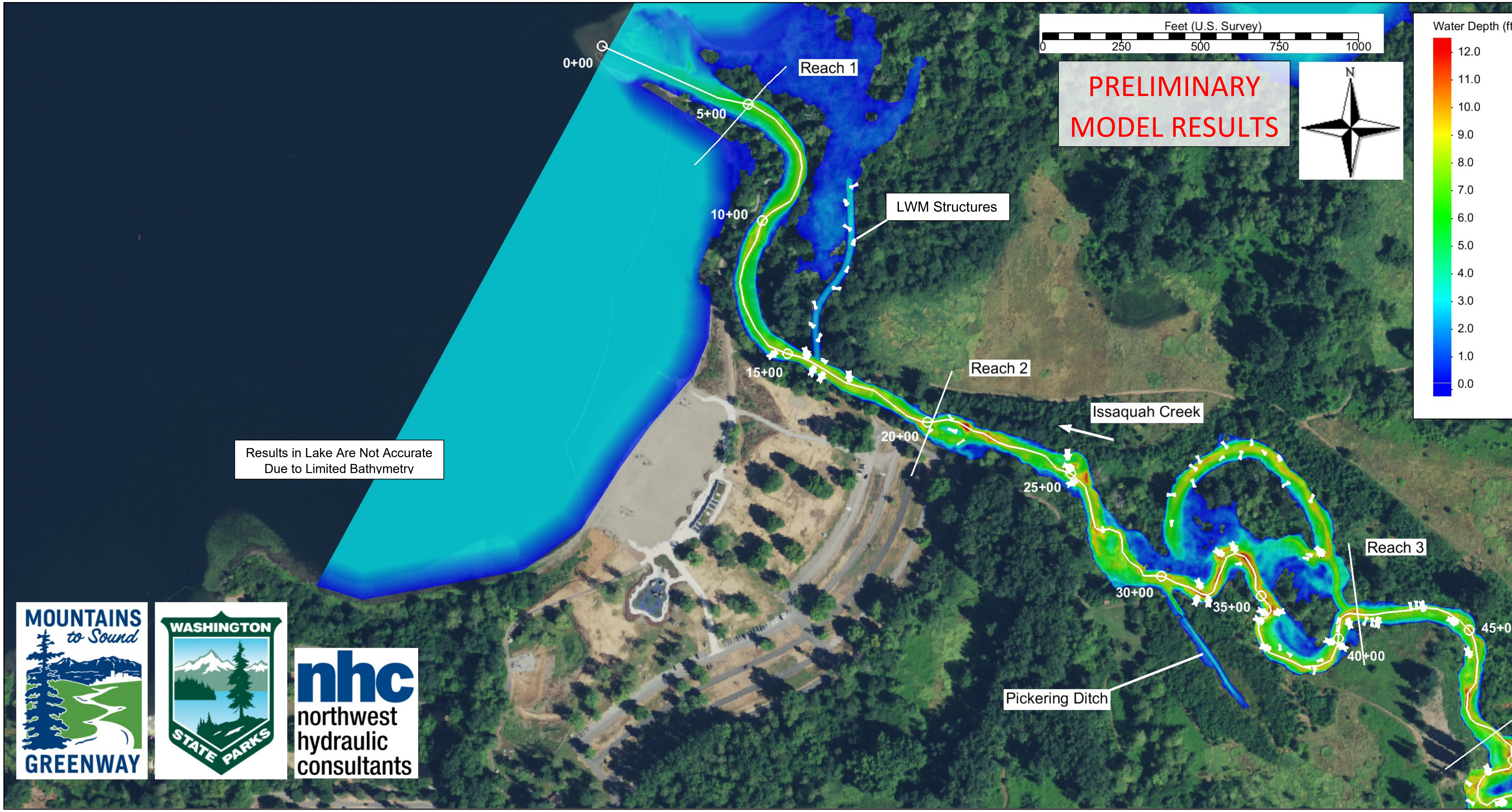


Figure H.5 Lower Issaquah Creek Proposed Conditions 2-Year Water Depth (Reaches 1 and 2)

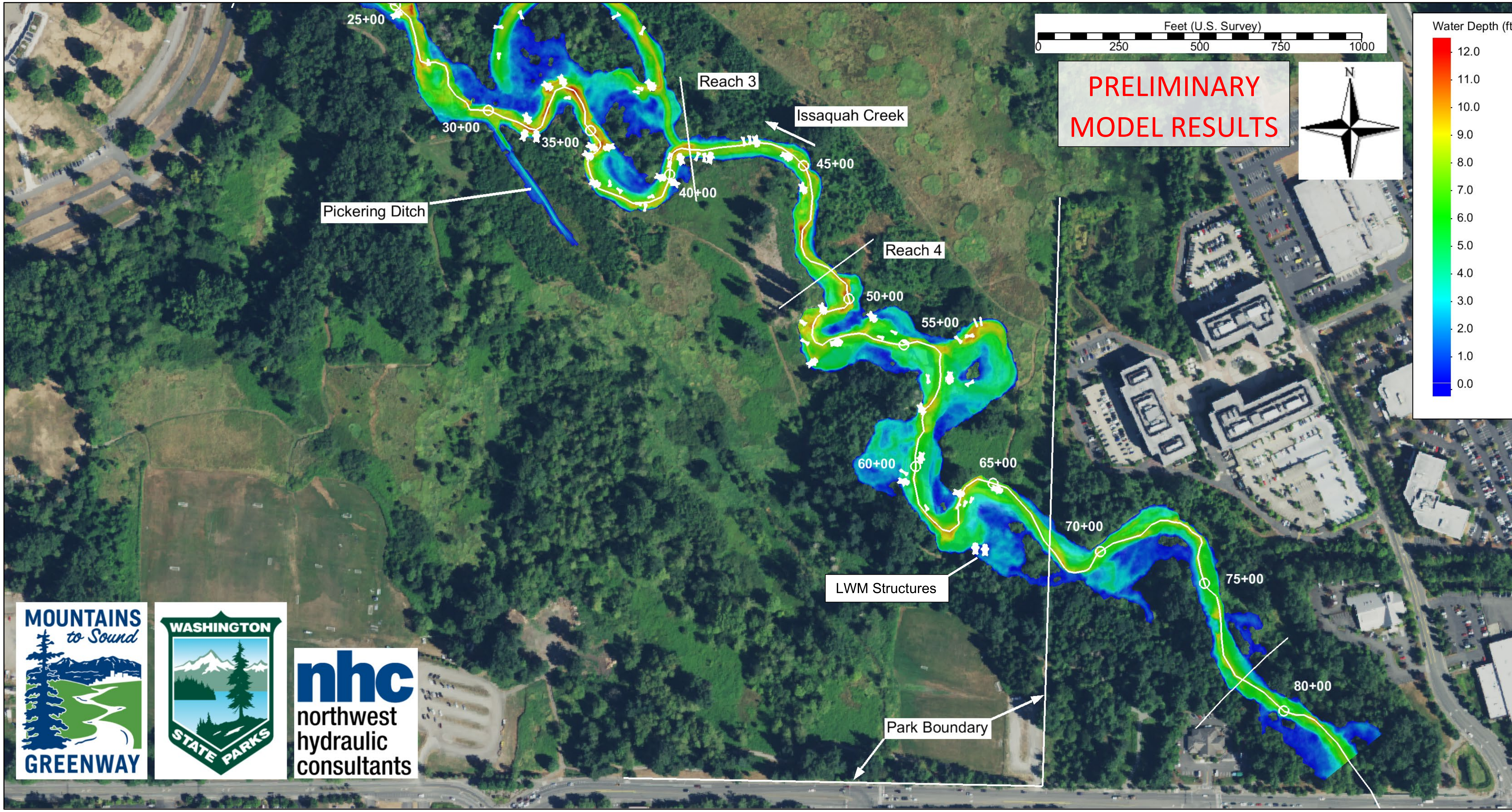


Figure H.6 Lower Issaquah Creek Proposed Conditions 2-Year Water Depth (Reaches 3 and 4)

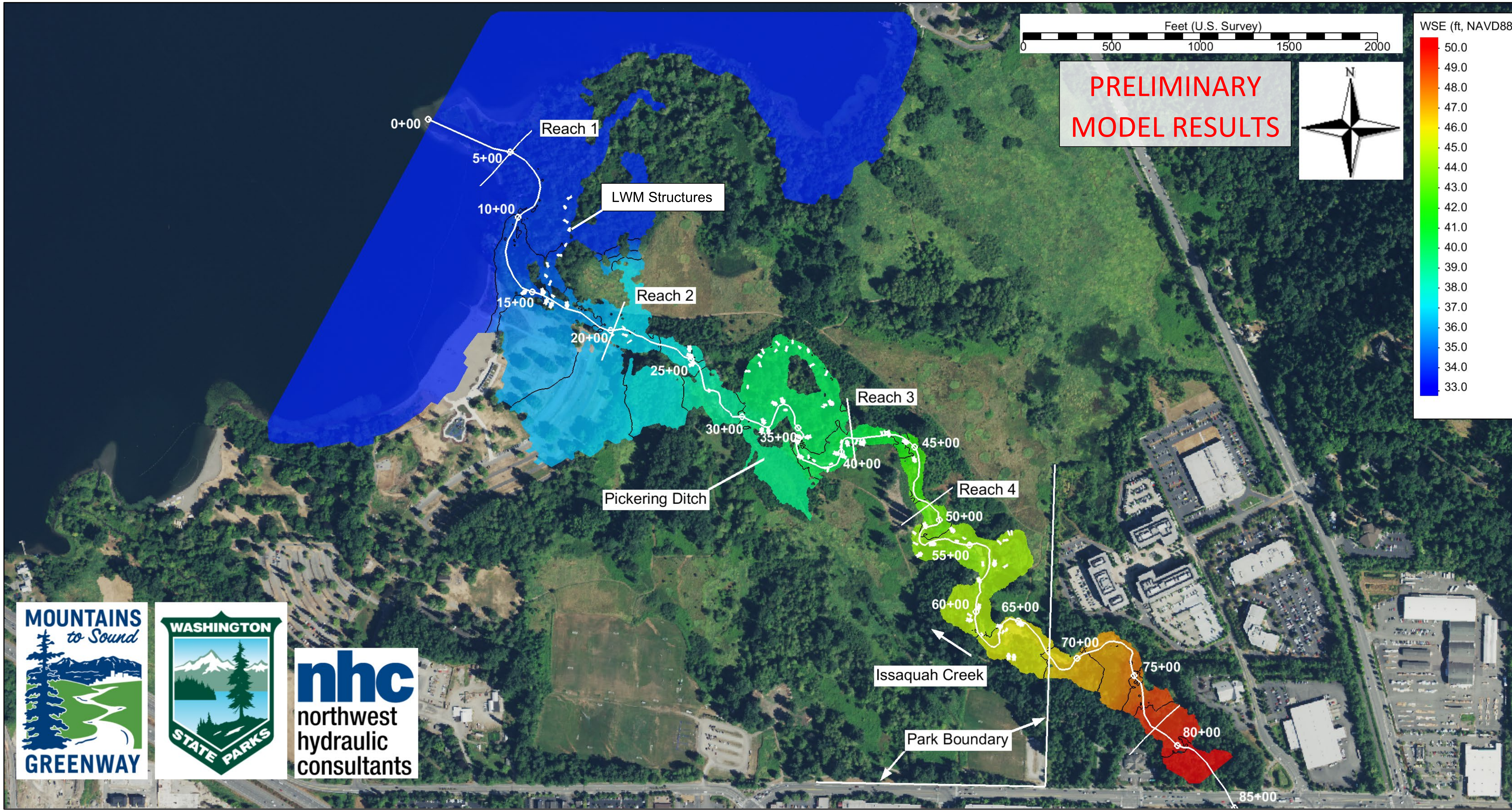


Figure H.7 Lower Issaquah Creek Proposed Conditions February 6, 2020 Flood Event Water Surface Elevation (WSE)

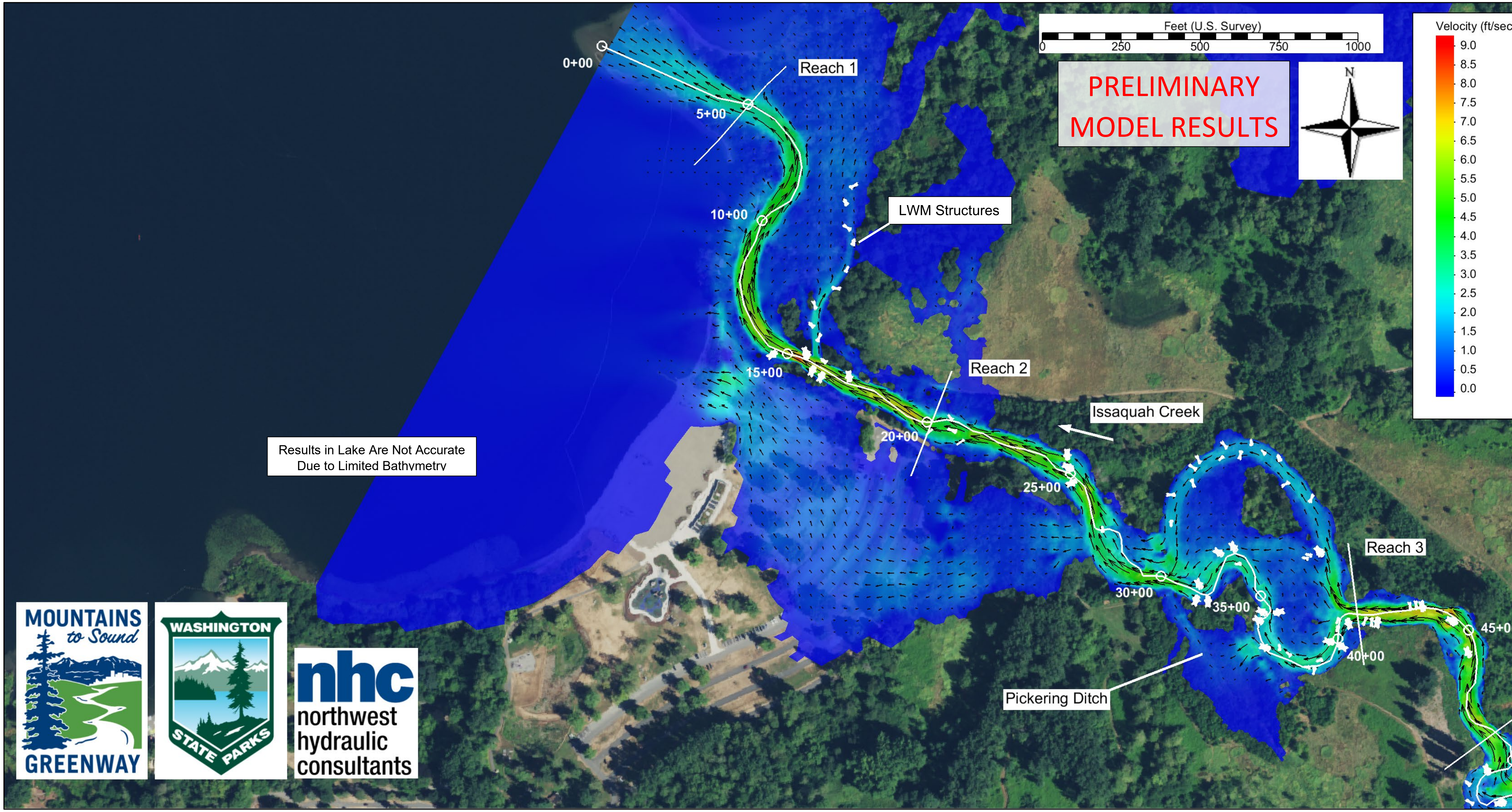


Figure H.8 Lower Issaquah Creek Proposed Conditions February 6, 2020 Flood Event Velocity (Reaches 1 and 2)

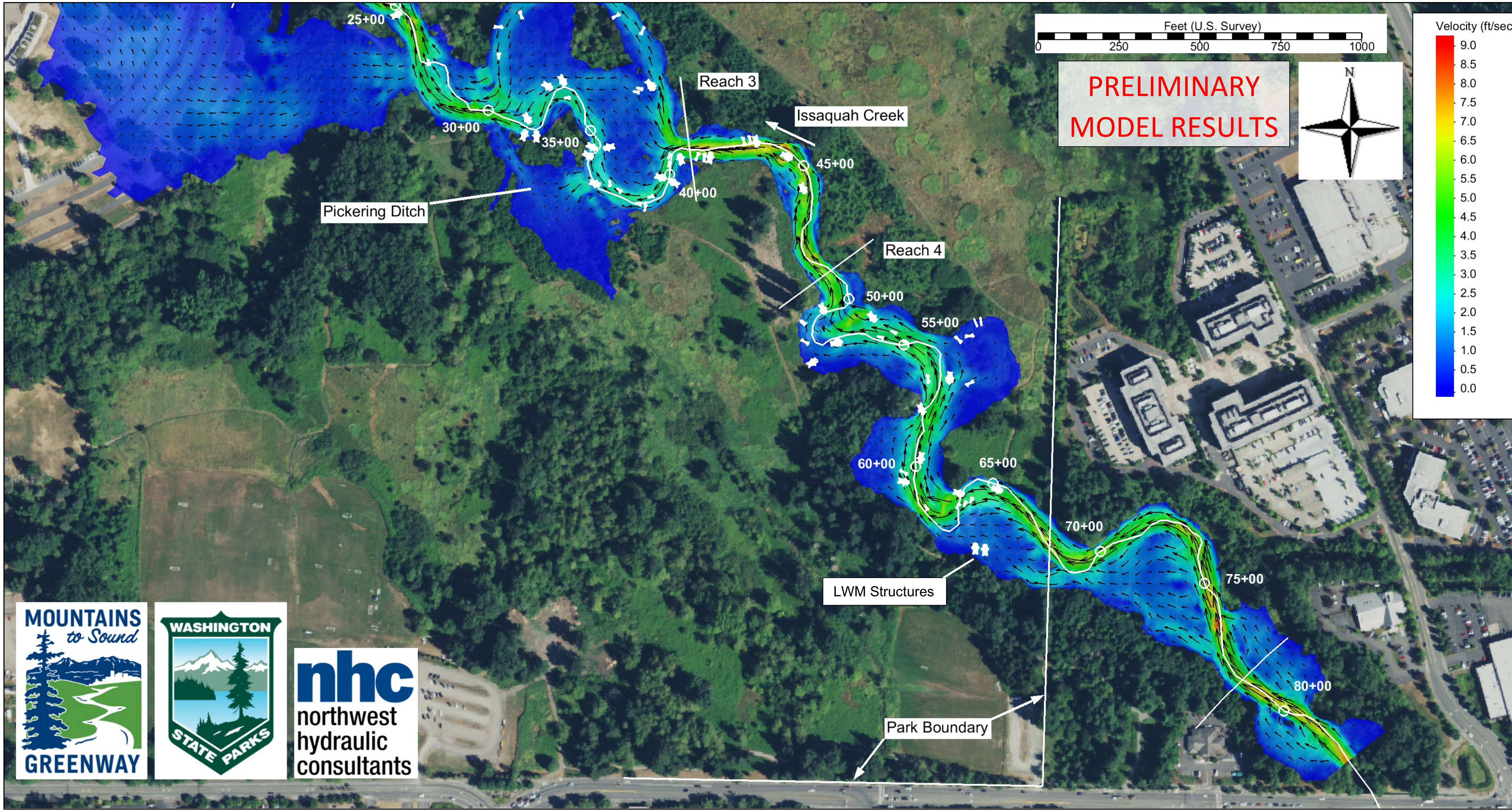


Figure H.9 Lower Issaquah Creek Proposed Conditions February 6, 2020 Flood Event Velocity (Reaches 3 and 4)

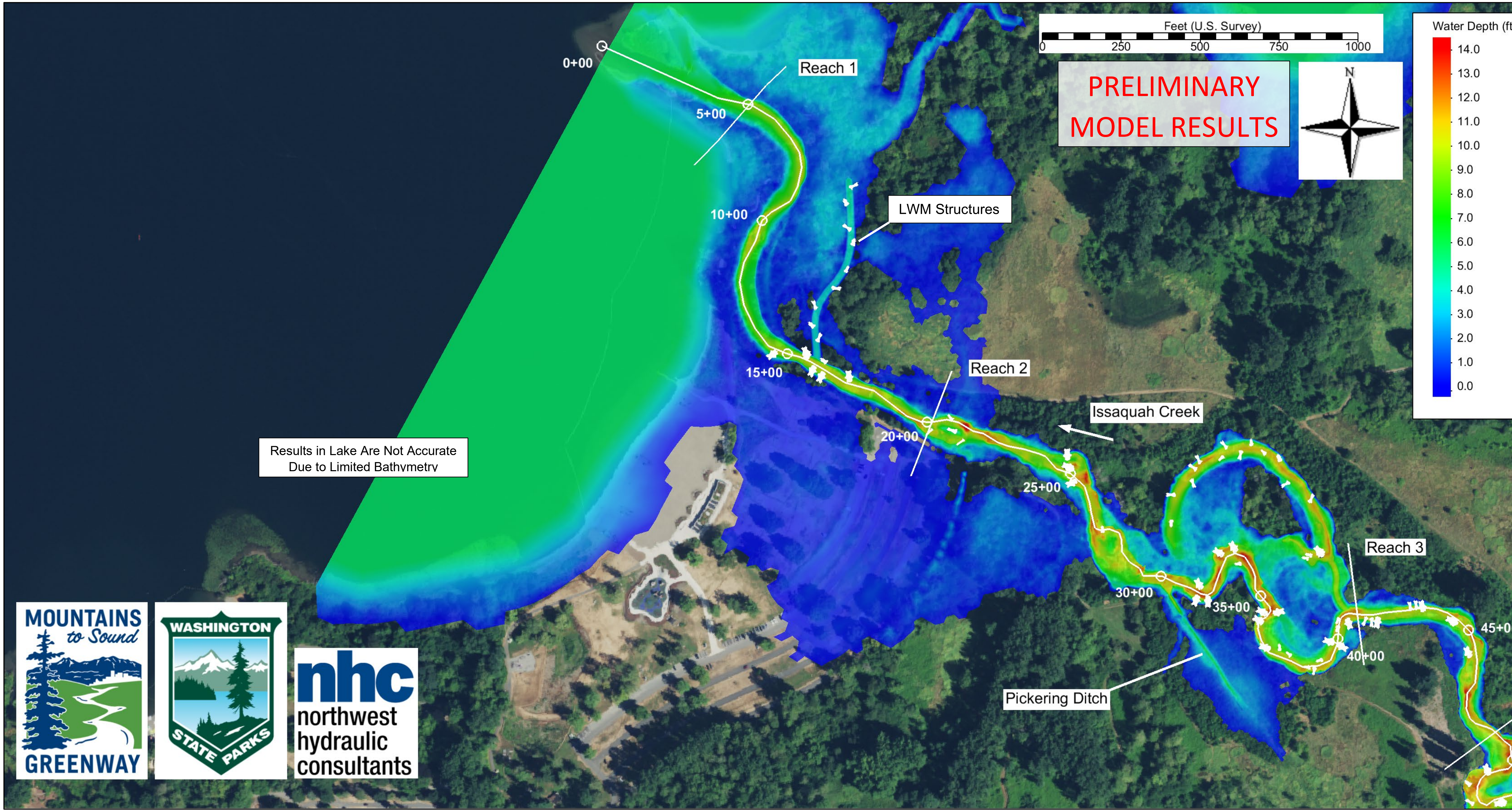


Figure H.10 Lower Issaquah Creek Proposed Conditions February 6, 2020 Flood Event Water Depth (Reaches 1 and 2)

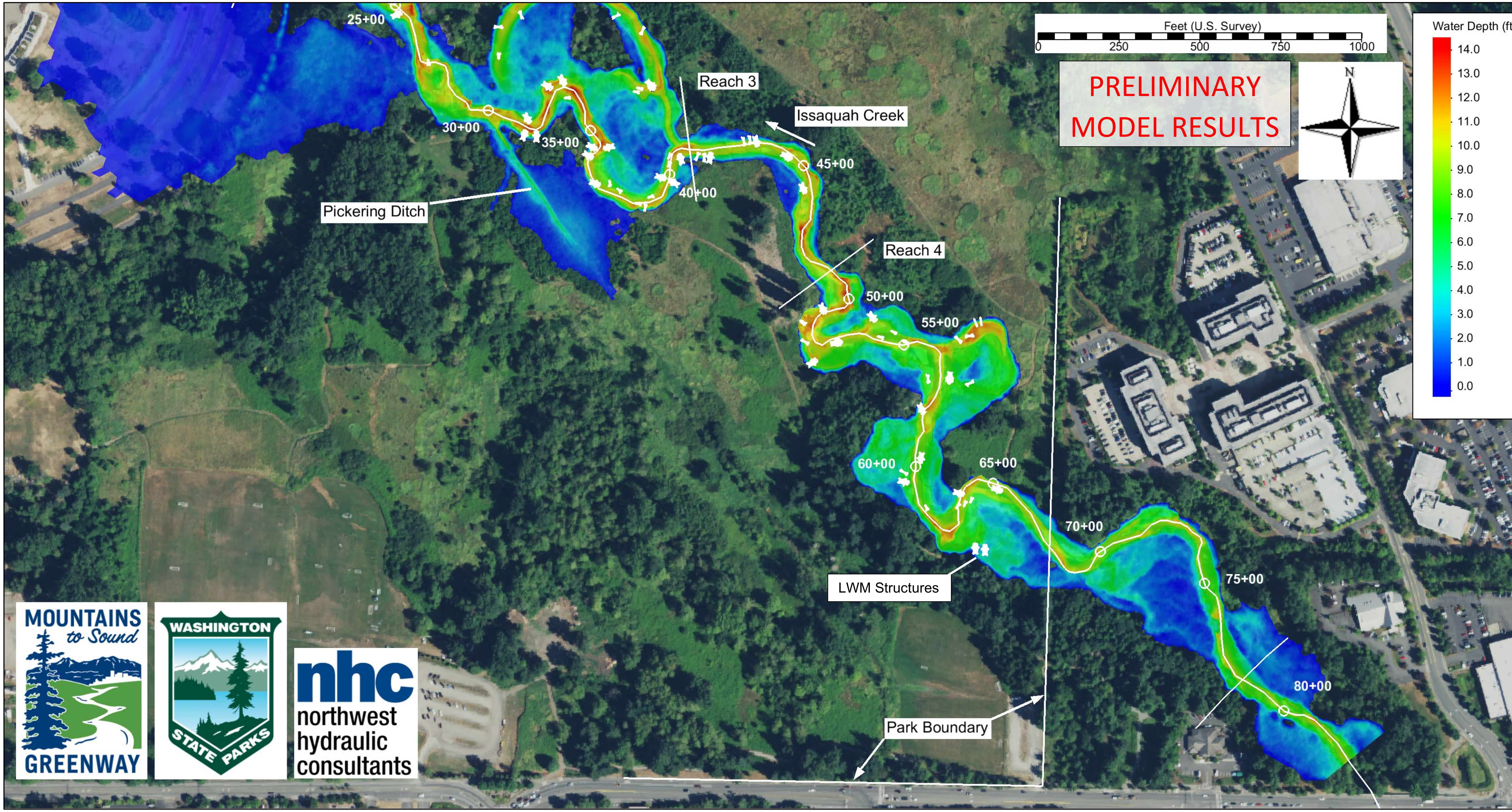


Figure H.11 Lower Issaquah Creek Proposed Conditions February 6, 2020 Flood Event Water Depth (Reaches 3 and 4)

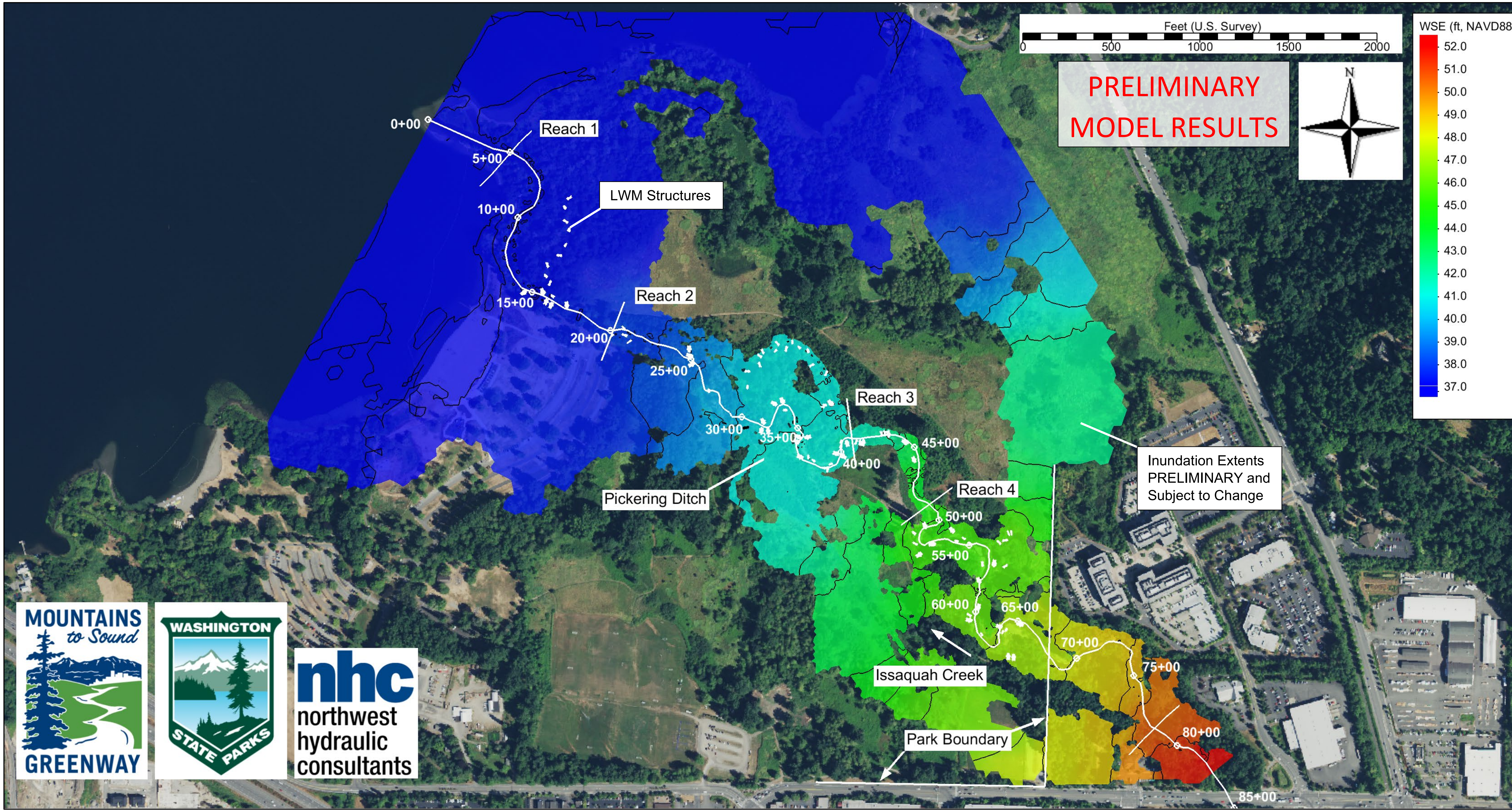


Figure H.12 Lower Issaquah Creek Proposed Conditions 100-Year Water Surface Elevation (WSE)

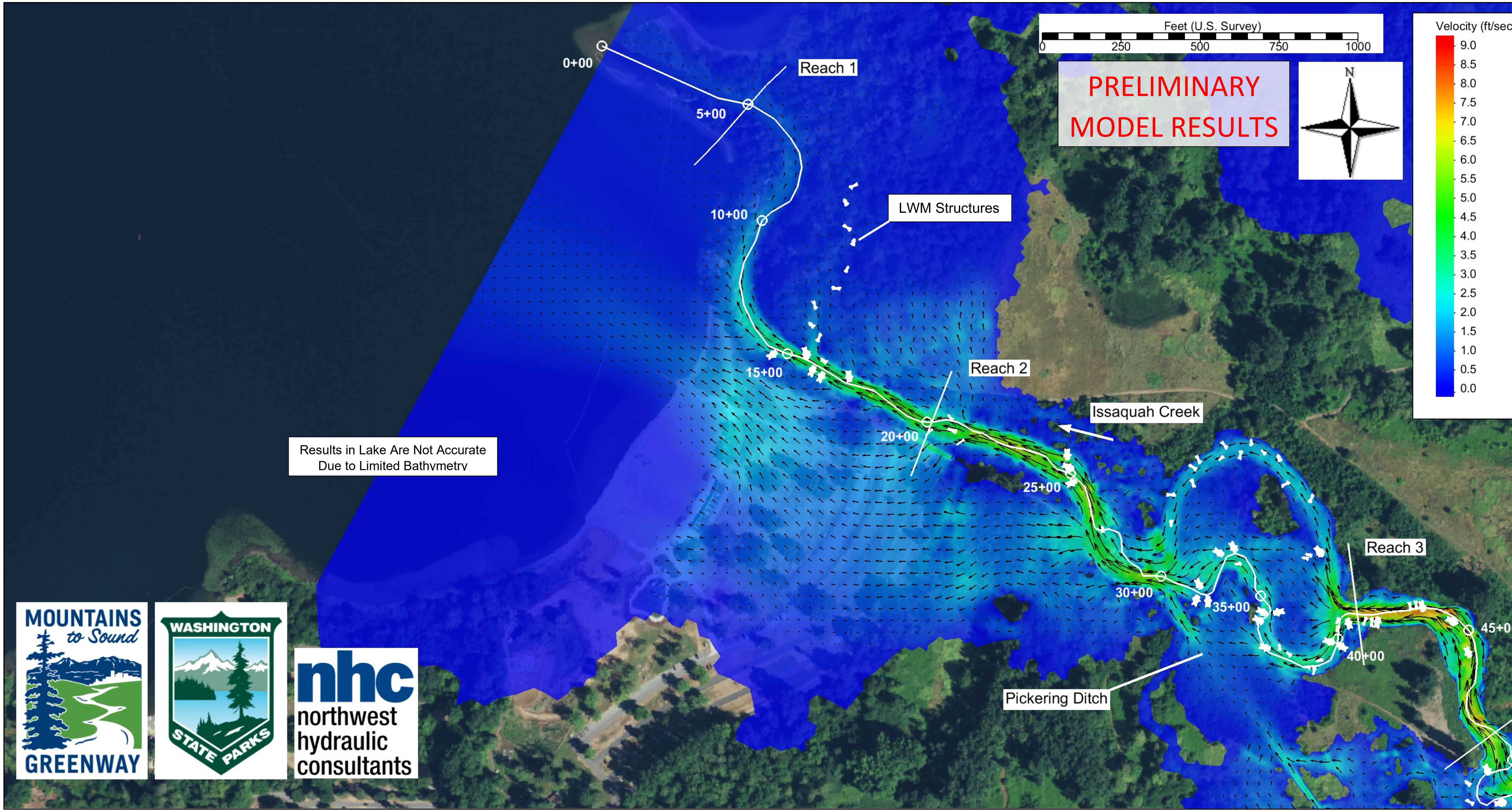


Figure H.13 Lower Issaquah Creek Proposed Conditions 100-Year Velocity (Reaches 1 and 2)

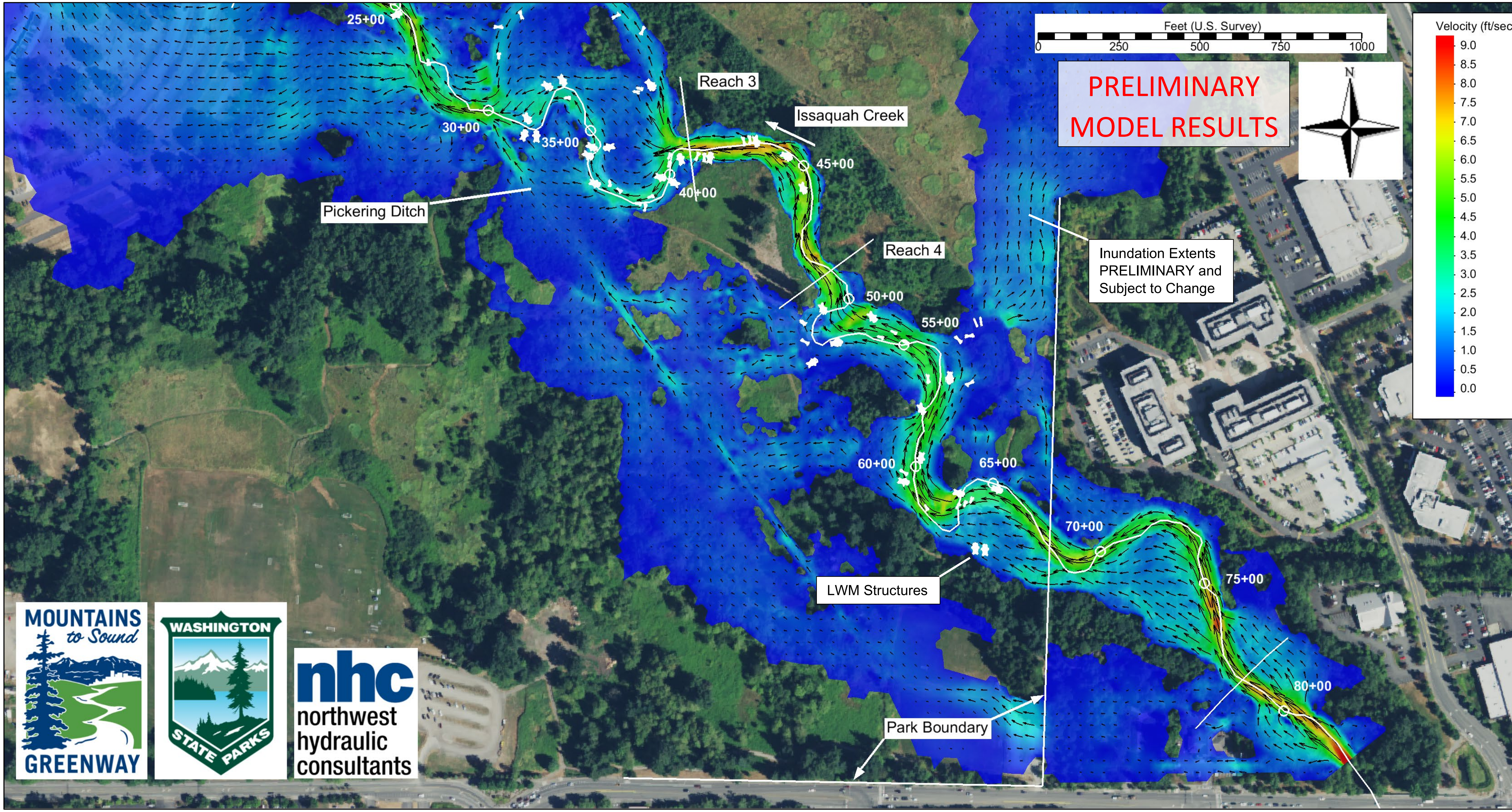


Figure H.14 Lower Issaquah Creek Proposed Conditions 100-Year Velocity (Reaches 3 and 4)

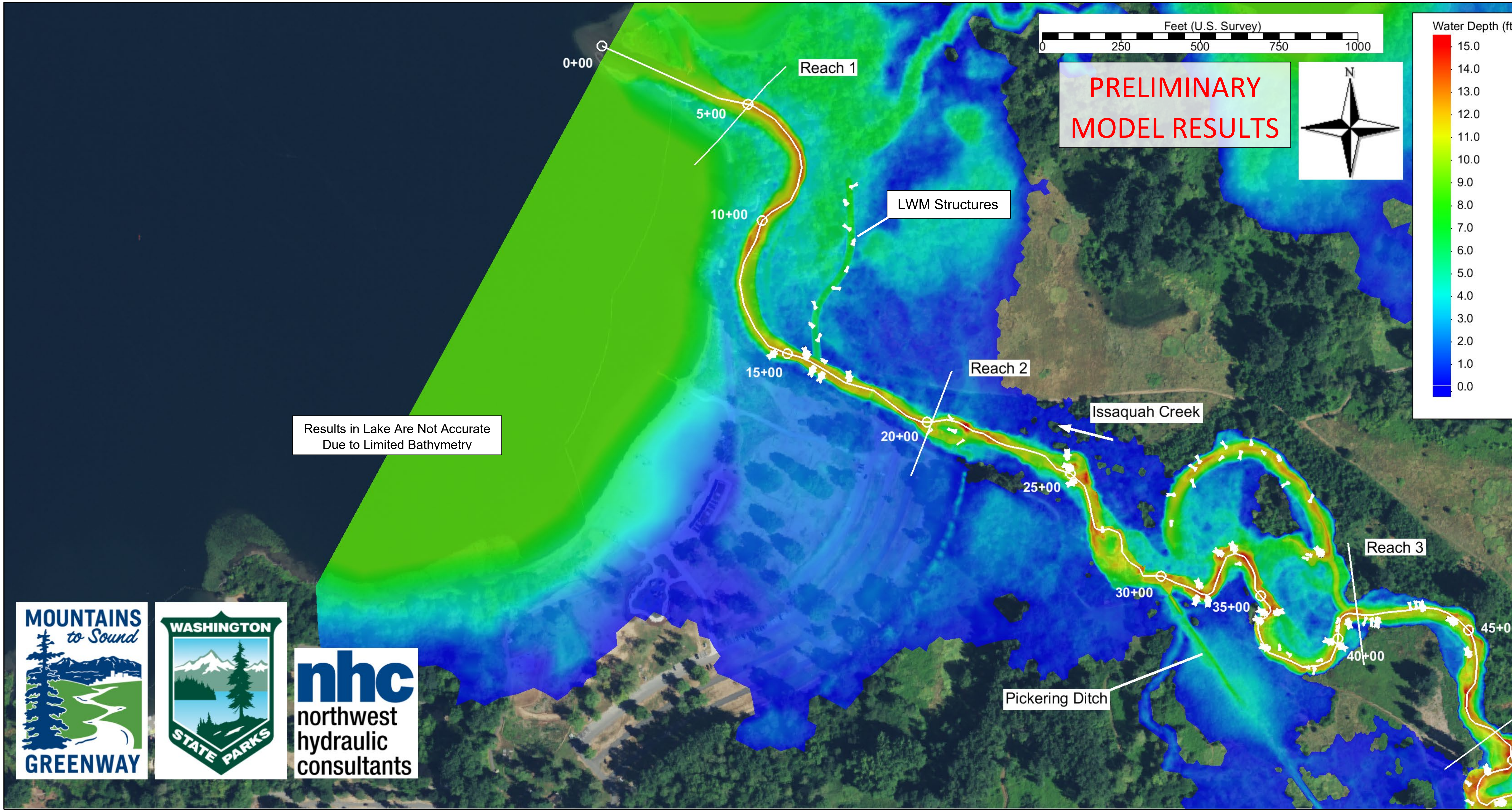


Figure H.15 Lower Issaquah Creek Proposed Conditions 100-Year Water Depth (Reaches 1 and 2)

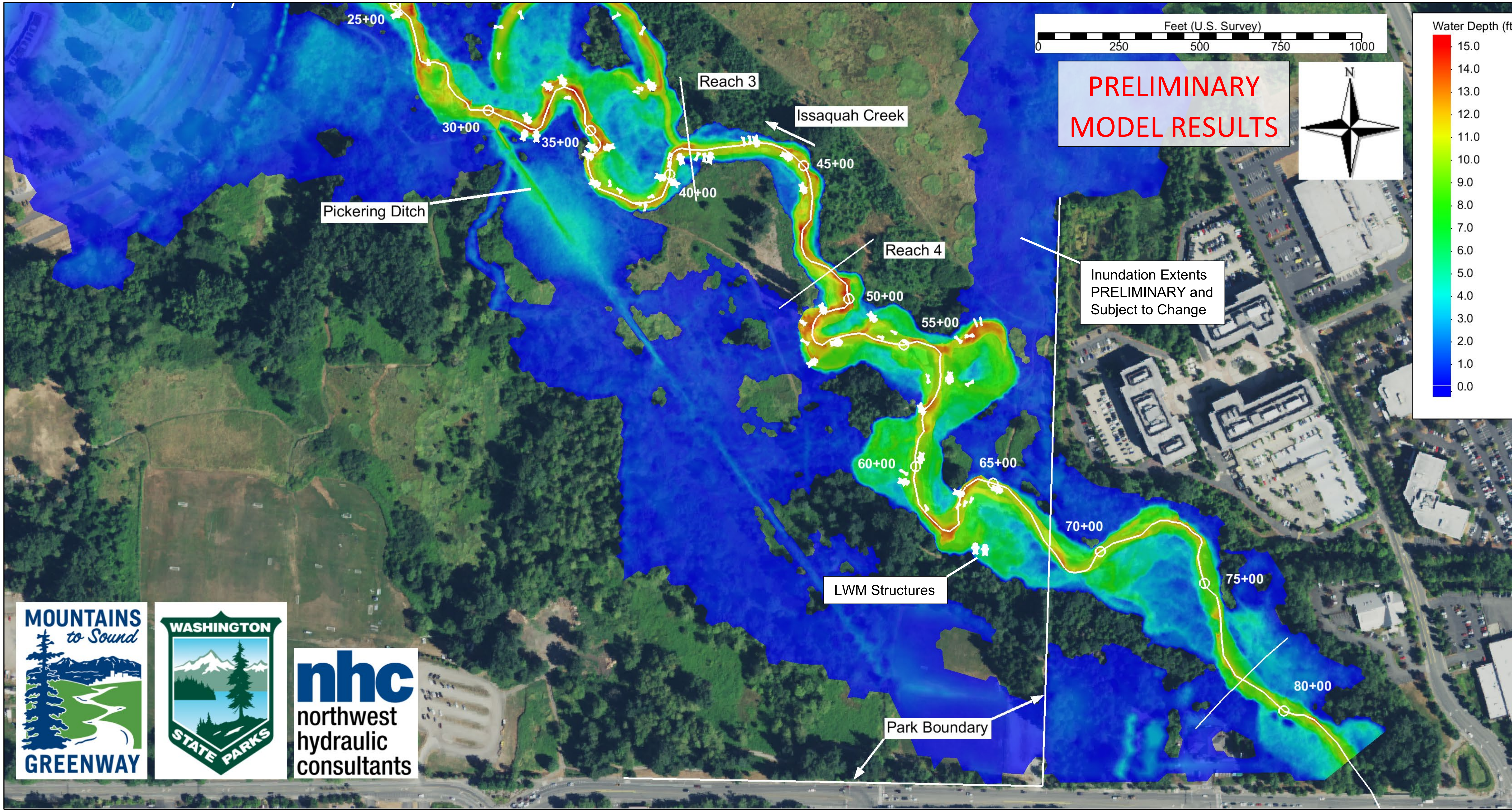


Figure H.16 Lower Issaquah Creek Proposed Conditions 100-Year Water Depth (Reaches 3 and 4)

APPENDIX I: FLOODPLAIN AND FLOODWAY ANAYLSIS

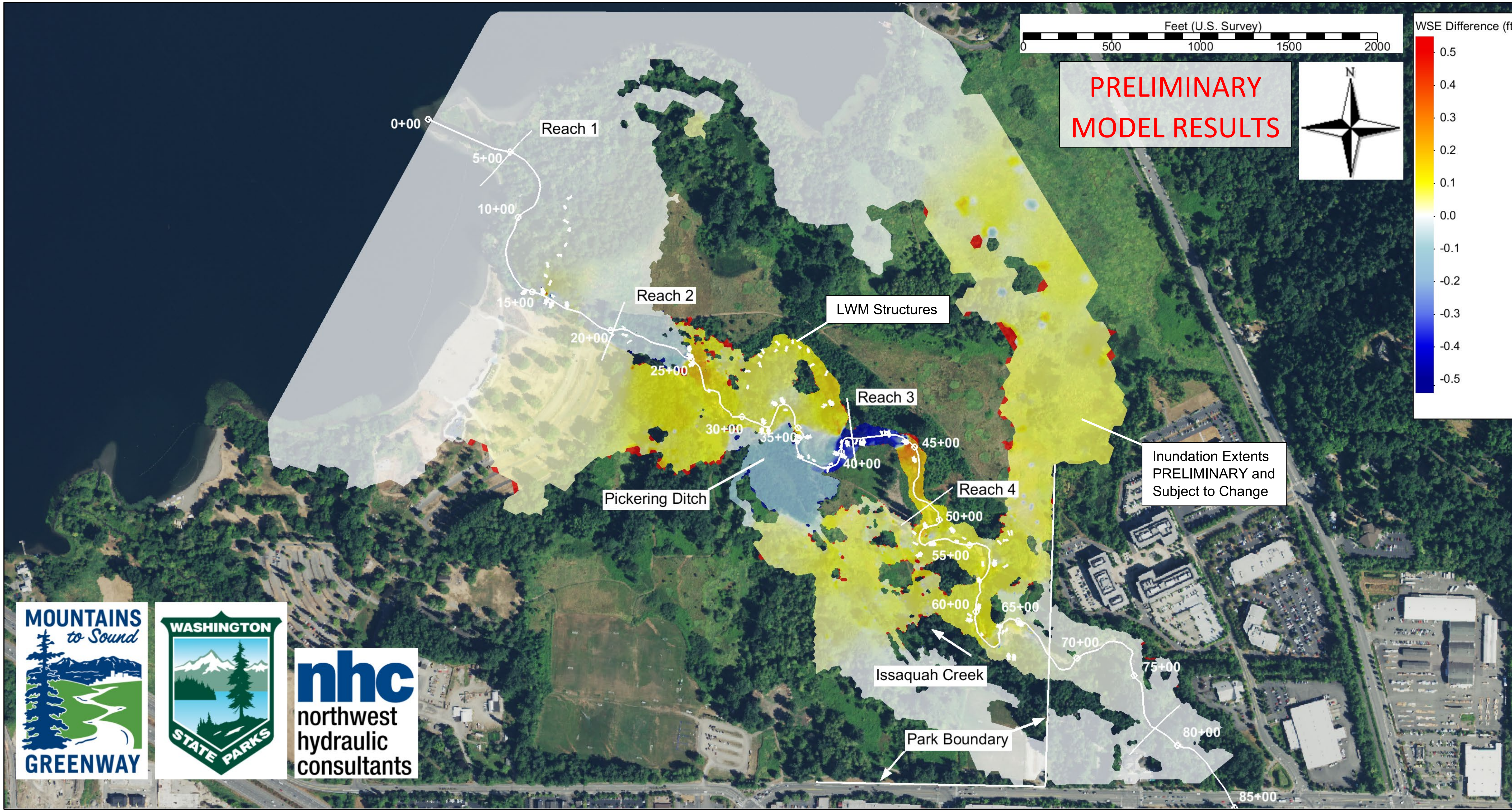


Figure I.1 Lower Issaquah Creek Change in Water Surface Due to the Preferred Alternative (Warm Colors = Increase in WSE, Cool Colors = Decrease in WSE Compared to Existing Conditions)

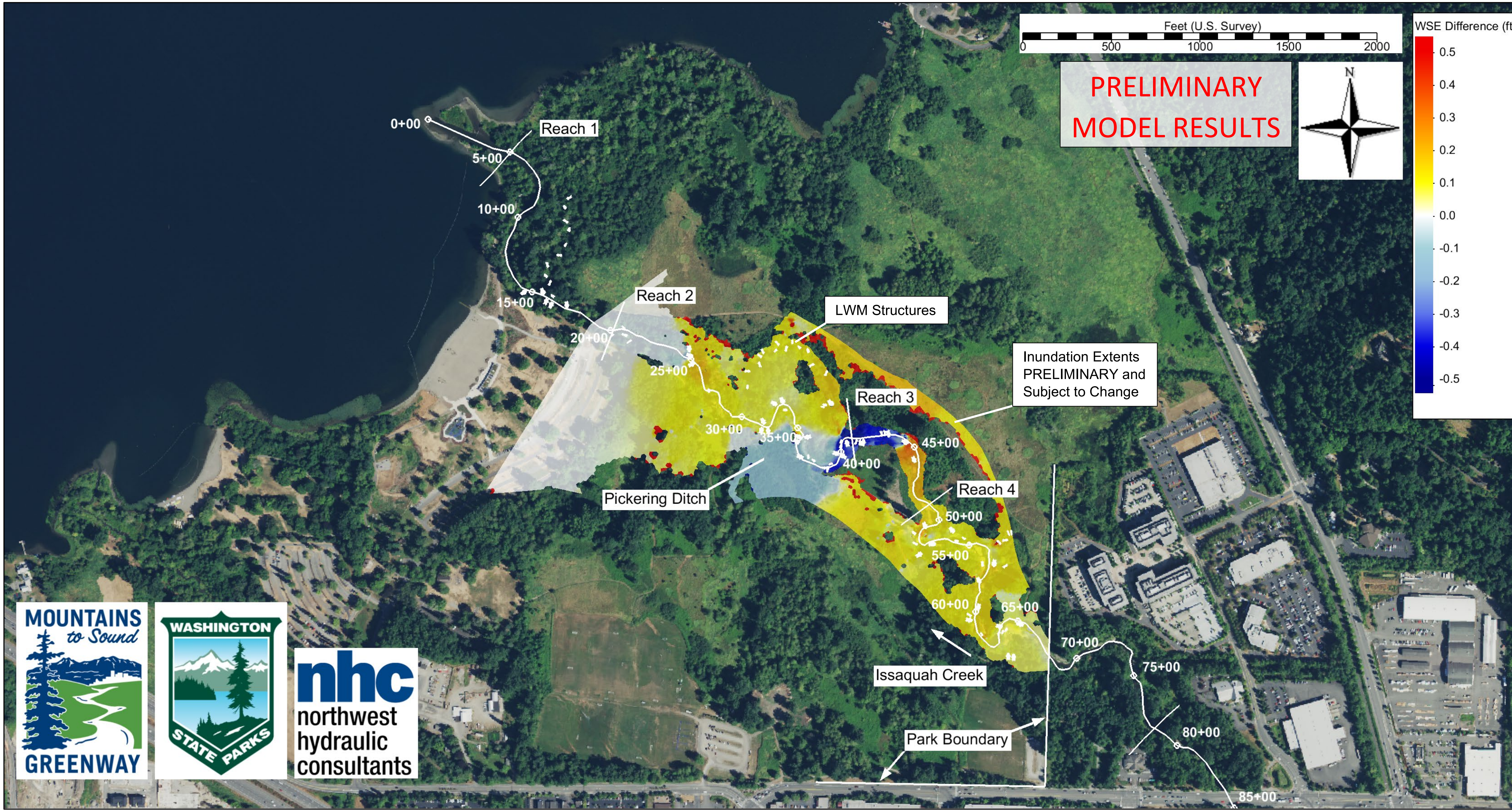


Figure I.2 Lower Issaquah Creek Floodway Change in Water Surface Due to the Preferred Alternative (Warm Colors = Increase in WSE, Cool Colors = Decrease in WSE Compared to Existing Conditions)

APPENDIX J: PRELIMINARY COST ESTIMATE

PROJECT COST ESTIMATE

Bid Item			Selected Alternative	
Name	Unit	Unit Cost	Quantity	Cost
Excavated Features				
Channel Excavation Incl. Haul	CY	$50	3,500	$ 175,000
Streambed Material	TON	$45	1,650	$ 74,300
LWM				
Helicopter Mobilization - Small Twin Rotor	LS	$30,000	1	$ 30,000
Helicopter Mobilization - Large Helicopter	LS	$55,000	1	$ 55,000
Helicopter Supplies/Fuel/Etc...	LS	$20,000	1	$ 20,000
Individual Logs	EACH	$3,000	57	$ 171,000
Log Jacks	EACH	$7,000	24	$ 168,000
Small Spur Jam	EACH	$8,000	6	$ 48,000
Large Spur Jam	EACH	$25,000	31	$ 775,000
Apex Jams	EACH	$40,000	6	$ 240,000
Riparian Restoration				
Staffing	LS	$240,000	1.0	$ 240,000
Project Supplies	LS	$75,000	1.0	$ 75,000
Commerical Services & Crew Time	LS	$90,000	1.0	$ 90,000
Transportation	LS	$5,000	1.0	$ 5,000
Office Expenses/Overhead	LS	$60,000	1.0	$ 60,000
Signs	EACH	$5,000	6.0	$ 30,000
		Items Subtotal		**$ 2,256,300**
Erosion Control and Construction				
Clearing and Grubbing	LS	$75,000	1	$ 75,000
Construction Entrance/Staging Area	EACH	$5,000	2	$ 10,000
Access Road	EACH	$15,000	11	$ 165,000
Turbidity Monitoring	DAY	$250	90	$ 22,500
Cultural Resources	LS	$25,000	1	$ 25,000
Temporary Stream Diversion	LS	$40,000	5	$ 200,000
Water Control	EACH	$5,000	13	$ 65,000
Spill Pevention, Control & Countermeasures (SPCC) Plan	LS	$4,000	1	$ 4,000
ESC Lead	DAY	$300	90	$ 27,000
		Items Subtotal		**$ 593,500**
Mobilization	LS	10%	1	$ 285,000
Construction Engineering Support	LS	10%	1	$ 285,000
		Subtotal		**$ 3,419,800**
Taxes	LS	10%	1	$ 342,000
		Total		***$ 3,762,000***

REACH 1 COST ESTIMATE

Bid Item			Selected Alternative	
Name	Unit	Unit Cost	Quantity	Cost
Distributary Channel				
Channel Excavation Incl. Haul	CY	$50	1,815	$ 90,800
Streambed Material	TON	$45	1,210	$ 54,500
LWM				
Helicopter Mobilization - Small Twin Rotor	LS	$30,000	1	$ 30,000
Helicopter Mobilization - Large Helicopter	LS	$55,000	1	$ 55,000
Helicopter Supplies/Fuel/Etc...	LS	$20,000	1	$ 20,000
Individual Logs	EACH	$3,000	10	$ 30,000
Log Jacks	EACH	$7,000	1	$ 7,000
Small Spur Jam	EACH	$8,000	4	$ 32,000
Large Spur Jam	EACH	$23,000	4	$ 92,000
Apex Jams	EACH	$38,000	1	$ 38,000
Riparian Restoration				
Staffing	LS	$240,000		$ -
Project Supplies	LS	$75,000		$ -
Commerical Services & Crew Time	LS	$90,000		$ -
Transportation	LS	$5,000		$ -
Office Expenses/Overhead	LS	$60,000		$ -
Signs	EACH	$5,000		$ -
		Items Subtotal		**$ 449,300**
Erosion Control and Construction				
Clearing and Grubbing	LS	$15,000	1	$ 15,000
Construction Entrance/Staging Area	EACH	$5,000	1	$ 5,000
Access Road	EACH	$15,000	3	$ 45,000
Turbidity Monitoring	DAY	$250	30	$ 7,500
Cultural Resources	LS	$25,000	1	$ 25,000
Temporary Stream Diversion	LS	$40,000	1	$ 40,000
Water Control	EACH	$5,000	4	$ 20,000
Spill Pevention, Control & Countermeasures (SPCC) Plan	LS	$4,000	1	$ 4,000
ESC Lead	DAY	$300	30	$ 9,000
		Items Subtotal		**$ 170,500**
Mobilization	LS	10%	1	$ 62,000
Construction Engineering Support	LS	15%	1	$ 93,000
		Subtotal		**$ 774,800**
Taxes	LS	10%	1	$ 77,500
		Total		***$ 853,000***

REACH 2 COST ESTIMATE

Bid Item			Selected Alternative	
Name	Unit	Unit Cost	Quantity	Cost
Pilot Channel				
Channel Excavation Incl. Haul	CY	$50	880	$ 44,000
Streambed Material	TON	$45	410	$ 18,500
LWM				
Helicopter Mobilization - Small Twin Rotor	LS	$30,000	1	$ 30,000
Helicopter Mobilization - Large Helicopter	LS	$55,000	1	$ 55,000
Helicopter Supplies/Fuel/Etc...	LS	$20,000	1	$ 20,000
Individual Logs	EACH	$3,000	24	$ 72,000
Log Jacks	EACH	$7,000	16	$ 112,000
Small Spur Jam	EACH	$8,000	1	$ 8,000
Large Spur Jam	EACH	$23,000	14	$ 322,000
Apex Jams	EACH	$38,000	2	$ 76,000
Riparian Restoration				
Staffing	LS	$240,000		$ -
Project Supplies	LS	$75,000		$ -
Commerical Services & Crew Time	LS	$90,000		$ -
Transportation	LS	$5,000		$ -
Office Expenses/Overhead	LS	$60,000		$ -
Signs	EACH	$5,000		$ -
		Items Subtotal		**$ 757,500**
Erosion Control and Construction				
Clearing and Grubbing	LS	$15,000	1	$ 15,000
Construction Entrance/Staging Area	EACH	$5,000	1	$ 5,000
Access Road	EACH	$15,000	3	$ 45,000
Turbidity Monitoring	DAY	$250	30	$ 7,500
Cultural Resources	LS	$25,000	1	$ 25,000
Temporary Stream Diversion	LS	$40,000	1	$ 40,000
Water Control	EACH	$5,000	4	$ 20,000
Spill Pevention, Control & Countermeasures (SPCC) Plan	LS	$4,000	1	$ 4,000
ESC Lead	DAY	$300	30	$ 9,000
		Items Subtotal		**$ 170,500**
Mobilization	LS	10%	1	$ 92,800
Construction Engineering Support	LS	15%	1	$ 139,200
		Subtotal		**$ 1,160,000**
Taxes	LS	10%	1	$ 116,000
		Total		***$ 1,276,000***

REACH 3 COST ESTIMATE

Bid Item			Selected Alternative	
Name	Unit	Unit Cost	Quantity	Cost
Bank Scraping				
Channel Excavation Incl. Haul	CY	$50	500	$ 25,000
Streambed Material	TON	$45	0	$ -
LWM				
Helicopter Mobilization - Small Twin Rotor	LS	$30,000	1	$ 30,000
Helicopter Mobilization - Large Helicopter	LS	$55,000	1	$ 55,000
Helicopter Supplies/Fuel/Etc...	LS	$20,000	1	$ 20,000
Individual Logs	EACH	$3,000	8	$ 24,000
Log Jacks	EACH	$7,000	0	$ -
Small Spur Jam	EACH	$8,000	0	$ -
Large Spur Jam	EACH	$23,000	3	$ 69,000
Apex Jams	EACH	$38,000	1	$ 38,000
Riparian Restoration				
Staffing	LS	$240,000		$ -
Project Supplies	LS	$75,000		$ -
Commerical Services & Crew Time	LS	$90,000		$ -
Transportation	LS	$5,000		$ -
Office Expenses/Overhead	LS	$60,000		$ -
Signs	EACH	$5,000		$ -
		Items Subtotal		**$ 261,000**
Erosion Control and Construction				
Clearing and Grubbing	LS	$15,000	1	$ 15,000
Construction Entrance/Staging Area	EACH	$5,000	1	$ 5,000
Access Road	EACH	$15,000	2	$ 30,000
Turbidity Monitoring	DAY	$250	30	$ 7,500
Cultural Resources	LS	$25,000	1	$ 25,000
Temporary Stream Diversion	LS	$40,000	2	$ 80,000
Water Control	EACH	$5,000	3	$ 15,000
Spill Pevention, Control & Countermeasures (SPCC) Plan	LS	$4,000	1	$ 4,000
ESC Lead	DAY	$300	30	$ 9,000
		Items Subtotal		**$ 190,500**
Mobilization	LS	10%	1	$ 45,200
Construction Engineering Support	LS	15%	1	$ 67,800
		Subtotal		**$ 564,500**
Taxes	LS	10%	1	$ 56,500
		Total		***$ 621,000***

REACH 4 COST ESTIMATE

Bid Item			Selected Alternative	
Name	Unit	Unit Cost	Quantity	Cost
Pilot Channel				
Channel Excavation Incl. Haul	CY	$50	250	$ 12,500
Streambed Material	TON	$45	0	$ -
LWM				
Helicopter Mobilization - Small Twin Rotor	LS	$30,000	1	$ 30,000
Helicopter Mobilization - Large Helicopter	LS	$55,000	1	$ 55,000
Helicopter Supplies/Fuel/Etc...	LS	$20,000	1	$ 20,000
Individual Logs	EACH	$3,000	15	$ 45,000
Log Jacks	EACH	$7,000	7	$ 49,000
Small Spur Jam	EACH	$8,000	1	$ 8,000
Large Spur Jam	EACH	$23,000	10	$ 230,000
Apex Jams	EACH	$38,000	2	$ 76,000
Riparian Restoration				
Staffing	LS	$240,000		$ -
Project Supplies	LS	$75,000		$ -
Commerical Services & Crew Time	LS	$90,000		$ -
Transportation	LS	$5,000		$ -
Office Expenses/Overhead	LS	$60,000		$ -
Signs	EACH	$5,000		$ -
Items Subtotal				**$ 525,500**
Erosion Control and Construction				
Clearing and Grubbing	LS	$15,000	1	$ 15,000
Construction Entrance/Staging Area	EACH	$5,000	1	$ 5,000
Access Road	EACH	$15,000	3	$ 45,000
Turbidity Monitoring	DAY	$250	30	$ 7,500
Cultural Resources	LS	$25,000	1	$ 25,000
Temporary Stream Diversion	LS	$40,000	1	$ 40,000
Water Control	EACH	$5,000	4	$ 20,000
Spill Pevention, Control & Countermeasures (SPCC) Plan	LS	$4,000	1	$ 4,000
ESC Lead	DAY	$300	30	$ 9,000
Items Subtotal				**$ 170,500**
Mobilization	LS	10%	1	$ 69,600
Construction Engineering Support	LS	15%	1	$ 104,400
Subtotal				**$ 870,000**
Taxes	LS	10%	1	$ 87,000
Total				***$ 957,000***

APPENDIX K: LARGE WOODY MATERIAL INVENTORY

Lower Issaquah LWM Inventory - Pieces Needed

REACH 1

Structure Type	Total Structures	Total Logs	Key Pieces (3 ft diameter, 30 ft long, with rootwad)	Non-Key Pieces (3 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2.5 ft diameter, 25 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 20 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 10 ft long, without rootwad)	Non-Key Piece (1 ft diameter, 10 ft long, with rootwad)
Single Pieces	10	10	0	0	10	0	0	0	0
Log Jack	1	4	0	1	0	0	0	3	0
Small Spur Jam	4	16	0	0	0	4	8	0	4
Large Spur Jam	4	24	8	0	0	16	0	0	0
Apex Jam	1	12	2	0	0	10	0	0	0
TOTAL		66	10	1	10	30	8	3	4

REACH 2

Structure Type	Total Structures	Total Logs	Key Pieces (3 ft diameter, 30 ft long, with rootwad)	Non-Key Pieces (3 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2.5 ft diameter, 25 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 20 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 10 ft long, without rootwad)	Non-Key Piece (1 ft diameter, 10 ft long, with rootwad)
Single Pieces	24	24	0	0	24	0	0	0	0
Log Jack	16	64	0	16	0	0	0	48	0
Small Spur Jam	1	4	0	0	0	1	2	0	1
Large Spur Jam	14	84	28	0	0	56	0	0	0
Apex Jam	2	24	4	0	0	20	0	0	0
TOTAL		200	32	16	24	77	2	48	1

REACH 3

Structure Type	Total Structures	Total Logs	Key Pieces (3 ft diameter, 30 ft long, with rootwad)	Non-Key Pieces (3 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2.5 ft diameter, 25 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 20 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 10 ft long, without rootwad)	Non-Key Piece (1 ft diameter, 10 ft long, with rootwad)
Single Pieces	8	8	0	0	8	0	0	0	0
Log Jack	0	0	0	0	0	0	0	0	0
Small Spur Jam	0	0	0	0	0	0	0	0	0
Large Spur Jam	3	18	6	0	0	12	0	0	0
Apex Jam	1	12	2	0	0	10	0	0	0
TOTAL		38	8	0	8	22	0	0	0

REACH 4

Structure Type	Total Structures	Total Logs	Key Pieces (3 ft diameter, 30 ft long, with rootwad)	Non-Key Pieces (3 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2.5 ft diameter, 25 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 20 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 10 ft long, without rootwad)	Non-Key Piece (1 ft diameter, 10 ft long, with rootwad)
Single Pieces	15	15	0	0	15	0	0	0	0
Log Jack	7	28	0	7	0	0	0	21	0
Small Spur Jam	1	4	0	0	0	1	2	0	1
Large Spur Jam	10	60	20	0	0	40	0	0	0
Apex Jam	2	24	4	0	0	20	0	0	0
TOTAL		131	24	7	15	61	2	21	1

PROJECT TOTALS

NUMBER OF PIECES PER WOOD TYPE:	**74**	**24**	**57**	**190**	**12**	**72**	**6**

KEY PIECES TOTAL **74**

TOTAL LOGS **435**

Lower Issaquah LWM Inventory - Pieces Identified

Source	Logs Identified						
	Key Pieces (3 ft diameter, 30 ft long, with rootwad)	Key Pieces (3 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 25 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 20 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 15 ft long, with rootwad)	Non-Key Piece (2 ft diameter, 10 ft long, without rootwad)	Non-Key Piece (1 ft diameter, 10 ft long, with rootwad)
TOTAL REMAINING	**74**	**24**	**57**	**190**	**12**	**72**	**6**