LOWER ISSAQUAH CREEK RESTORATION AT LAKE SAMMAMISH STATE PARK

CONCEPTUAL DESIGN REPORT

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Technical Committee

- Washington State Parks & Recreation Commission
- Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Technical Review Committee
- King County Water and Land Resources Division
- Washington State Recreation and Conservation Office

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WASHINGTON STATE PARKS

BOEING

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1 INTRODUCTION

The Mountains to Sound Greenway Trust and the Washington State Parks and Recreation Commission are partnering to study in-stream habitat and natural process improvements along the stretch of lower Issaquah Creek that flows through Lake Sammamish State Park. Funding for this effort comes through a King County Flood Control District Cooperative Watershed Management grant via the Lake Washington/Cedar/Sammamish Watershed (WRIA 8), and a grant from The Boeing Company. The Greenway Trust has contracted with Northwest Hydraulic Consultants (NHC) and sub-consultant, The Watershed Company, to evaluate alternatives and develop a conceptual design to improve this stretch of the creek as the first phase of a multi-year effort. The project primarily targets enhancing and creating salmonid fish habitat, to accommodate spawning, rearing, resting, migration, food production, protective cover (from predation), and high-flow refuge. The emphasis is on ESA-listed Chinook salmon habitat restoration and enhancement, with anticipated improvements for other fish and wildlife habitat as well, including habitat for coho, sockeye, and kokanee salmon, and cutthroat and steelhead trout. The project objectives include enhancing the quality and quantity of key, strategically located salmonid habitat, particularly for juvenile Chinook rearing and adult Chinook holding, along the lower 6,600 feet of Issaquah Creek. The current channel is incised in many locations and thus disconnected from the surrounding floodplain. This condition adversely impacts habitat for Chinook and other salmonid fish by confining moderate to high flows to a primary, single-thread channel with little high-flow refugia provided and little floodplain activation. To compound matters, there are no longer substantial sources for wood recruitment to provide structure, diversity, and habitat within the channel. The proposed conceptual design will add wood and plantings to the stream to increase hydraulic and geomorphic complexity and available cover for salmonids. Young trees planted throughout the project area will be able to grow and mature; thus providing long-term wood supply through the restoration of natural stream processes.

This report summarizes existing restoration efforts and the conceptual analysis conducted to understand existing hydrologic, hydraulic, geomorphic, and habitat conditions through the project reach. In addition, several conceptual design alternatives are presented. Ultimately, Greenway Trust, key stakeholders, and the project team will select a preferred alternative and progress through final design.

2 ON-GOING RESTORATION EFFORTS

2.1 Previous Restoration Efforts

In 2005, the Washington State Parks & Recreation Commission approached the Watershed Company to prepare a *Wetland, Stream and Lakeshore Restoration Plan* for Lake Sammamish State Park. Over 40 restoration projects were identified in that plan, separated into A, B, and C level implementation groups based on their anticipated level of required permitting. Over the last 12 years, the Greenway Trust and State Parks have partnered to implement restoration projects along Issaquah Creek, with funding from a variety of sources.

The Greenway Trust has worked closely with State Parks while implementing these projects in an effort to be sure the goals of State Parks are being met and restoration efforts are not a hindrance to reaching State Parks' goals. Future sites of bridges, trails and other infrastructure are communicated with the Greenway Trust, and a collaborated long-term plan of restoring this stretch of the creek while meeting State Parks goals is necessary.

Volunteers have played a critical role in restoration efforts along Issaquah Creek. Since 2002, more than 10,000 community volunteers have provided over 50,000 volunteer hours toward restoration projects at Lake Sammamish State Park and on other public land in Issaquah. Volunteers include employees of local businesses, youth groups, local residents, school groups, and many others.

In summary, over 40 acres of land have been restored within Lake Sammamish State Park, resulting in invasive plants being replaced with tens of thousands of native plants. Greenway Trust's ongoing goal is to keep these restoration sites maintained until they are mature enough to outcompete non-native threats, and to continue to meet other goals of State Parks.

2.2 Future Restoration Efforts

Restoration of this lower reach of Issaquah Creek will enhance and connect efforts currently taking place along Issaquah Creek in the Park and immediately upstream on property owned by the City of Issaquah. Continued removal of invasive vegetation and replanting with native species will also be planned as part of the overall habitat restoration design. These efforts will mirror those already in progress by the Greenway Trust and State Parks, and will focus on establishment of tree canopy and overhanging vegetation to provide leaf litter and terrestrial insect inputs to the stream. Both of these are important, indirectly and directly (respectively) to increase the food supply for juvenile salmonid fish. Fostering a structurally diverse native plant species community in the riparian zone with high food and cover values for native terrestrial wildlife species is also a primary goal. These measures will be implemented throughout the 100-foot jurisdictional stream buffer as much as is possible. Any additional areas disturbed by installation of large woody debris will be restored and revegetated. Long-term weeding and maintenance actions will be included to assure success of revegetation efforts.

Re-establishment of functioning stream buffers may also include removal and/or reconfiguring of the Sunset Beach parking lot to create a wider, vegetated stream buffer. Some trails may also need to be relocated; this will be coordinated with an overall trail planning effort by State Parks. With 1.3 million annual visitors to the park, this stream restoration project will be a high visibility project with a tremendous outreach and education opportunity.

3 HYDROLOGY

3.1 Watershed Analysis

At the mouth of Issaquah Creek where it flows into Lake Sammamish, Issaquah Creek drains approximately 56 square miles and receives a mean annual precipitation of 62 inches. The maximum and mean basin elevations are 2,990 feet and 897 feet, respectively. Issaquah Creek's headwaters originate in the steep slopes of Squak, Cougar, Tiger and Taylor Mountains (See Figure 1). A significant portion of the basin's upper reaches reside in Washington State Forest Lands where development has been minimal; the lower reaches reside within Issaquah's city limits; and the basin's average canopy coverage is approximated at 65.6%. Throughout the project area, Issaquah Creek is in a FEMA regulated floodway. During further stages of design, collaborating with landowners and stakeholders will be critical as there will likely be a rise in water surface elevations as a result of increased wood placement throughout the project reach. FEMA Region 10 allows for some rise within a floodway for habitat restoration projects; however, this will need to be discussed early on to ensure project timelines are met. Peak flow values from the effective FEMA Flood Insurance Study (FIS) can be found in Table 2.

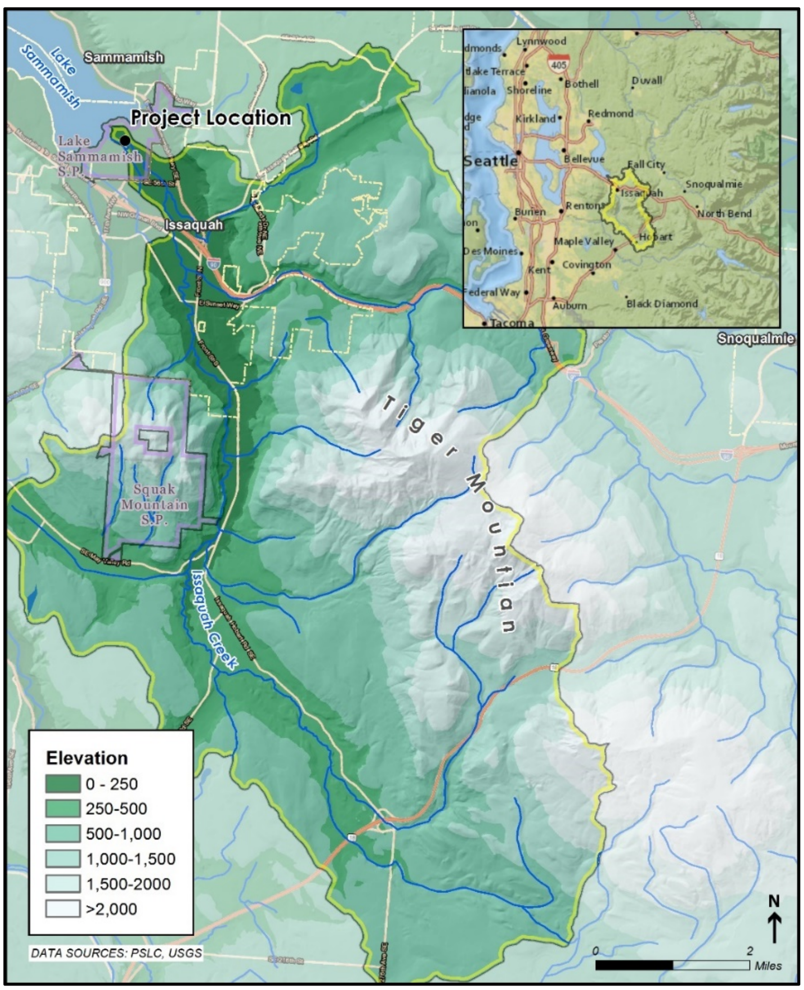


Figure 1. Project Location and Basin Overview

3.2 Peak Flow Analysis

The USGS operates a continuous recording flow gage (Gage Number 12121600) located approximately 1.1 river miles upstream of the mouth of Issaquah Creek at Lake Sammamish (Table 1). Flow data from this gage was evaluated using the U.S. Army Corps of Engineers Statistical Software Package (HEC-SSP), developed by the Hydrologic Engineering Center. Utilizing the software, a flow frequency analysis following procedures outlined in the USGS publication Bulletin 17B was performed and flood flow frequency curves were developed for estimating peak flows. These peak flow values were scaled to the basin area at the mouth of Issaquah Creek following procedures outlined in the USGS publication Magnitude, Frequency, and Trends of Floods at Gaged and Ungaged Sites in Washington. Table 2 contains the calculated peak flows for the mouth of Issaquah Creek at Lake Sammamish.

Table 1. USGS Operated Stream Gage Near the Mouth of Issaquah Creek

USGS Gage Number	Station Name / Location	Available Peak Data	Basin Area (mi^2)	Mean Annual Precipitation (in)	Maximum Basin Elevation (ft)	Mean Basin Elevation (ft)	Minimum Basin Elevation (ft)
12121600	Issaquah Creek Near Mouth Near Issaquah, WA	1964 - 2015	54.3	63	2,990	919	41.8

Because the FEMA peak flow values from the FIS resulted in higher, more conservative values, these were utilized for the conceptual design. The 1-, 2- and 25-year peak flow values were interpolated from the publish FEMA flows. Peak flow values used for the preliminary hydraulic modeling of Lower Issaquah Creek are contained in the last column of Table 2.

Table 2. Peak Flows for Issaquah Creek

Mean Recurrence Interval (MRI)	King County Flood Insurance Study At Mouth (FEMA, 2005), Flow (cfs)	Gage Analysis At Mouth from Issaquah Creek USGS Gage No. 12121600, Flow (cfs)	Lower Issaquah Creek Modeled Flow Values (cfs)
1	—	400	**450**
2	—	1,500	**1,500**
10	2,890	2,580	**2,890**
25	—	3,060	**3,400**
50	3,700	3,390	**3,700**
100	3,960	3,690	**3,960**

4 CHANNEL CONDITIONS AND PROJECT OBJECTIVES

The project reach has been divided into four distinct component reaches to better define habitat conditions and appropriate restoration strategies. The four reaches were divided based on differences between the existing channel morphology, geomorphic history, biological conditions and potential, and hydraulic processes through each reach. These four reaches are depicted in the enclosed figures in Appendix A, *Geomorphic Overview – Reach 1 through Reach 4* and described in the subsequent sections.

4.1 Reach 1

4.1.1 Geomorphology

Reach 1 consists of the transition zone from Issaquah Creek into Lake Sammamish. This reach is a relatively stable segment of channel that is influenced by Lake Sammamish. At low flow, the water surface is functionally flat and there is very little current. The bed material is dominated by sand and fine sediments, although some fine to medium-sized gravel is transported through this reach during floods. Mature trees line the channel banks (Photo 1), and large wood is recruited to the channel by windthrow; and possibly undercutting of the banks by the channel.

Photo 1. Reach 1 - View Looking Downstream From Existing Pedestrian Bridge at Station 17+50

The channel migration rate in this reach has been extremely slow over the historic record, typically ranging from less than one to two feet per year (Figure 2). The abandoned historic 19th century channel (visible in Figure 3) had a much higher sinuosity in its lowest reach, probably reflecting a long period of channel development (allowing for meanders to develop) and, possibly, the influence of human activity in forming the present channel alignment. Actions to increase the sinuosity of this reach and/or encourage development of distributary channels would accelerate formation of high-quality habitat through natural processes.

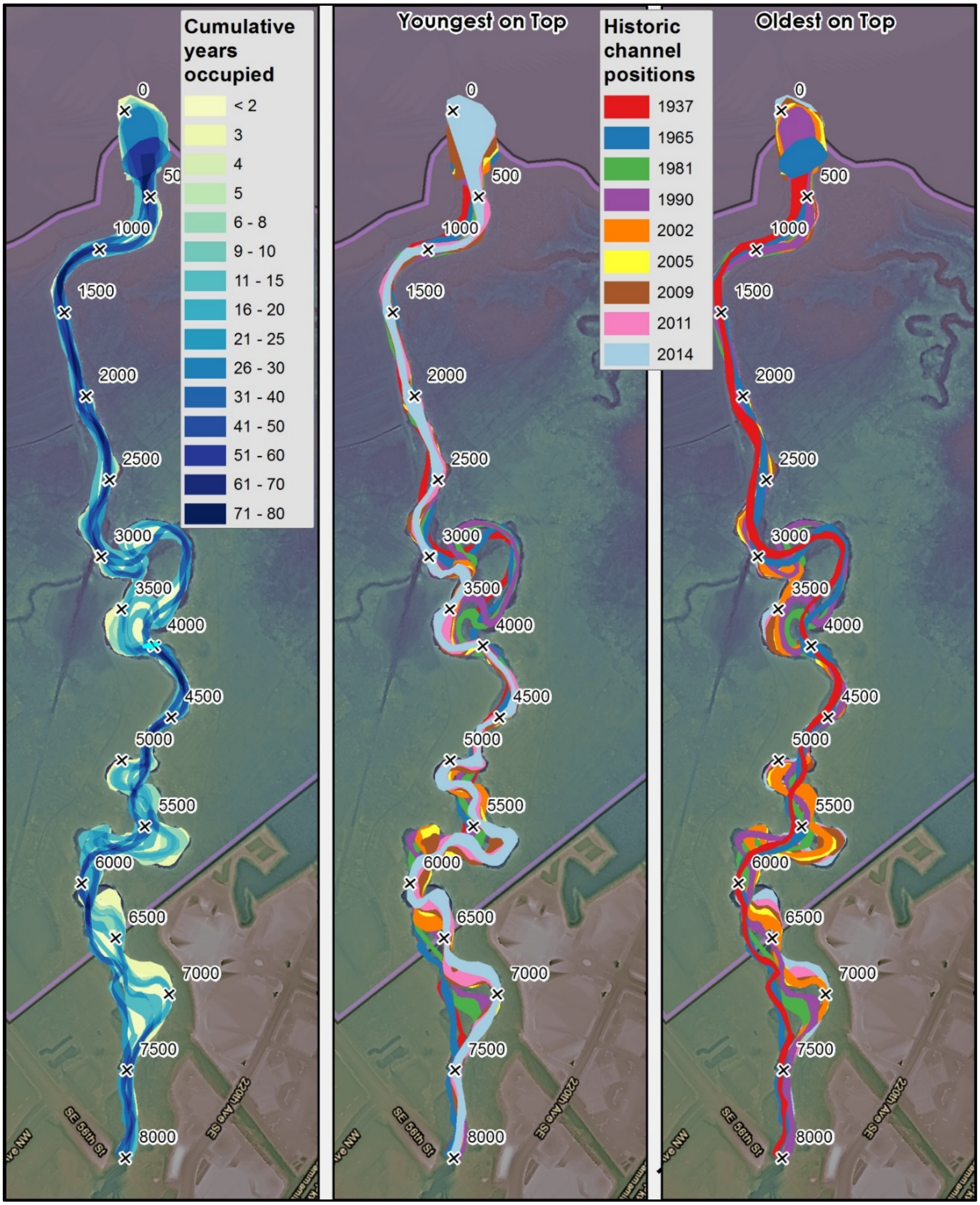


Figure 2. Summary of Historic Channel Migration Based on Aerial Photo Analysis

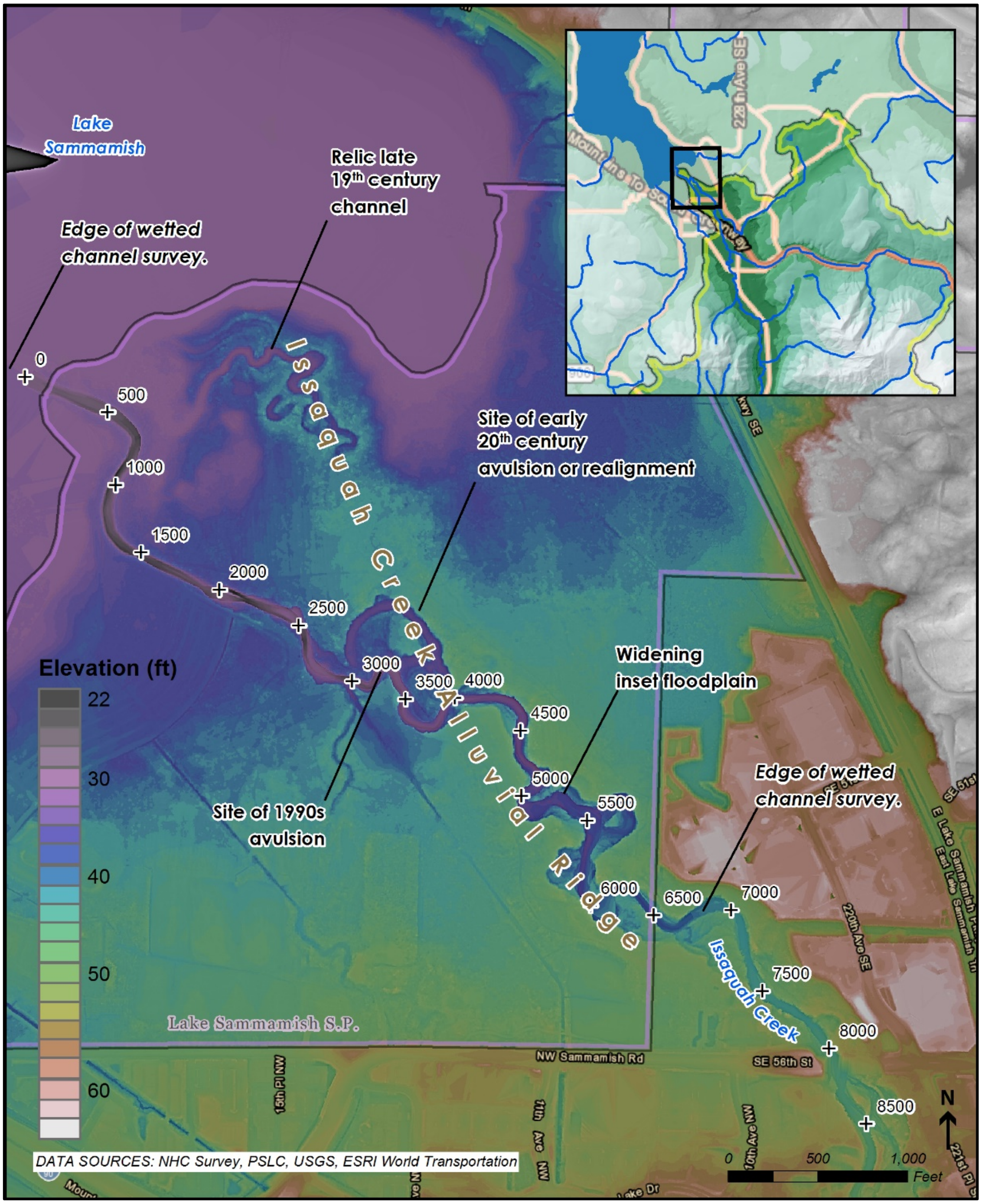


Figure 3. Topographic Base Map of Study Reach Depicting the Abandoned Historic 19th Century Channel

4.1.2 Hydraulics

Reach 1 is largely influenced by backwater from Lake Sammamish. Based on preliminary hydraulic modeling, under 10-year and larger peak flow events, the overbank areas through this reach are completely inundated (Appendix B, Figures B-7 through B-14). Under a 2-year peak flow event channel depths range between 6 and 10 feet with channel velocities ranging between 1 and 4 feet per second with small pockets as high as 7 feet per second in the upper portion of the reach. The main channel through this reach has relatively deep, uniform flow. However, with the highly activated overbank areas there is opportunity to create hydraulic diversity during high flow conditions.

4.1.3 Habitat

Within Reach 1, in-stream wood is generally limited to widely-spaced, specimen fallen trees. A previous project placed wood along the lakeshore near the mouth, but the wood was placed along the lakeshore, beyond and outside of the stream channel. Reach 1 is dominated by run-type habitat – long stretches of somewhat deep, uniform flow, with few deeper pockets and uninterrupted by riffles, primarily due to low gradient and scarce wood. Suitable spawning gravel for salmonid fish is generally not present; however, the lower stream gradient approaching Lake Sammamish is not conducive to the establishment or maintenance of such a spawning substrate. If spawning gravel were to be placed, it would quickly silt in. Some bank vegetation is present along the existing banks, but vegetated buffers are narrow, especially along the left bank downstream of the parking lot and footbridge.

Since salmonid spawning is generally not expected to occur along this reach, it functions primarily as migratory and short-term rearing habitat. Salmonid fish of several species use this reach primarily to get safely to and from spawning reaches farther upstream in Issaquah Creek and tributaries. Juvenile Chinook, in particular, tend to seek out and linger at creek mouths for short-term rearing opportunities along their seaward migration route.

4.1.4 Infrastructure

Reach 1 includes several existing trails along both river banks. Additionally, there is an existing pedestrian bridge located at Station 17+50 (see Appendix A, Figure Reach 1). Proposed conceptual design elements may effect existing infrastructure and therefore, further investigation of potential benefits/impacts to existing and planned infrastructure will continue to be examined and discussed with stakeholders to develop a multi-beneficial project.

4.1.5 Conceptual Design Objectives

Additional cover provided by wood in the channel may benefit rearing juveniles in this reach. Deep water, however, could cause unanchored individual pieces of wood to float and likely be flushed out into Lake Sammamish during flood events. More traditional anchored structures such as single pieces (Appendix C, Figure Single Pieces) or log jack key members (Appendix C, Figure Log Jack Key Member) could provide cover in existing run habitat and locally increase scour to form pools to punctuate the long runs. The existing mature trees lining the channel banks may provide opportunity for anchoring, as wood pieces could be wedged in-between or anchored to existing riparian trees. Additionally, untreated log pilings could also serve as an anchoring mechanism. The proposed conceptual design should also ensure banks are well-vegetated with native plant species and that functional vegetated buffers are sufficient width.

A relatively efficient approach to increase channel edge area and rearing habitat in Reach 1 would be to construct or induce formation of new distributary channels. To accelerate floodplain function, grading in this reach along the right bank could enhance natural stream processes and available habitat. However, this may affect existing infrastructure and/or trails and require them to be relocated outside of the natural creek corridor. As discussed above, the interaction between park infrastructure and changes in the stream corridor will continue to be examined and discussed with stakeholders to develop a multi-beneficial project.

4.2 Reach 2

4.2.1 Geomorphology

Reach 2 is the lowest fully alluvial reach of the creek and has a pool-riffle morphology. Although it is mostly downstream of the large late 19th Century/early 20th Century channel avulsion that occurred, the channel is incised, with new inset floodplain surfaces forming 4 to 8 feet below the abandoned surface of the alluvial ridge. It is dominated by a sand bed with local patches of gravel (Photo 2 and Photo 3). A meander cut-off avulsion in the 1990s left a large remnant low elevation oxbow feature in the floodplain that provides abundant off-channel refugia habitat (Appendix A, Reach 2). In addition to this abrupt avulsion event, persistent lateral channel migration in this reach (Photo 4) has recruited a substantial volume of Large Woody Material (LWM), which has accumulated into two prominent jams. Local erosion is occurring around these jams (Appendix A, Reach 2), indicating the potential for local flow obstructions to concentrate flow and widen the channel area. Deep scour occurs around small flow obstructions, probably due to the relatively fine bed material.

Photo 2. Characteristic Sandy Substrate for Reach 2 at Station 39+00 Just Below the Gravel to Sand Transition

Photo 3. Location of Pebble Count and LWM Jam Upstream in Reach 2 at Station 24+00 (Left) and Material Sampled (Right)

Photo 4. Aggressive Channel Migration, Looking Upstream from Approximately Station 36+00

4.2.2 Hydraulics

Reach 2 is hydraulically diverse with the oxbow along the right bank. Based on preliminary hydraulic modeling, during the 2-year peak flow event the oxbow along the right bank of the main stem of Issaquah Creek is activated and provides relatively low velocity (1 foot/second), low depth (1 to 3 feet) and low shear stress (less than 0.2 pounds per square foot). In the main stem, depths range between 4 and 10 feet while velocities range from 3 to 6 feet/second (Appendix B, Figures B-4 through B-6). During 100-year peak flow events, depths and velocity in the main stem reach as high as approximately 15 feet and 7 feet/second, respectively. In the oxbow and overbank areas, velocities remain low ranging between 1 and 3 feet/second (Appendix B, Figures B-16 through B-18).

4.2.3 Habitat

In Reach 2 at approximately Station 27+50, a large "old growth size" cottonwood has fallen spanning the channel and serves as an anchor for additional wood. Some bank erosion has occurred around the root end, widening the channel and possibly the beginnings of a more significant channel migration. As recently as 2014 there has been basically no wood in the lower portion of Issaquah Creek. Wood continues to accumulate due to the instream, channel-spanning jam which serves as a log filter, intercepting and storing wood mobilized upstream and keeping it from reaching the lake. Wood in Lake Sammamish would be fine for habitat, but would not be a desired outcome of the project from a lakeshore landowner or community perspective. Non-native vegetation is prevalent throughout Reach 2 with mostly open or shrubby areas. Forested areas are scarce and immature where they are present.

Pools are scoured by the log jams, beneath and around them, with abundant and complex cover provided by the tangle of wood of various sizes. These pool areas beneath and around the jams tend to provide excellent rearing habitat for juvenile Chinook and coho salmon, and holding areas for adults. Kokanee, cutthroat and steelhead would similarly make use of this habitat as well. This is the first such complex habitat adults may have encountered on their way upstream and the last that juveniles may encounter on their way downstream to the lake. Substrate conditions are less than ideal for spawning, with finer-grained materials rather than gravel prevalent. Little spawning is expected to occur along this reach, either before or after project implementation. The substrate is still sand-dominated throughout the reach, transitioning more to gravel only approaching the upper reach boundary.

4.2.4 Infrastructure

Reach 2 includes existing trails along the top of the river banks. The trail on the left bank is adjacent the channel while the trail on the right back is set back into the riparian zone (Appendix A, Figure Reach 2). Proposed conceptual design elements may effect existing infrastructure and therefore, further investigation of potential benefits/impacts to existing and planned infrastructure will continue to be examined and discussed with stakeholders to develop a multi-beneficial project.

4.2.5 Conceptual Design Objectives

Reach 2 has diverse habitat and proposed conceptual design elements should maintain the existing natural processes of this reach. This reach serves as a natural filter for wood from upstream which might otherwise end up in Lake Sammamish. Bank erosion due to jam formation is a natural process and results in channel migration which, in turn recruits additional wood.

All proposed wood element types (Appendix C, Figures Single Pieces through Spur Log Jam) could provide beneficial habitat function as well as wood and sediment recruitment. Additionally, placement of piles, flood fencing, or other features could be utilized to retain existing accumulating wood and ensure that the wood-filtering function of this section remains intact. Utilizing wood structures for capturing and retaining additional wood and sediment could also result in material being recruited in the upper reaches; thus further preventing material from being transported to Lake Sammamish.

4.3 Reach 3

4.3.1 Geomorphology

Reach 3 occurs immediately upstream of the site of the Late 19th Century/Early 20th Century Avulsion (Figure 3). It is highly entrenched, with 8 to 12 feet of offset between the elevation of inset floodplain features and the top of bank. The reach has gravel-dominated substrate and a strongly concave profile. Lateral channel migration in the reach has been extremely limited, leaving a straight channel with steep banks, little hydraulic diversity, and almost no off-channel refugia habitat (Photo 5). The reach is immediately above the gravel to sand transition and bed material in the reach is gravel-dominated.

Habitat restoration measures in this reach should focus on increasing hydraulic diversity and encouraging the initiation of new meander features, which would be expected to migrate laterally and increase the quantity of available low-elevation floodplain habitat.

Photo 5. View Looking Upstream From Approximately Station 46+00 Showing Characteristic Confinement of the Channel in Reach 3

4.3.2 Hydraulics

Reach 3 is highly entrenched and disconnected from the surrounding floodplain resulting in high velocities, flow depths and shear stress. Based on preliminary hydraulic modeling, all flood events up to the 100-year peak flow event, are contained within the channel with little to no floodplain inundation (Appendix B, Figures B-1 through B-18). During a 2-year peak flow event channel depths range between 6 and 10 feet with channel velocities ranging between 4 and 6 feet per second (Appendix B, Figures B-4 and B-5). During a 100-year peak flow event channel depths range between 9 and 14 feet with channel velocities ranging between 4 and 8 feet per second (Appendix B, Figures B-16 and B-17). This reach would benefit from grading of a floodplain bench and incorporation of wood to reconnect the floodplain and provide more hydraulic diversity.

4.3.3 Habitat

Reach 3 has limited habitat features in terms of wood and pool/riffle sequence. The reach is narrow and incised with little wood and simple, fairly uninterrupted run habitat with little pool or riffle habitat. In 2015 a beaver dam spanning the entire channel width was observed at the upstream end of Reach 3. However, the dam has since been washed out and the wood transported downstream. More wood would improve downward as well as lateral erosion to form and deepen pools as well as provide cover.

The reach contains more gravel, less fines as you proceed upstream. Localized riffle areas could provide limited spawning habitat for Chinook, though their primary spawning areas outside the hatchery occur farther upstream where the substrate tends to be coarser. The smaller salmonid fish, such as kokanee, coho, and cutthroat, tend to use a smaller substrate size for spawning, such as is found in the project area; however, they also tend to spawn in smaller streams. Water velocities and depths in the lower main stem of Issaquah Creek during spawning periods may be less than ideal for these smaller fish.

The channel through this reach has moved little during the past century. As such, banks are relatively stable, but also near-vertical in places, and such stability does not necessarily lend itself to the development and maintenance of good habitat characteristics, for fish or other wildlife. A migrating channel would lead to bar and floodplain formation, as well as in-stream pool and riffle habitat.

4.3.4 Infrastructure

Reach 3 includes existing trails along both river banks (Appendix A, Figure Reach 3). As identified in previous studies, this reach would make a good location for a proposed bridge to connect State Park trails on the north and south sides of the creek due to its stability, however this conflicts with promoting channel migration and reconnecting the surrounding floodplain. Further discussion for bridge structure locations, structure types and structure spans will continue to develop a mutually beneficial solution to promote natural stream processes while providing a safe location for a new trail bridge.

4.3.5 Conceptual Design Objectives

Wood may be placed to actively encourage channel migration or a more passive approach employed whereby habitat features are placed irrespective of migration. As discussed previously, this non-migrating section may be a good location to place a bridge for trail connections, conversely such a bridge, depending on structure type and span length, may require bank armoring to preserve the bridge and thereby prevent channel migration to the detriment of habitat. Discussions will continue to take place to find a balance between the infrastructure and habitat enhancements.

A fairly high density of wood, should be placed along this reach to destabilize the channel somewhat and encourage natural, habitat-forming processes in an otherwise fairly simple and stable, somewhat sterile reach from a habitat perspective. Such dense wood placement may initiate channel migration processes, with attendant wood recruitment, bar and floodplain formation, jam formation, pool formation and abundant cover for both juveniles and adults. Preservation of a strategic, short, stable section, as feasible, could accommodate placement of a shorter and less costly bridge structure.

In order to achieve the dynamic configurations in concert with channel-forming processes, as described above, wood placed along Reach 3 should include limited and in some cases no anchoring. Options for limiting wood mobility without over anchoring include using logs that are too long and/or too massive to be mobile, attaching logs together to increase their collective mass, and/or pinning or otherwise configuring them in rigid shapes less prone to movement.

Reestablishment of floodplain areas will encourage overbank deposition of fines. Specifically, vegetation management on both banks to remove non-native invasive species and establish a forested condition based on native tree and understory species. Overbank deposition of fines is encouraged by dense vegetation, particularly fine-mesh groundcover, tall grasses, etc. This can reduce fines reaching Lake Sammamish and the lower reaches, and increase the proportion of gravel for the substrate remaining in the channel. Less fines and more gravel means better spawning substrate and habitat for aquatic insect production (food supply for juvenile salmonid fish). Additionally, deposition of fines on the floodplain retains nutrients for use by riparian vegetation and reduces nutrient loading to Lake Sammamish where it is problematic with respect to contributing to algae blooms and associated eutrophication.

Log structure placement and overall supply of woody materials is to occur in such a manner as to accommodate and facilitate the retention and accumulation of spawning gravel of a size range and gradation suitable for use by spawning Chinook salmon and other salmonid fish.

4.4 Reach 4

4.4.1 Geomorphology

Reach 4 is defined by the area where channel downcutting has been followed by major-channel widening and floodplain formation due to channel migration. The growth of a gravel wedge into this reach following initial downcutting has resulted in persistent (reach-average rates of 4 to 8 feet/year) and at times rapid (up to a reach-average rate of 20 feet per year) lateral channel migration (Photo 6). This has produced a reach with high hydraulic complexity including large areas of off-channel habitat (including one large backwater pool in an abandoned oxbow—Photo 7).

Riparian forest vegetation in the reach is relatively limited, and in one area protected from channel migration by a riprap revetment. As a consequence, the channel is relatively lacking in wood. Increased stable large wood in this reach would increase local-scale hydraulic diversity and provide cover for rearing juveniles.

Photo 6. Example of Rapidly Growing Gravel Bar and Aggressively Migrating Meander in Reach 4; View is Looking Upstream From Approximately Station 50+00

Photo 7. Large Backwater Pool in Oxbow at Approximately Station 54+00

4.4.2 Hydraulics

Reach 4 provides hydraulic diversity, including one large backwater pool and an oxbow (Photo 7). Based on preliminary hydraulic modeling, the oxbow is activated under low flow conditions (Appendix B, Figure B-1), with depths during a 2-year peak flow reaching as high as 7 feet. In the main channel during a 2-year peak flow depths range between 4 and 9 feet and velocities range between 3 to 6 feet per second with small isolated areas as high as 7 feet per second (Appendix B, Figures B-4 through B-6). During a 100-year peak flow, water depths range between 8 and 13 feet in the main channel and velocities range between 4 and 7 feet per second with small isolated areas as high as 8 feet per second (Appendix B, Figures B-16 through B-18).

4.4.3 Habitat

A few medium- to large-sized logs have been deposited along Reach 4, but far fewer than would be needed for properly functioning conditions or for optimized fish and wildlife habitat overall. Relatively little wood is recruited from upstream in part due to the urbanized nature of the reaches extending upstream. The channel is prevented from migrating within the City of Issaquah to protect property and infrastructure, and any significant log jams forming or threatening to form there would likely be removed to prevent flooding.

The existing channel banks are vertical cut-banks in the direction of migration, with point bars, floodplain benches, and less steeply sloped banks in the direction opposite the active migration. However, the migrating channel sections pass through non-forested areas often dominated by invasive, weedy vegetation which recruit little woody material to the channel and does not slow migration. These same weedy, invasive plants re-colonize the newly-formed bar, floodplain, and bank areas on the banks opposite the active erosion. Some outside-bend pools have formed in association with channel migration, however these tend to be of only moderate depth and are run-like in the absence of much wood. Additional wood would increase scour and deepen pools as well as provide cover.

As for Reach 3, existing localized riffle areas throughout Reach 4 may function as limited spawning habitat for Chinook, but their primary non-hatchery spawning areas are more likely to occur farther upstream where the substrate tends to be coarser. However, as mentioned above, the addition of wood throughout this reach would provide increased cover and refugia. The other salmonid fish using Issaquah Creek are also more likely to spawn farther upstream, though typically in smaller, tributary stream sections

As a secondary benefit, Reach 4 also provides perhaps the best potential spawning and adult holding habitats for kokanee within the overall project reach, with suitable pockets of gravel associated with bars between Stations 47+00 and 75+00 (Reach 4 and extending upstream off-site). However, during the typical spawning window for the local kokanee population from November through January, existing flow velocities that come with elevated discharge during the rainy season may generally be too high for kokanee spawning. The substrate class distribution is within the preferred range for kokanee (typically mostly 0.5-1.5 inches with smaller amounts up to 3 inches), but the velocities and depths may generally be too limiting.

4.4.4 Infrastructure

Reach 4 includes existing trails along the top of the river banks as well as a pump house located about Station 61+00. Both trails are set back into the riparian zone (Appendix A, Figure Reach 4). Proposed conceptual design elements may effect existing infrastructure and therefore, further investigation of potential benefits/impacts to existing and planned infrastructure will continue to be examined and discussed with stakeholders to develop a multi-beneficial project.

4.4.5 Conceptual Design Objectives

A large amount of wood should be placed along Reach 4 to mitigate the minimal wood being transported downstream as well as the insufficient material supplied along the banks through the migration zone. Wood should be included to enhance the existing deeper pools and provide the wood cover needed to form productive and effective juvenile rearing and adult holding habitat. Variability should be included in the wood elements and all conceptual design alternatives (Appendix C, Figures Single Pieces through Spur Log Jam) should be utilized throughout Reach 4 to provide complexity with the variety of shapes, sizes, species and durability. The proposed conceptual design should allow for natural stream processes to occur along this reach, including allowing the wood configuration to be in a state of flux over time resulting from the dynamic interplay of the factors contributing to channel dynamics. Additionally, large amounts of small woody debris should be included. Smaller wood is important for providing protective cover for juveniles and microhabitats of low water velocity, especially during high-flow events, and is a crucial component of productive and diverse rearing habitat.

As described for Reach 3, wood placed along Reach 4 should include limited and in some cases no anchoring. Options for limiting wood mobility without over anchoring include using logs that are too long and/or too massive to be mobile, attaching logs together to increase their collective mass, and/or pinning or otherwise configuring them in rigid shapes less prone to movement.

Reestablishment of floodplain areas will encourage overbank deposition of fines. This can reduce fines reaching Lake Sammamish and the lower reaches, and increase the proportion of gravel for the substrate remaining in the channel. Less fines and more gravel means better spawning substrate and habitat for aquatic insect production (food supply for juvenile salmonid fish). Overbank deposition of fines is to be encouraged by dense vegetation, particularly fine-mesh groundcover; tall grasses etc. Deposition of fines on the floodplain retains nutrients for use by riparian vegetation and reduces nutrient loading to Lake Sammamish where it is problematic with respect to contributing to algae blooms and associated eutrophication.

Log structure placement and overall supply of woody materials is to occur in such a manner as to accommodate and facilitate the retention and accumulation of spawning gravel. Floodplain re-engagement and the placement of stout, keyed-in woody debris will help to retain and store those materials for possible use by fish, as a spawning substrate over time.

5 CONCEPTUAL DESIGN DESCRIPTION

Conceptual designs to achieve the objectives described in Section 4 are illustrated in Appendix D and described in the following sections. Two conceptual alternatives are presented for each reach, with Alternative 1 generally representing a less aggressive approach and Alternative 2 generally involving more engineered wood structures and grading actions. The two alternatives are independent of each other from reach to reach and a no action alternative may be deemed appropriate in some cases —that is to say that the ultimately preferred design might, as an arbitrary example, consist of Alternative 2 in Reach 1, Alternative 1 in Reaches 2 and 3, and no action in Reach 4. Each alternative is scalable to ultimately arrive at a solution which provides the most benefit for project funding. For this reason, alternatives are described separately by reach in the following text.

5.1 Reach 1

As described in Section 3, the primary goals in Reach 1 are to increase available woody debris cover within the perennially wetted channel, increase total habitat area and increase edge habitat in the transition zone from the creek into the lake. Important infrastructure in the reach includes a pedestrian bridge that crosses the channel at approximately Station 18+00 and a Boardwalk trail that follows the creek between approximately Stations 5+00 and 14+00. Additionally, an undeveloped pedestrian trail follows along the creek's right bank through the entire reach. The conceptual alternatives described here are designed to meet the primary goals of Reach 1; but in addition, although not designed with the explicit intent to protect the existing infrastructure, may decrease channel-migration related risk to it. During future project phases, careful hydraulic and sediment transport/geomorphic analyses will be required to ensure the long-term function of the proposed conceptual designs in this reach and would be required to evaluate the magnitude of risk to the existing infrastructure present under existing and proposed channel conditions.

5.1.1 Alternative 1

Alternative 1 consists of three key elements:

1. Approximately 30 single pieces of wood placed throughout the reach to increase cover. These are placed at locations where they can be anchored/wedged against existing riparian trees and along the outside of meander bends where higher velocity secondary currents should maintain scoured conditions around the wood structure (as opposed to the expected infilling sediment if they were placed on the inside of bends).
2. A pilot channel intended to trigger the formation of a distributary channel that would ultimately connect it to the historic Issaquah Creek channel near its outlet into Lake Sammamish. This channel would consist of an approximately 1,000 cubic yards of excavation through the creek's natural right bank levee allowing flow to spill into a low floodplain wetland environment where it could flow to the northeast towards the historic creek channel.
3. A set of engineered spur and apex log jams at the pilot channel offtake location designed to push flow from the existing channel into the pilot channel.

5.1.2 Alternative 2

Alternative 2 consists of five key elements:

1. Approximately 35 single pieces of wood place throughout the reach to increase cover (similar to Alternative 1).
2. A constructed distributary channel that connects the existing creek channel all the way to the historic Issaquah Creek channel to the northeast and includes placement of wood pieces and structures along the new channel.
3. A set of engineered spur and apex log jams at the constructed distributary channel offtake location designed to push flow from the existing channel into the pilot channel (as with Alternative 1). Detailed hydraulic and sediment transport calculations will be required to optimize this design and determine which elements are most beneficial.
4. A set of spur jams between the existing pedestrian bridge and offtake channel location designed to increase thalweg sinuosity and low-moderate flow channel hydraulic diversity.
5. A set of spur jams placed along the left bank between approximately Stations 11+00 and 13+00 designed to increase available cover and hydraulic complexity and discourage channel migration towards the boardwalk trail.

5.2 Reach 2

Reach 2 is the lowest fully alluvial reach of the creek and includes a strongly concave channel profile. Reach 2 has diverse habitat and proposed conceptual design elements should maintain the existing natural processes of this reach. Furthermore, it naturally serves as a filter for wood transported from upstream which might otherwise end up in Lake Sammamish. Increasing the reliability of this function will allow placement of less engineered wood in upstream areas. Additionally, the remnant low elevation oxbow feature left by the 1990s avulsion provides abundant off-channel refugia habitat at present, and thus provides a unique opportunity to improve habitat within the active channel. At further stages of design, the effects of the increased wood volume within Reach 2 will be evaluated to minimize effects to the stormwater ditch located at approximately Station 30+00.

5.2.1 Alternative 1

Reach 2 Alternative 1 has six key elements:

1. A set of anchored individual wood pieces near Station 20+00 designed to provide cover and increase channel hydraulic complexity.
2. A set of two spur jams and one apex jam at approximately Station 25+00 designed to act as a reliable long-term collector for wood transported to the reach from upstream. This would prevent loss of wood from the creek and transport into Lake Sammamish where it may pose or be perceived as a hazard.

3. Approximately 30 individual pieces of wood placed strategically where high banks allow self-ballasting or where they can be wedged amongst existing riparian trees. This wood will increase channel hydraulic complexity and available cover. Some future mobilization, transport, and reorganization of this material would be expected over time.
4. Approximately 5 log jacks placed throughout the reach at locations where large wood would naturally be expected to accumulate. These features are expected to initiate local scour resulting in their own partial burial and long-term stability, such that they may form the nucleus of future large wood jams.
5. An apex jam at approximately Station 31+00 designed to split the flow and increase connectivity of the riparian floodplain and historic oxbow.
6. An apex jam, spur jam, and excavated pilot channel (approximately 350 cubic yards) designed to split the flow and increase hydraulic complexity. This pilot channel is located in recently deposited sediment, minimizing cultural resources risks. Material from the excavated pilot channel could be utilized to backfill the apex jam.

5.2.2 Alternative 2

Reach 2 Alternative 2 has six key elements:

1. A set of anchored individual wood pieces near Station 20+00 designed to provide cover and increase channel hydraulic complexity.
2. A set of two spur jams and one apex jam at approximately Station 25+00 designed to act as a reliable long-term collector for wood transported to the reach from upstream. This would prevent loss of wood from the creek and transport into Lake Sammamish where it may pose or be perceived as a hazard.
3. A pilot channel at approximately Station 40+00 designed (in conjunction with wood described below) to split the flow and reactivate the historic oxbow feature. The excavation at this site would be through relatively high ground and have a total volume of about 1,000 cubic yards. Excavated material could be disposed of locally outside of the active floodplain, but the excavation will involve older Holocene sediment.
4. An extensive volume of large wood and large wood structures placed mostly between Stations 30+00 and 40+00 designed to induce sedimentation and raise the channel grade upstream at the site of the pilot channel increasing hyporheic exchange and activating the historic oxbow channel.
5. An apex jam placed in the left bank floodplain to increase complexity of the new channel and protect the existing relatively mature riparian forest within the historic oxbow, allowing it to continue to mature.
6. Various wood pieces and small structures placed throughout the historic oxbow feature to provide cover and increase hydraulic diversity.

5.3 Reach 3

Reach 3 occurs immediately upstream of the site of the Late 19th Century/Early 20th Century Avulsion and has had little to no channel migration since then. The reach consists of highly entrenched conditions with high flow velocities and relatively little available rearing or adult holding habitat and potential fish passage barrier conditions during higher flow conditions. Habitat restoration measures in this reach are designed to increase hydraulic diversity and encourage the initiation of new meander features, which are expected to migrate laterally and increase the quantity of available low-elevation floodplain habitat. As discussed in Section 4.3, this reach represents a good, cost-effective location for an additional pedestrian crossing across the creek. Collaboration with State Parks will continue to take place to provide a design solution that is forward compatible with the long term comprehensive State Parks trail plan. Alternative 2 presents an approach designed to harmonize this value with the habitat restoration goal of floodplain creation.

5.3.1 Alternative 1

Reach 3 Alternative 1 consists of two key sets of elements:

1. Various large wood structures and individual pieces placed to increase thalweg sinuosity, channel hydraulic complexity and direct flow against the banks to initiate meander formation.
2. Bank scraping to remove existing root strength and increase the likelihood of meander formation.

5.3.2 Alterative 2

Alternative 2 for Reach 3 provides the same design features as Alternative 1, but the narrow floodplain at the location of the upstream most meander is maintained and protected to allow for the potential placement of a pedestrian bridge at that location. In addition to elements 1 and 2 from Alternative 1, Alternative 2 includes a set of wood spur structures and anchored wood revetments to create a gradual funnel-transition from active channel migration in Reach 4 to desired stability under the potential location for the bridge. Providing features in Reach 3 that promote increased channel sinuosity and activation of floodplain habitat would best meet project objectives for the reach. Placing the proposed bridge at the upstream end of the reach, allows for an increased area of channel sinuosity downstream of the bridge, without the potential of adversely affecting a new structure.

5.4 Reach 4

Channel migration following initial incision in Reach 4 has restored a large area of floodplain and most large-scale geomorphic processes, but has limited transport from upstream riparian forests which results in low large wood concentrations throughout the reach. The primary goal for restoration actions in Reach 4 is to increase the total load of stable to partially stable large wood in the reach so as to provide abundant cover, hydraulic diversity, and hyporheic exchange along the reach.

5.4.1 Alternative 1

Reach 4 Alternative 1 consists of three key elements:

1. Removal of riprap along the left bank at approximately Station 60+00. If this riprap is protecting important buried infrastructure, then spur jams should be considered on the waterward side of the revetment.
2. Placement of approximately 13 log jacks to initiate the formation of LWM jams in a wide range of geomorphic positions relative to the channel.
3. Placement of approximately 20 individual pieces of wood placed strategically where high banks allow self-ballasting or where they can be wedged amongst existing riparian trees. This wood will increase channel hydraulic complexity and available cover. Some future mobilization, transport, and reorganization of this material would be expected.

5.4.2 Alternative 2

Reach 4 Alternative 2 consists of seven key elements:

1. Removal of riprap along the left bank at approximately Station 60+00. If this riprap is protecting important buried infrastructure, then spur jams should be considered on the waterward side of the revetment.
2. Placement of approximately 7 log jacks in conjunction with other structure types to initiate the formation of LWM jams in a wide range of geomorphic positions relative to the channel.
3. Placement of approximately 14 individual pieces of wood placed strategically where high banks allow self-ballasting or where they can be wedged amongst existing riparian trees. This wood will increase channel hydraulic complexity and available cover. Some future mobilization, transport, and reorganization of this material would be expected.
4. Placement of apex jams to encourage stable island formation in the floodplain and pool formation in the channel. Jams at Stations 51+00, 57+00 and 61+00 are placed in the middle of the active channel to encourage the development of flow splits. Jams at Stations 49+00 and 55+00 are designed to protect existing islands and allow development of mature riparian vegetation.
5. Placement of spur jams at approximately Stations 56+00 and 57+00 to encourage scour of pools.
6. Excavation of a pilot channel (approximately 350 cubic yards) at the upstream most apex jam to split the flow and accelerate development of hydraulic complexity. This pilot channel would be excavated in recently deposited sediment, minimizing cultural resources risks. Material from the excavated pilot channel could be utilized to backfill the apex jam.
7. Construction of two spur jams at the location of the revetment protecting a State Parks Pump House facility on the left bank near Station 62+00. These jams would prevent possible future channel migration from becoming entrained against the existing riprap revetment. They should be buried below the present water table to increase the wood longevity because channel migration into this area is possible, but not necessarily expected within the next couple of decades.

6 PREFERRED ALTERNATIVE SELECTION

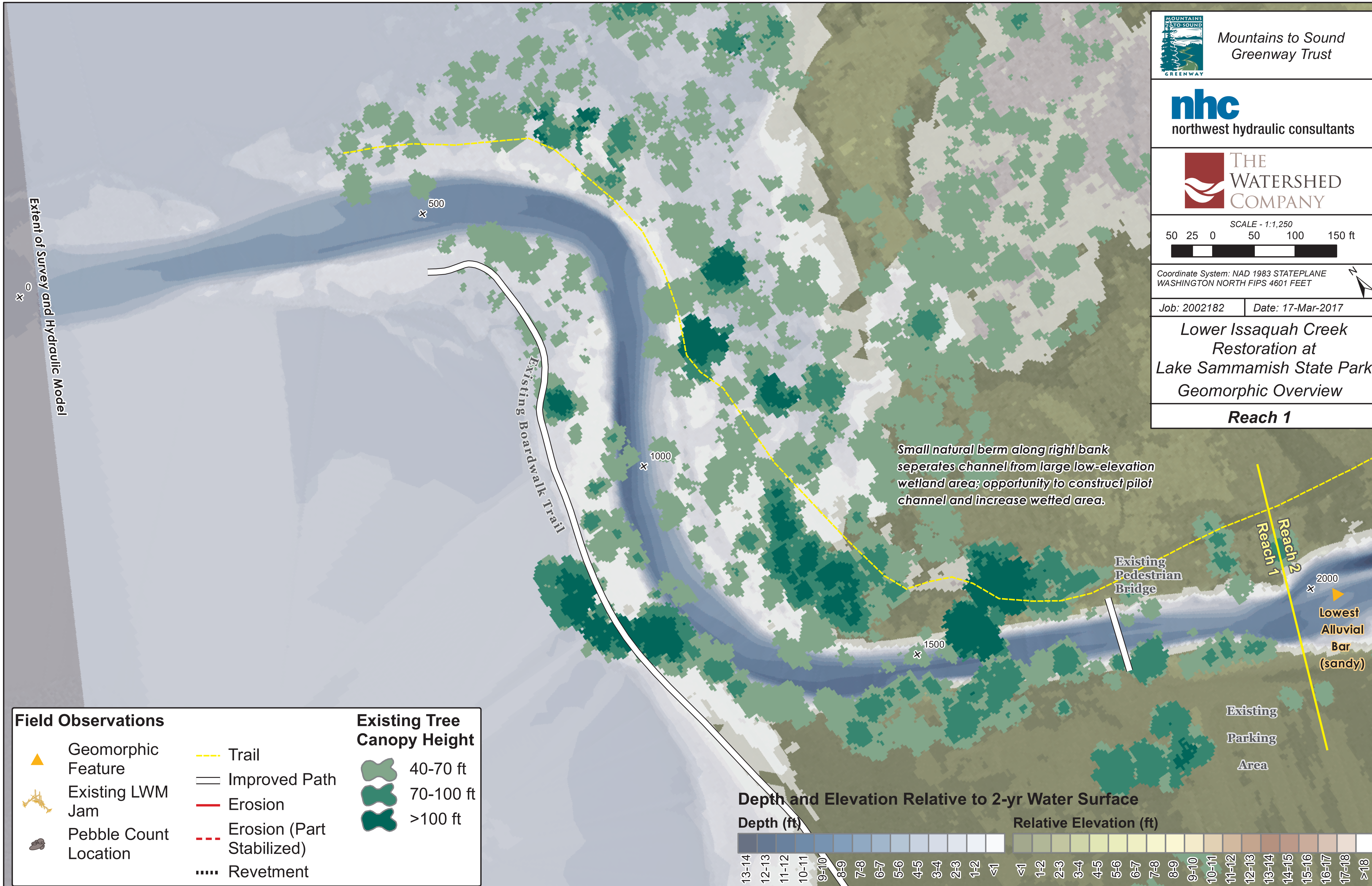
Through extensive stakeholder involvement, Alternative 2 was chosen as the preferred alternative as is discussed in Appendix E.

7 CONCEPTUAL COST ESTIMATE

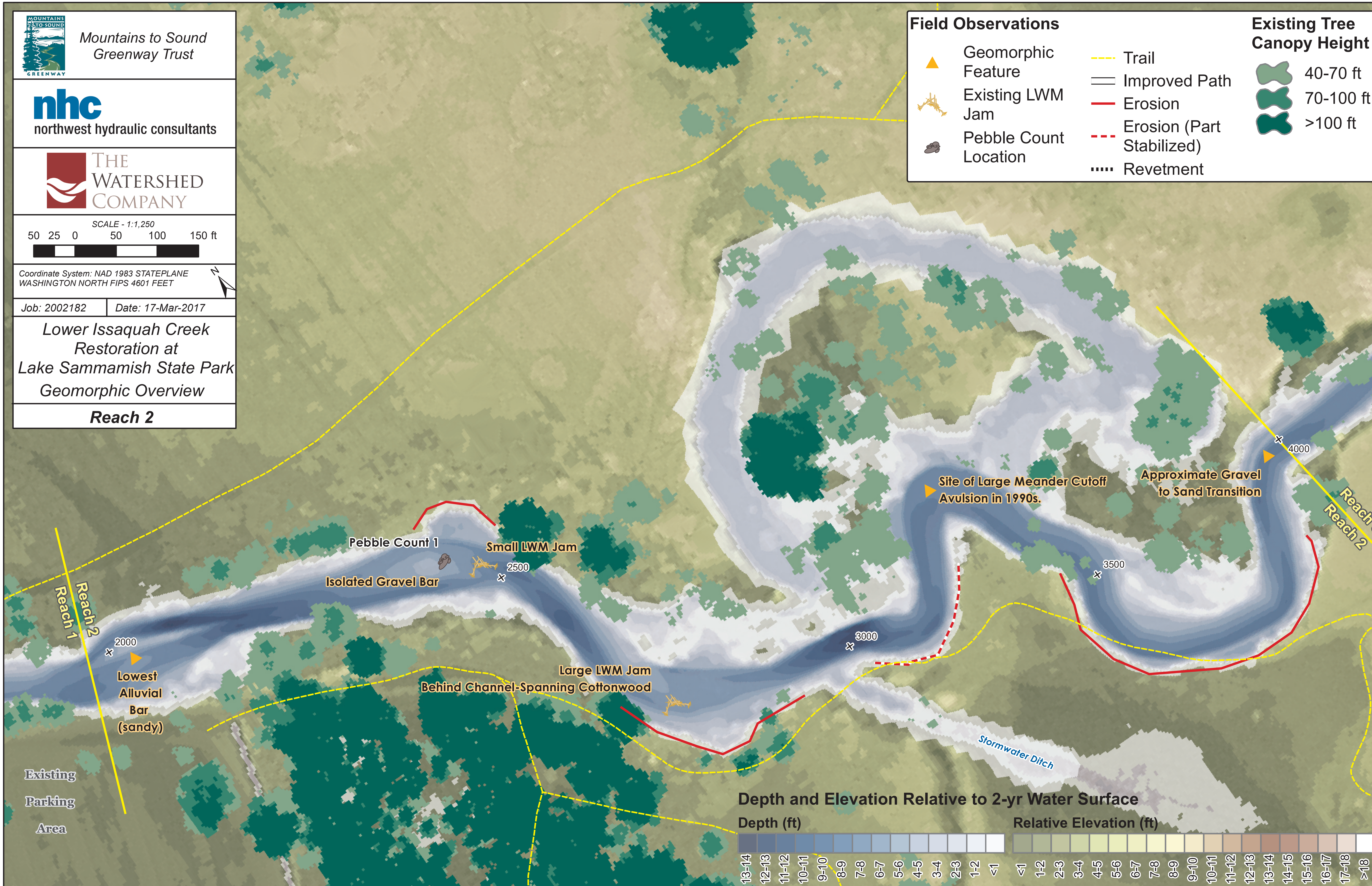
A conceptual cost estimate for implementing Alternative 2 was evaluated. As previously discussed, each reach is independent which provides a scalable design to ultimately arrive at a solution that offers the most benefit with available project funding. At later stages of design, a phased approach of Alternative 2 will be evaluated depending on available project funding and input from stakeholders.

Based on correspondence with stakeholders, Alternative 2 was chosen, which is expected to cost roughly $2.5 million. The WSDOT Bid Tabs was utilized to determine material costs and should be re-evaluated at later stages of design. Changes in prevailing wages, material availability, hauling costs, etc, could affect bid prices. The items evaluated for Alternative 2 include material costs for the LWM, pilot channels, and potential planting measures as well as construction costs such as potential dewatering and temporary erosion and sediment control measures. All quantities were developed on a conceptual level and should be re-evaluated at later stages of design once additional project details are determined.

APPENDIX A – Geomorphic Overview



Mountains to Sound Greenway Trust
nhc northwest hydraulic consultants
The Watershed Company
SCALE - 1:1,250
50 25 0 50 100 150 ft
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 1
Extent of Survey and Hydraulic Model
0
500
1000
1500
2000
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
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



Mountains to Sound Greenway Trust
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SCALE - 1:1,250
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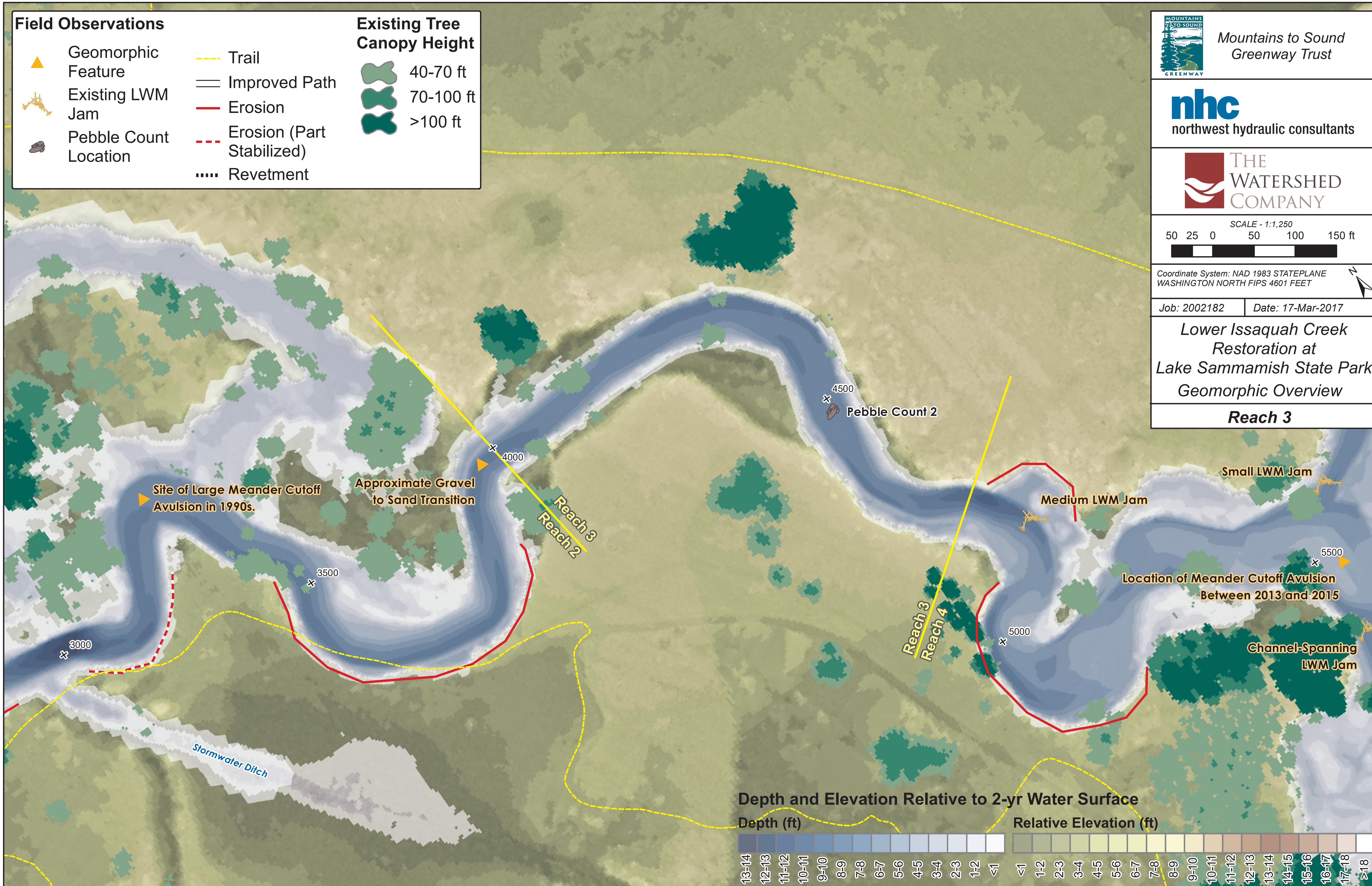
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
N
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Geomorphic Overview
Reach 2
Field Observations
Geomorphic Feature
Existing LWM Jam
Pebble Count Location
Trail
Improved Path
Erosion
Erosion (Part Stabilized)
Revetment
Existing Tree Canopy Height
40-70 ft
70-100 ft
>100 ft
Reach 1
Reach 2
2000
Lowest Alluvial Bar (sandy)
Pebble Count 1
Small LWM Jam
Isolated Gravel Bar
2500
Large LWM Jam Behind Channel-Spanning Cottonwood
3000
Site of Large Meander Cutoff Avulsion in 1990s.
3500
Approximate Gravel to Sand Transition
4000
Reach 3
Reach 2
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 >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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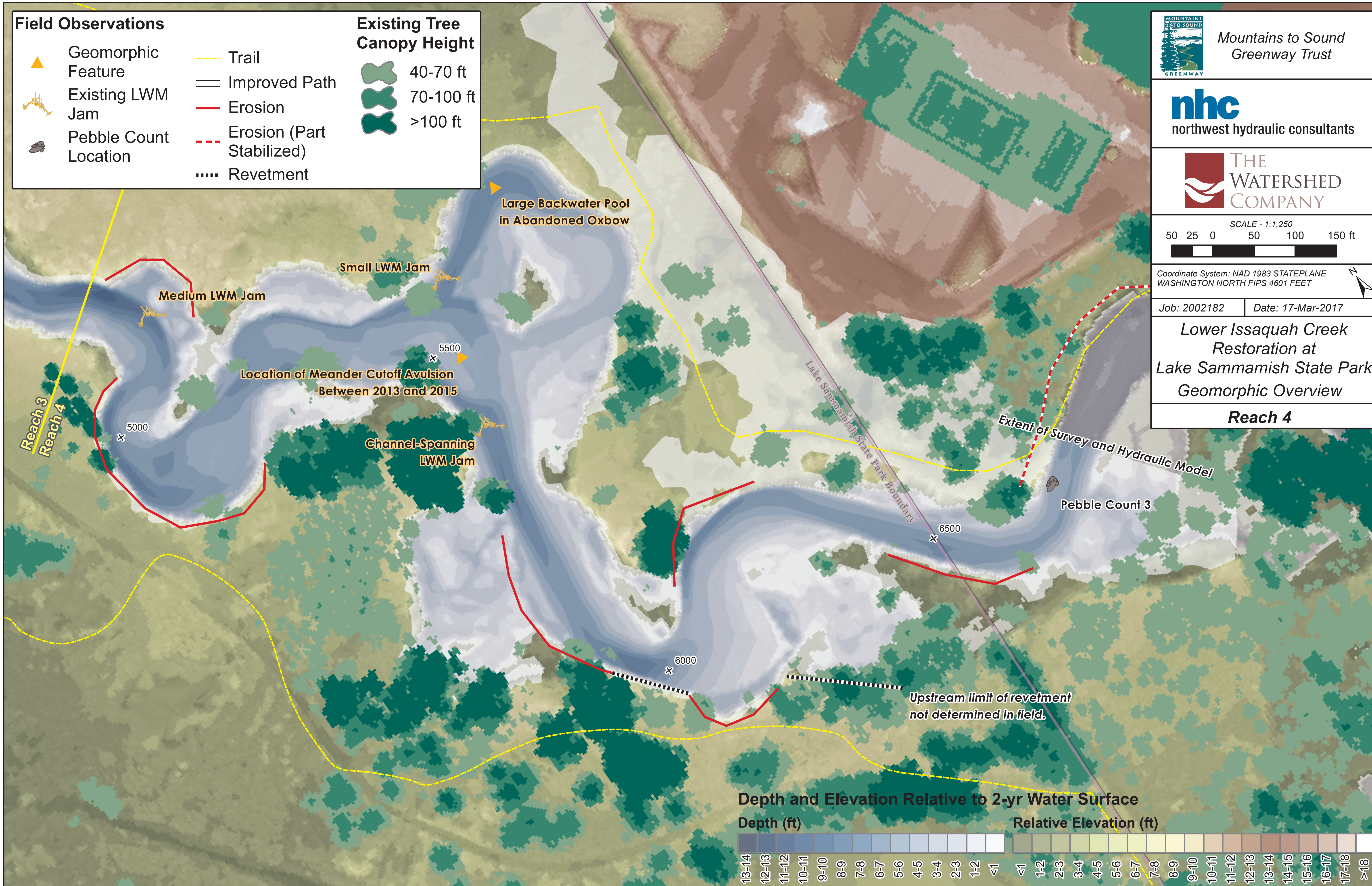
SCALE - 1:1,250
50 25 0 50 100 150 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Geomorphic Overview
Reach 3
Site of Large Meander Cutoff Avulsion in 1990s.
Approximate Gravel to Sand Transition
Reach 3
Reach 2
Pebble Count 2
Reach 3
Reach 4
Medium LWM Jam
Small LWM Jam
Location of Meander Cutoff Avulsion Between 2013 and 2015
Channel-Spanning LWM Jam
Stormwater Ditch
3000
3500
4000
4500
5000
5500
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
Mountains to Sound Greenway Trust
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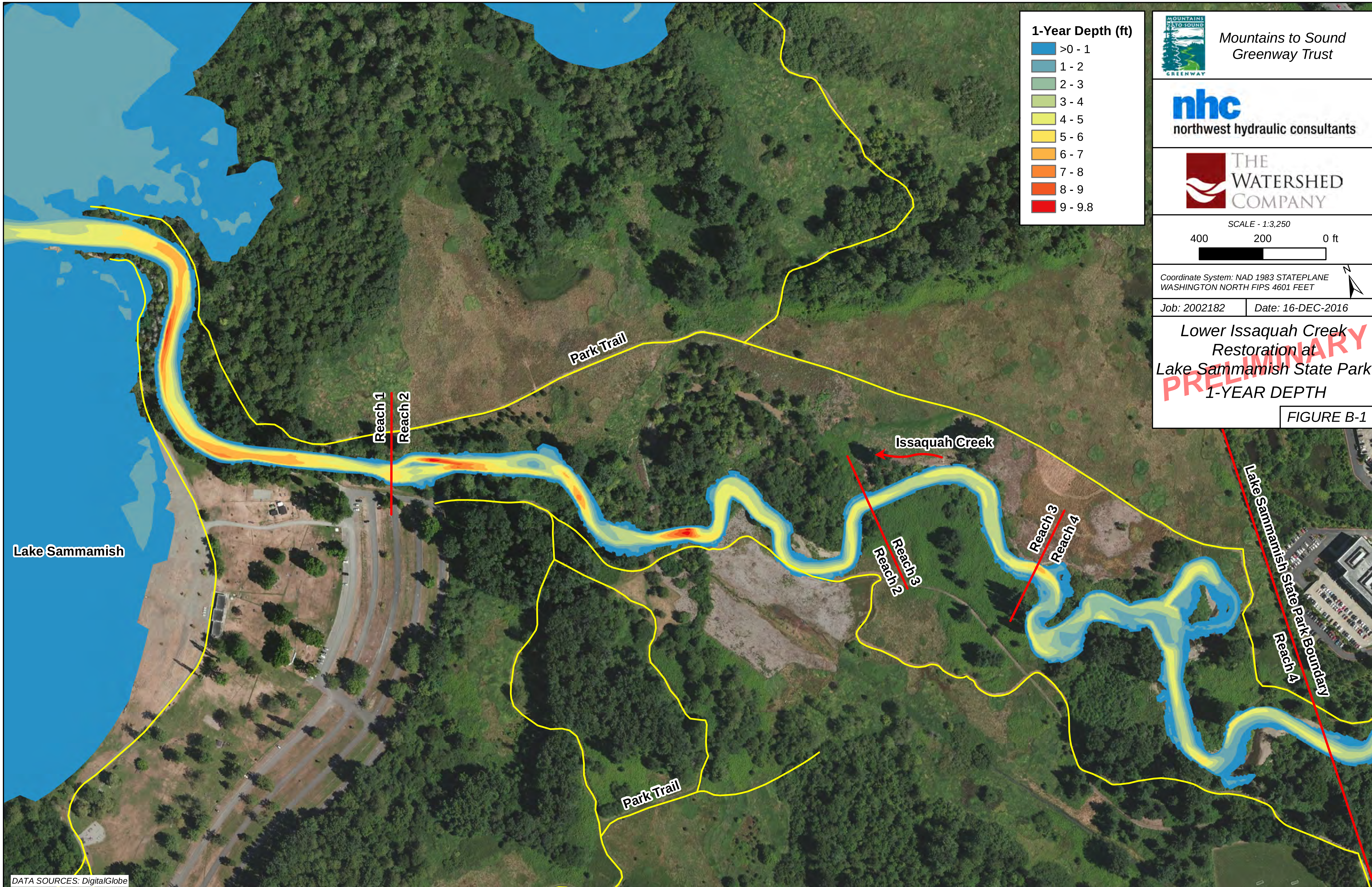
The Watershed Company
SCALE - 1:1,250
50 25 0 50 100 150 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Geomorphic Overview
Reach 4
Large Backwater Pool in Abandoned Oxbow
Small LWM Jam
Medium LWM Jam
Location of Meander Cutoff Avulsion Between 2013 and 2015
Channel-Spanning LWM Jam
Reach 3
Reach 4
5000
5500
6000
6500
Lake Sammamish State Park Boundary
Extent of Survey and Hydraulic Model
Pebble Count 3
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 B – Hydraulic Overview


1-Year Depth (ft)
>0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 - 9.8
Mountains to Sound Greenway Trust
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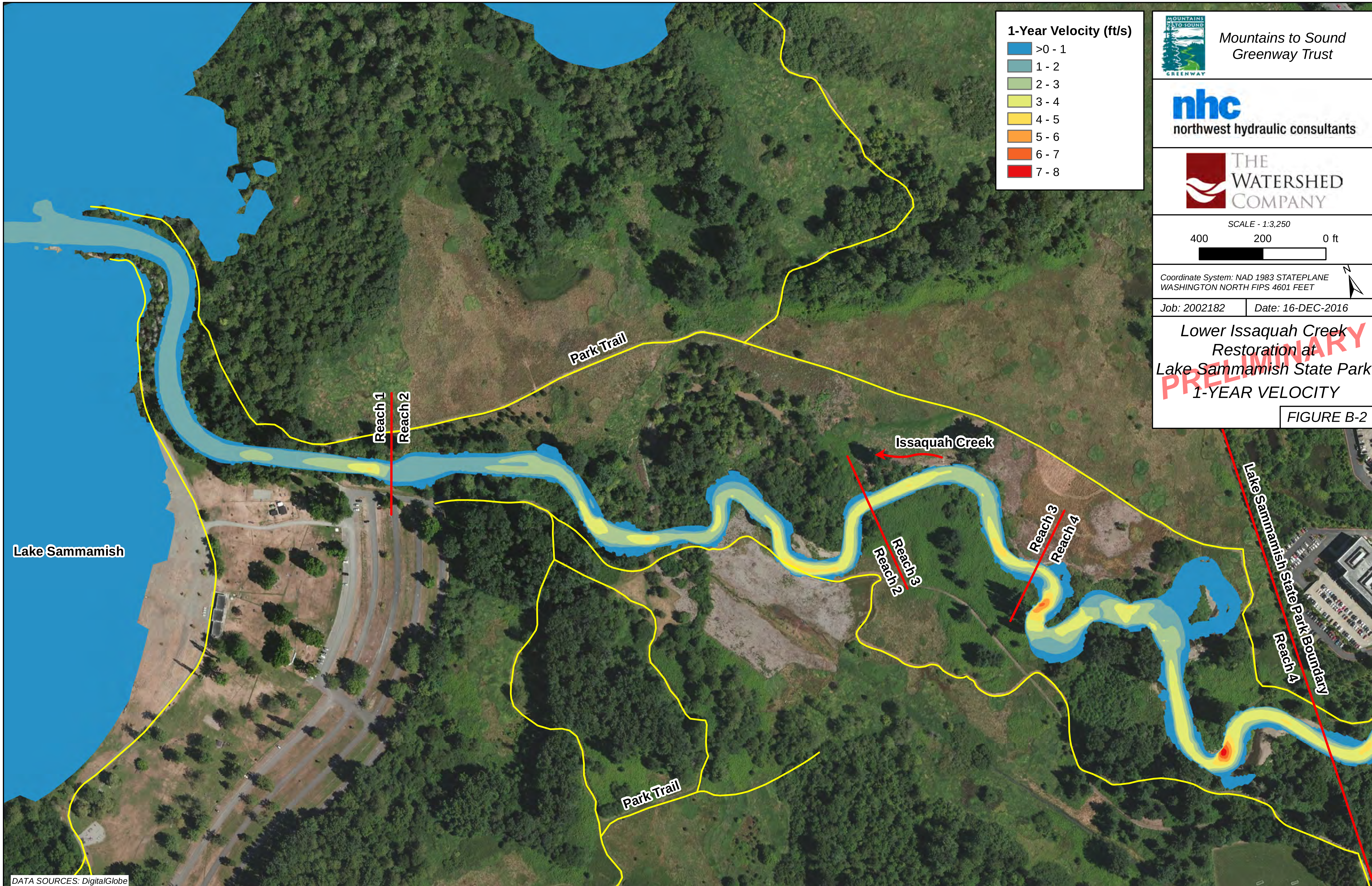
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
N
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
1-YEAR DEPTH
PRELIMINARY
FIGURE B-1
Lake Sammamish
Park Trail
Park Trail
Issaquah Creek
Reach 1
Reach 2
Reach 2
Reach 3
Reach 3
Reach 4
Reach 4
Lake Sammamish State Park Boundary
DATA SOURCES: DigitalGlobe



1-Year Velocity (ft/s)
>0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
Mountains to Sound Greenway Trust
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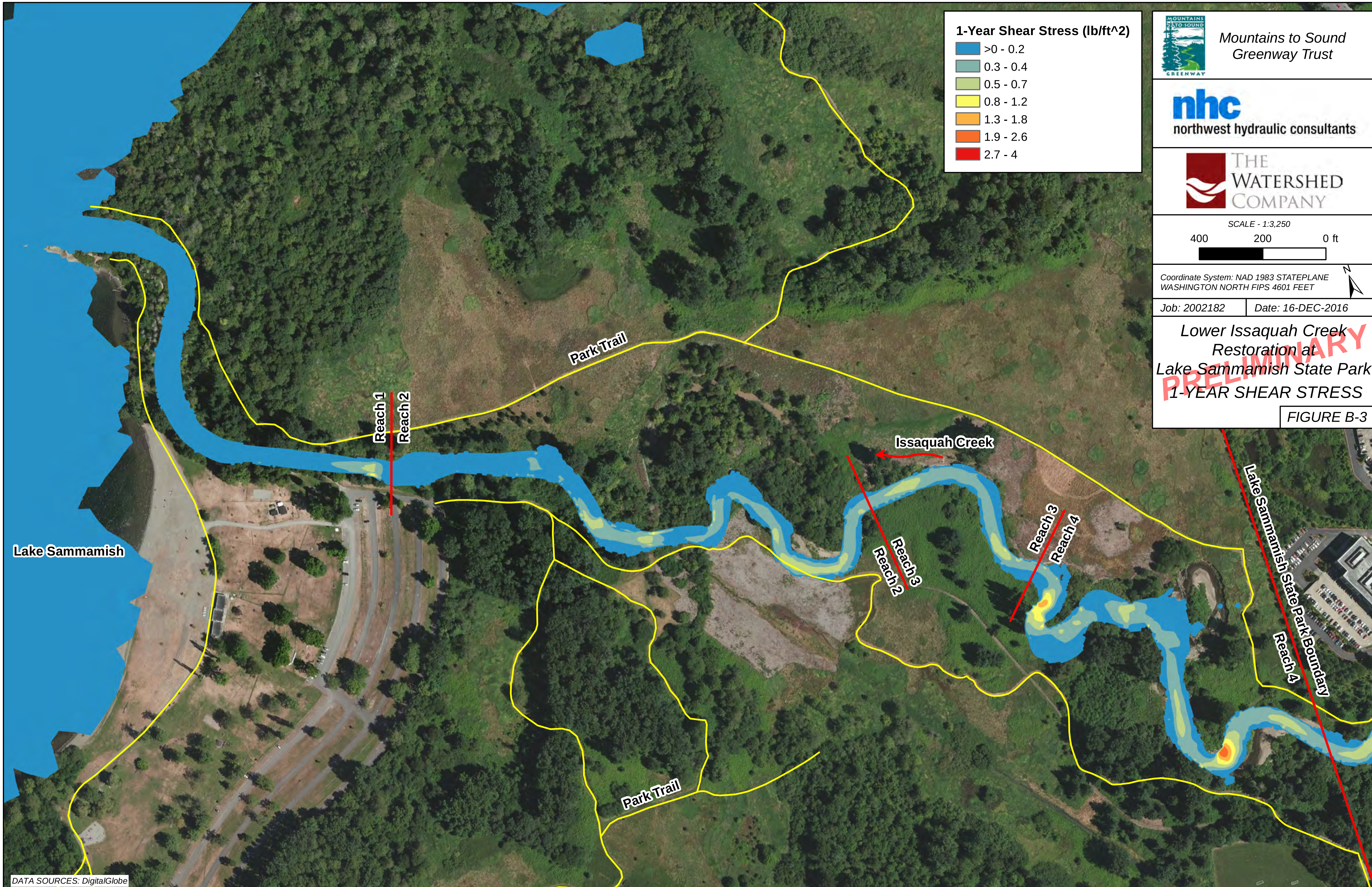
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
N
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
1-YEAR VELOCITY
PRELIMINARY
FIGURE B-2
Lake Sammamish
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 3
Reach 2
Reach 3
Reach 4
Lake Sammamish State Park Boundary
Reach 4
Park Trail
DATA SOURCES: DigitalGlobe


1-Year Shear Stress (lb/ft^2)
>0 - 0.2
0.3 - 0.4
0.5 - 0.7
0.8 - 1.2
1.3 - 1.8
1.9 - 2.6
2.7 - 4
Mountains to Sound Greenway Trust
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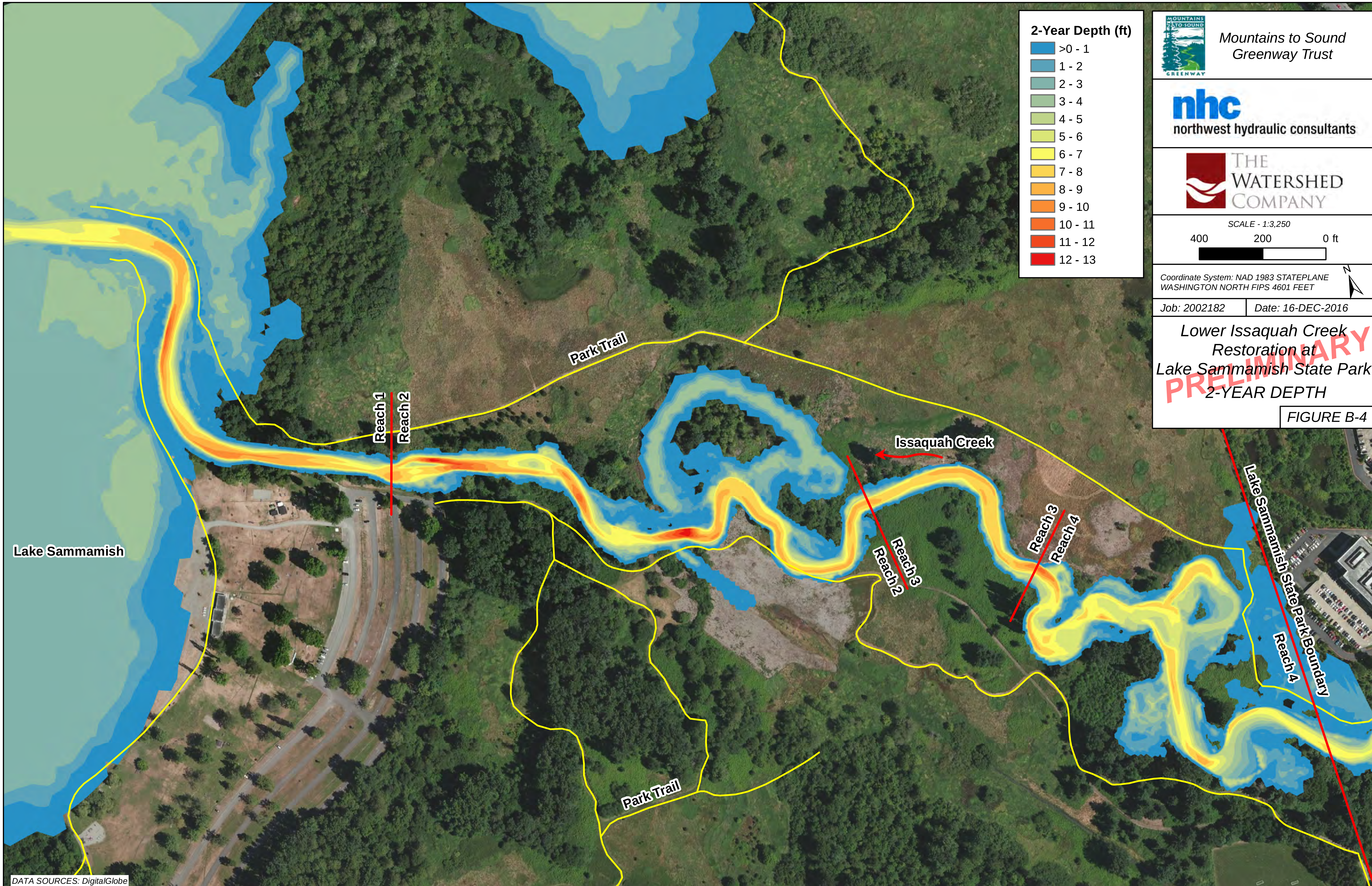
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
N
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
1-YEAR SHEAR STRESS
PRELIMINARY
FIGURE B-3
Park Trail
Reach 1
Reach 2
Issaquah Creek
Lake Sammamish
Reach 3
Reach 2
Reach 3
Reach 4
Lake Sammamish State Park Boundary
Reach 4
Park Trail
DATA SOURCES: DigitalGlobe



2-Year Depth (ft)
>0 - 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
Mountains to Sound Greenway Trust
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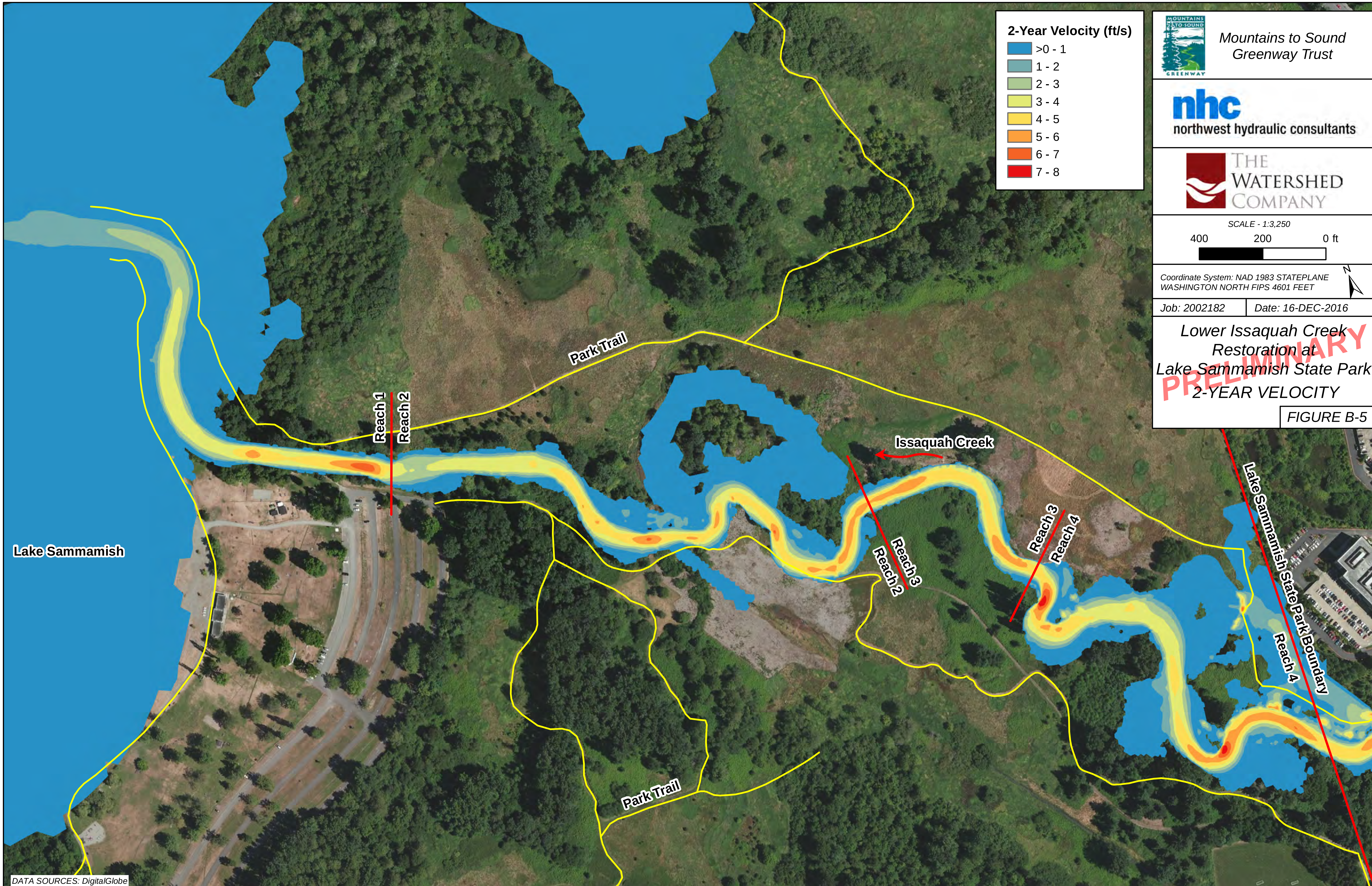
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
N
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
2-YEAR DEPTH
PRELIMINARY
FIGURE B-4
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 3
Reach 4
Lake Sammamish
Lake Sammamish State Park Boundary
Park Trail
DATA SOURCES: DigitalGlobe



2-Year Velocity (ft/s)
>0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
Mountains to Sound Greenway Trust
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The Watershed Company
SCALE - 1:3,250
400 200 0 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
N
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
2-YEAR VELOCITY
PRELIMINARY
FIGURE B-5
Lake Sammamish
Park Trail
Park Trail
Reach 1
Reach 2
Reach 2
Reach 3
Reach 3
Reach 4
Reach 4
Issaquah Creek
Lake Sammamish State Park Boundary
DATA SOURCES: DigitalGlobe
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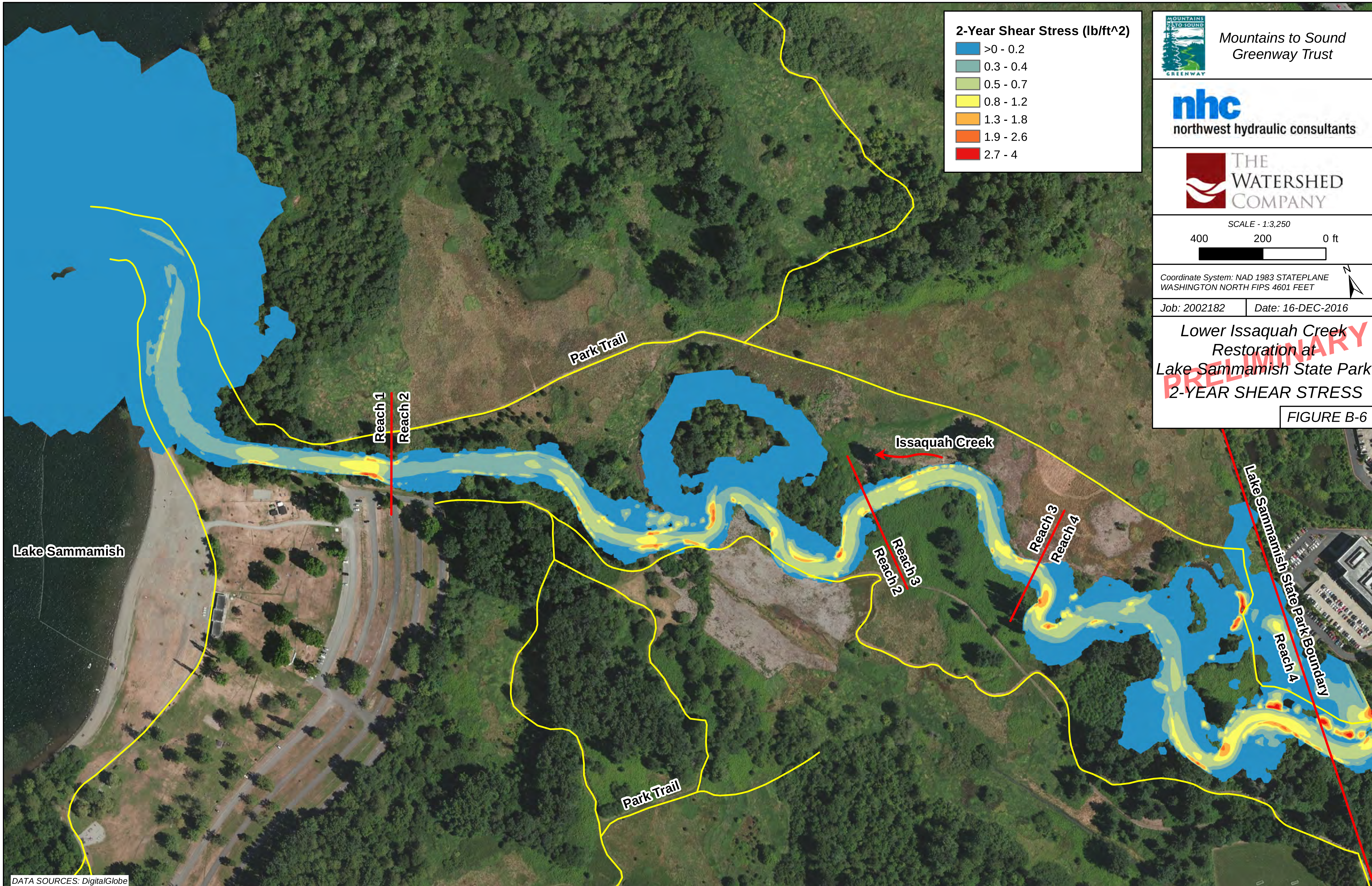
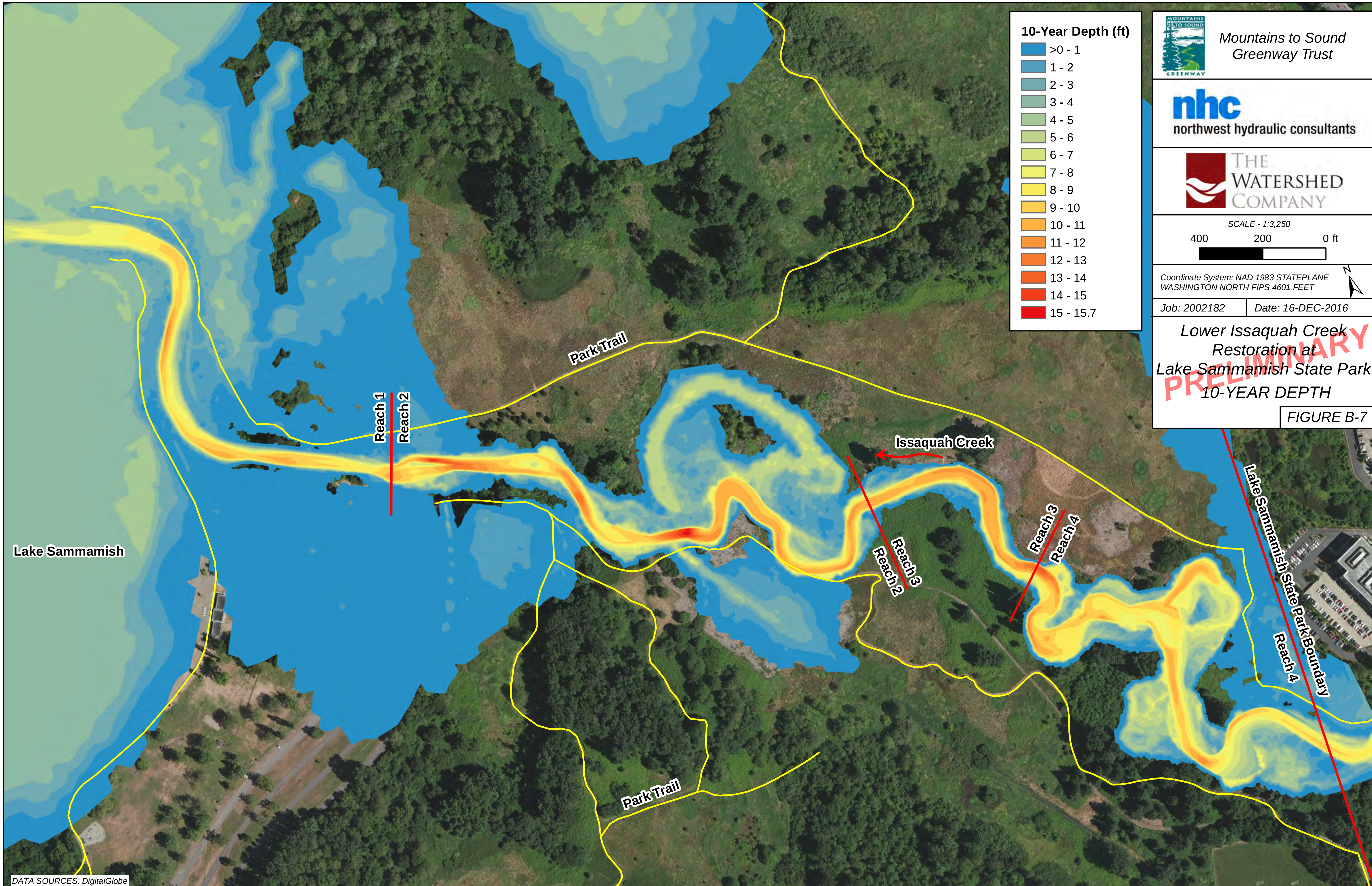
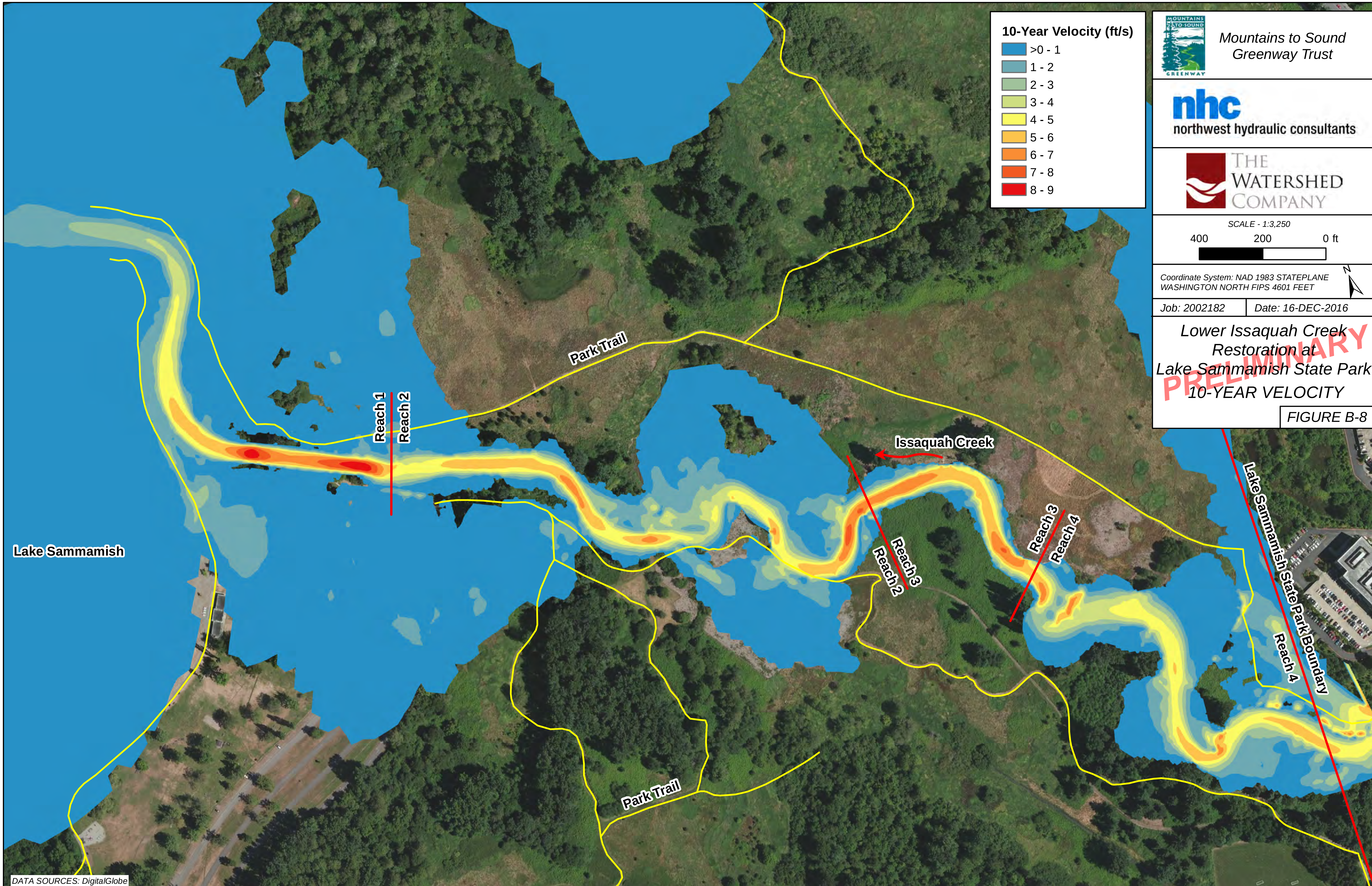


2-Year Shear Stress (lb/ft^2)
>0 - 0.2
0.3 - 0.4
0.5 - 0.7
0.8 - 1.2
1.3 - 1.8
1.9 - 2.6
2.7 - 4
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
N
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
2-YEAR SHEAR STRESS
PRELIMINARY
FIGURE B-6
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 3
Reach 2
Reach 3
Reach 4
Lake Sammamish
Lake Sammamish State Park Boundary
Reach 4
Park Trail
DATA SOURCES: DigitalGlobe
X:\PROJECTS\2002182 - Lower Issaquah Creek Restoration\GIS\Maps\Figures\Hydraulics\Maps-Lowerissaquah-2yrShear.mxd



X:\PROJECTS\2002182 - Lower Issaquah Creek Restoration\GIS\Maps\Figures\Hydraulics\Maps-LowerIssaquah-10yrDepth.mxd



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The Watershed Company

SCALE - 1:3,250

400 200 0 ft

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

Job: 2002182 | Date: 16-DEC-2016

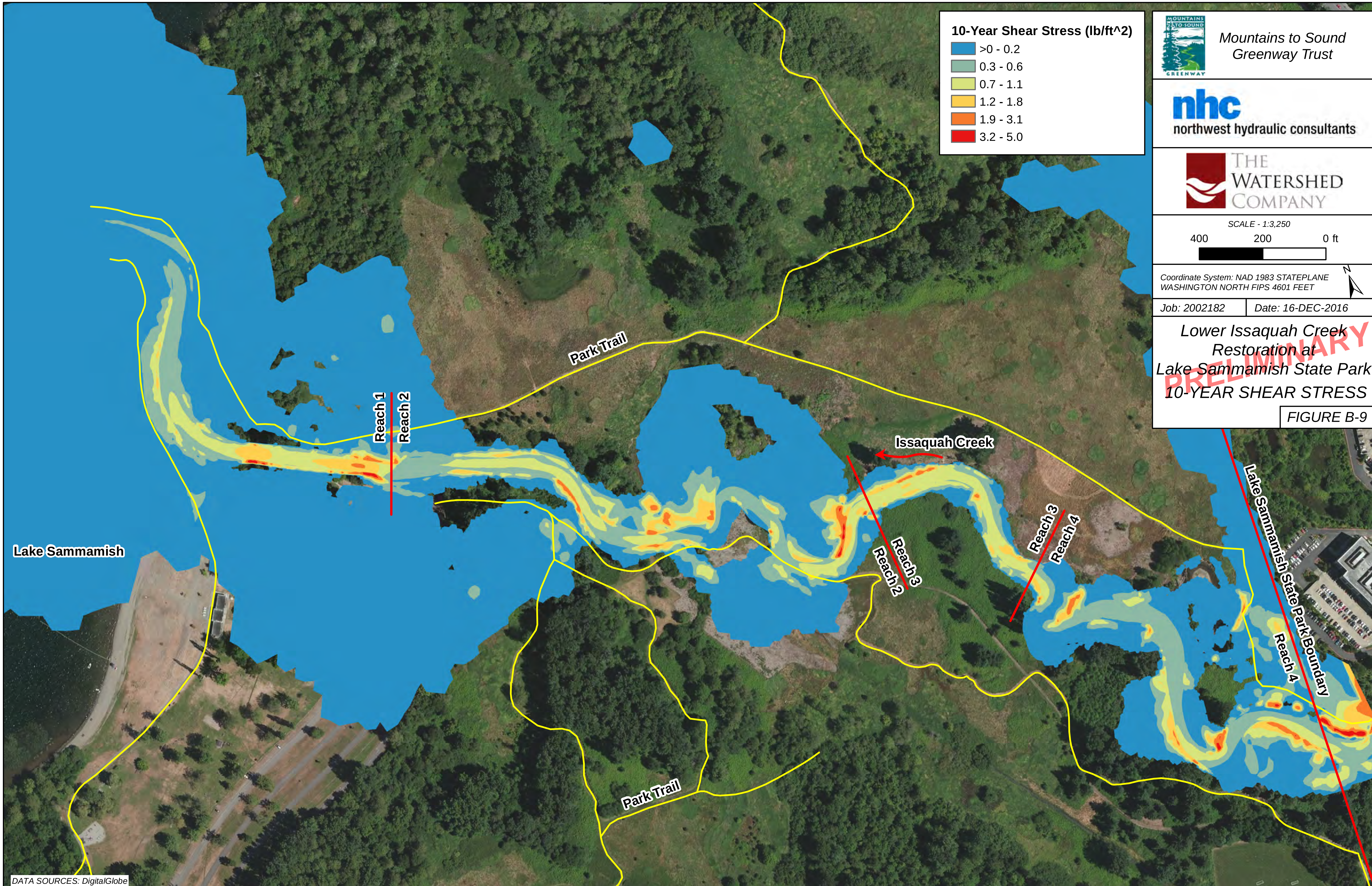
Lower Issaquah Creek Restoration at Lake Sammamish State Park

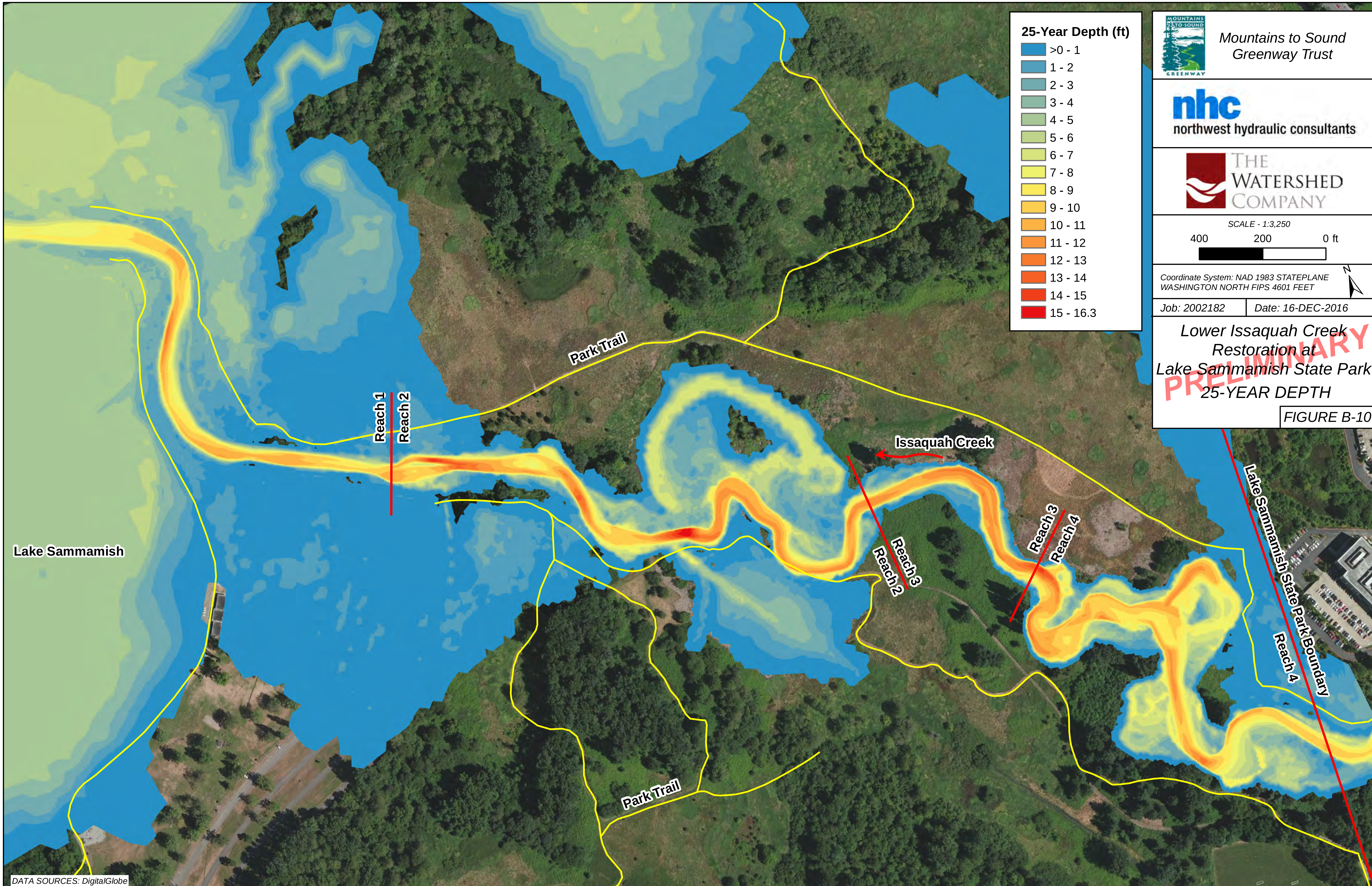
10-YEAR VELOCITY

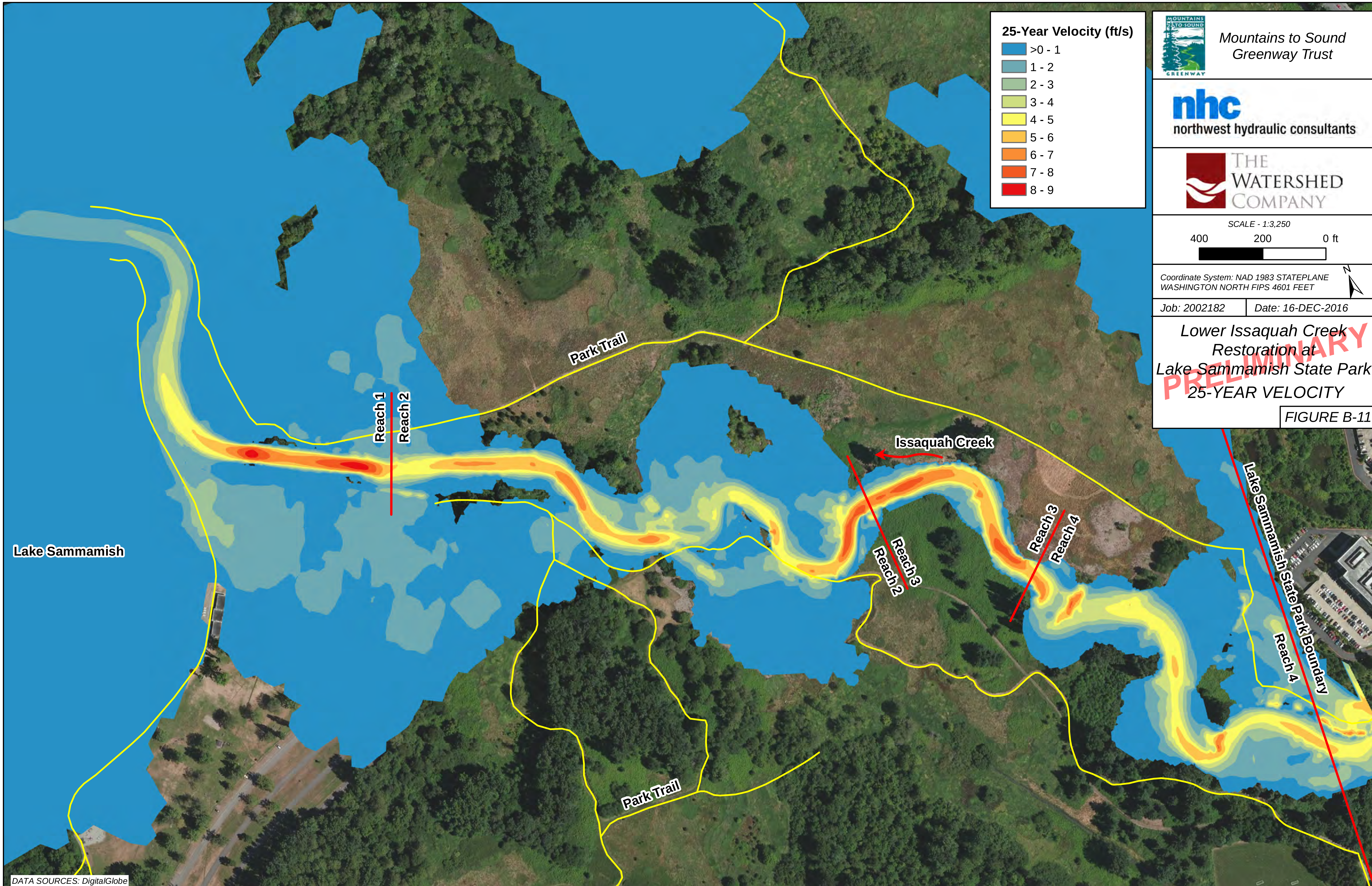
PRELIMINARY

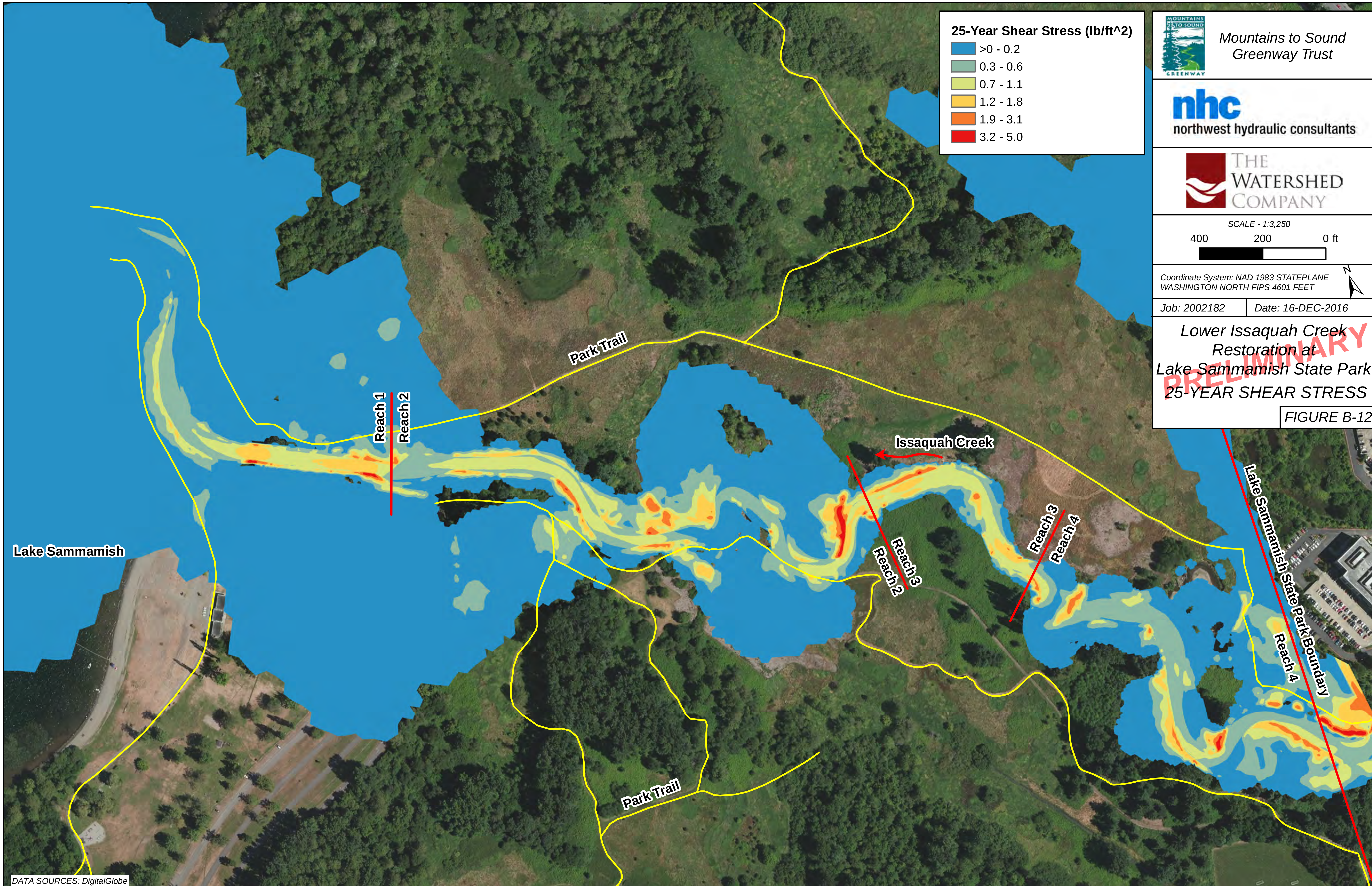
FIGURE B-8

X:\PROJECTS\2002182 - Lower Issaquah Creek Restoration\GIS\MapsFigures\HydraulicMaps\HydraulicsMaps-LowerIssaquah-10yrVelocity.mxd

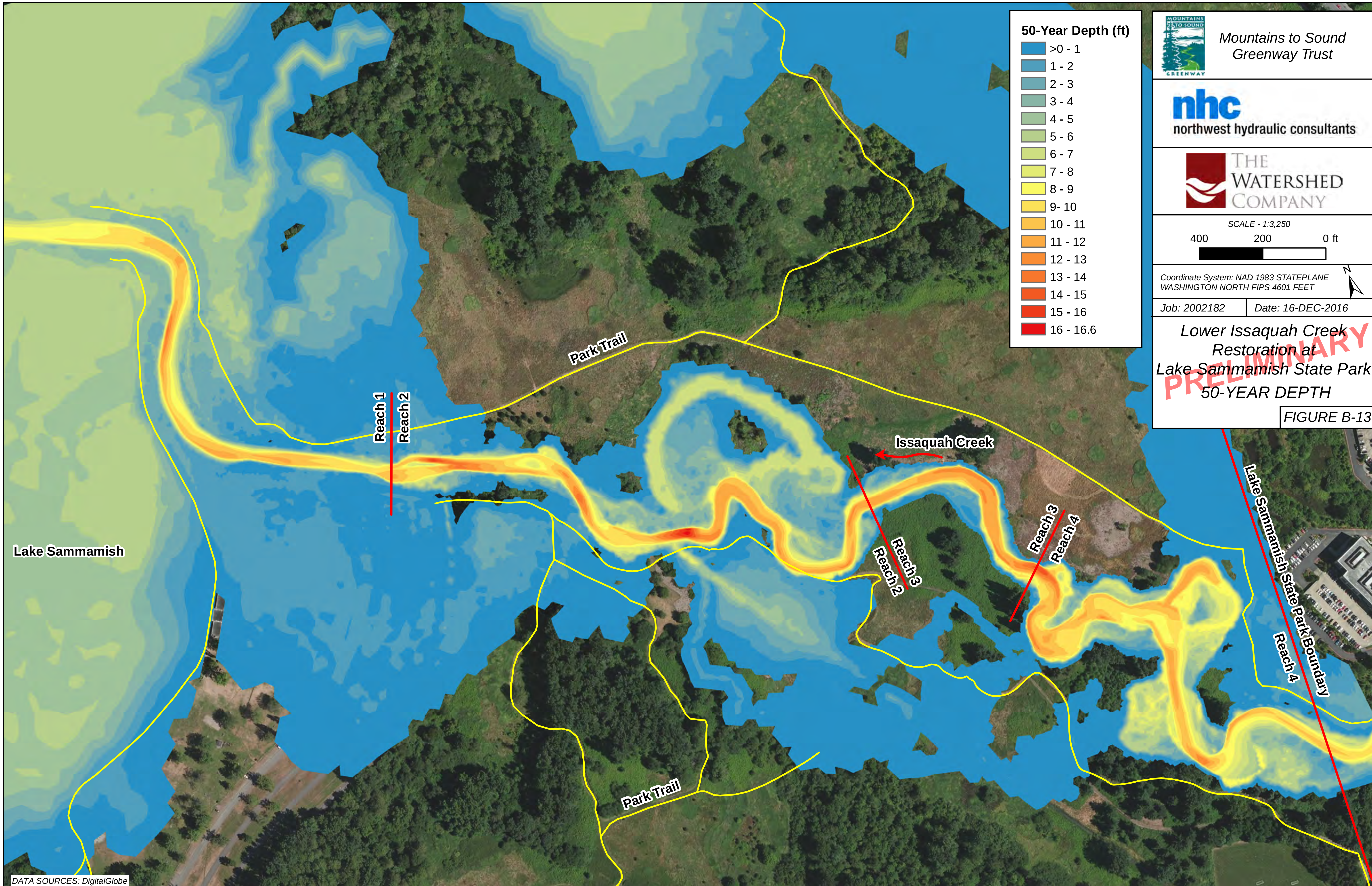

10-Year Shear Stress (lb/ft^2)
>0 - 0.2
0.3 - 0.6
0.7 - 1.1
1.2 - 1.8
1.9 - 3.1
3.2 - 5.0
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
N
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
10-YEAR SHEAR STRESS
PRELIMINARY
FIGURE B-9
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 3
Reach 4
Lake Sammamish
Lake Sammamish State Park Boundary
DATA SOURCES: DigitalGlobe


25-Year Depth (ft)
>0 - 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 - 16.3
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
N
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
25-YEAR DEPTH
PRELIMINARY
FIGURE B-10
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 2
Reach 3
Reach 3
Reach 4
Lake Sammamish State Park Boundary
Reach 4
Lake Sammamish
Park Trail
DATA SOURCES: DigitalGlobe

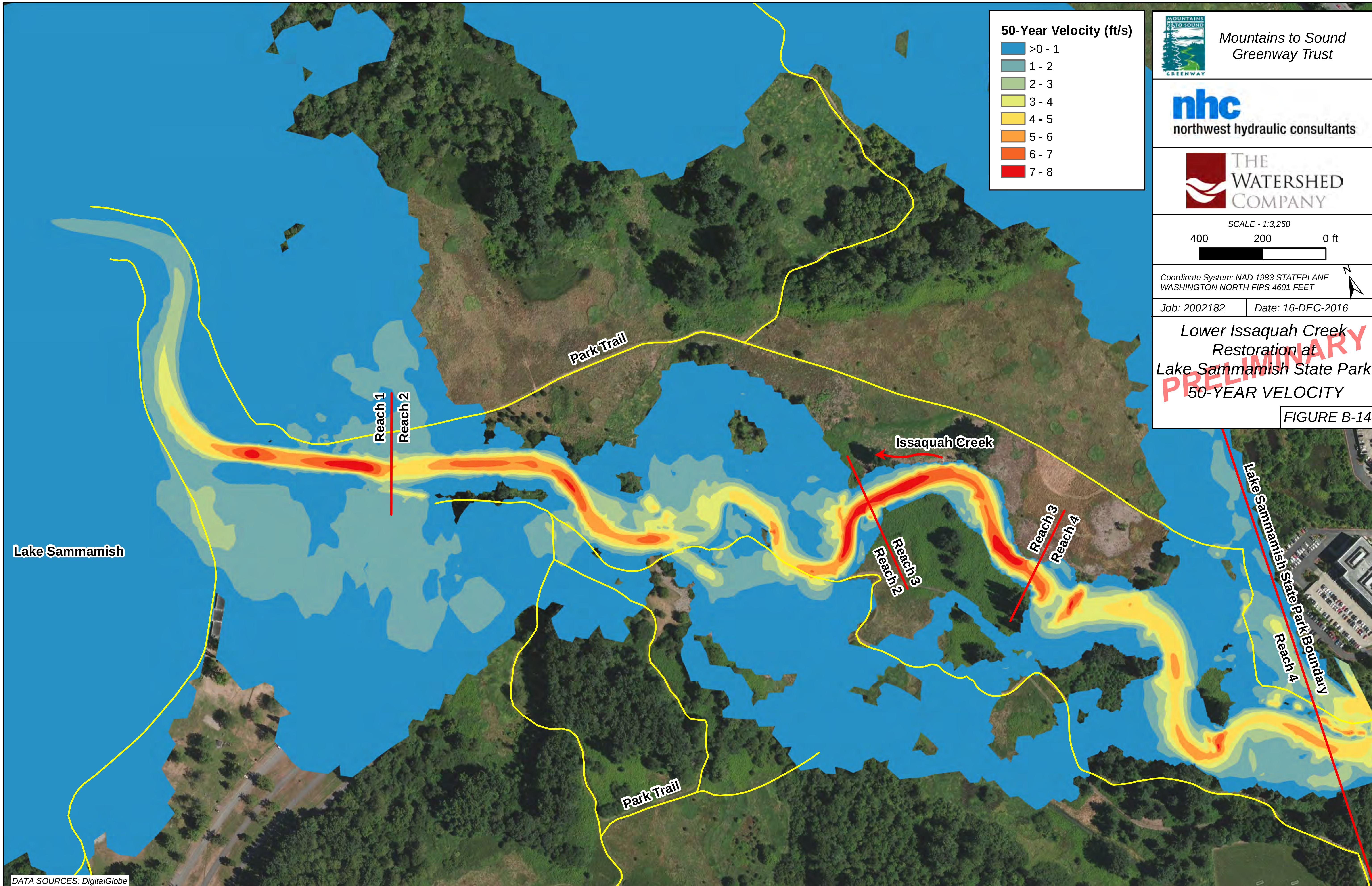

25-Year Velocity (ft/s)
>0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
N
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
25-YEAR VELOCITY
PRELIMINARY
FIGURE B-11
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 3
Reach 2
Reach 3
Reach 4
Lake Sammamish State Park Boundary
Reach 4
Lake Sammamish
Park Trail
DATA SOURCES: DigitalGlobe



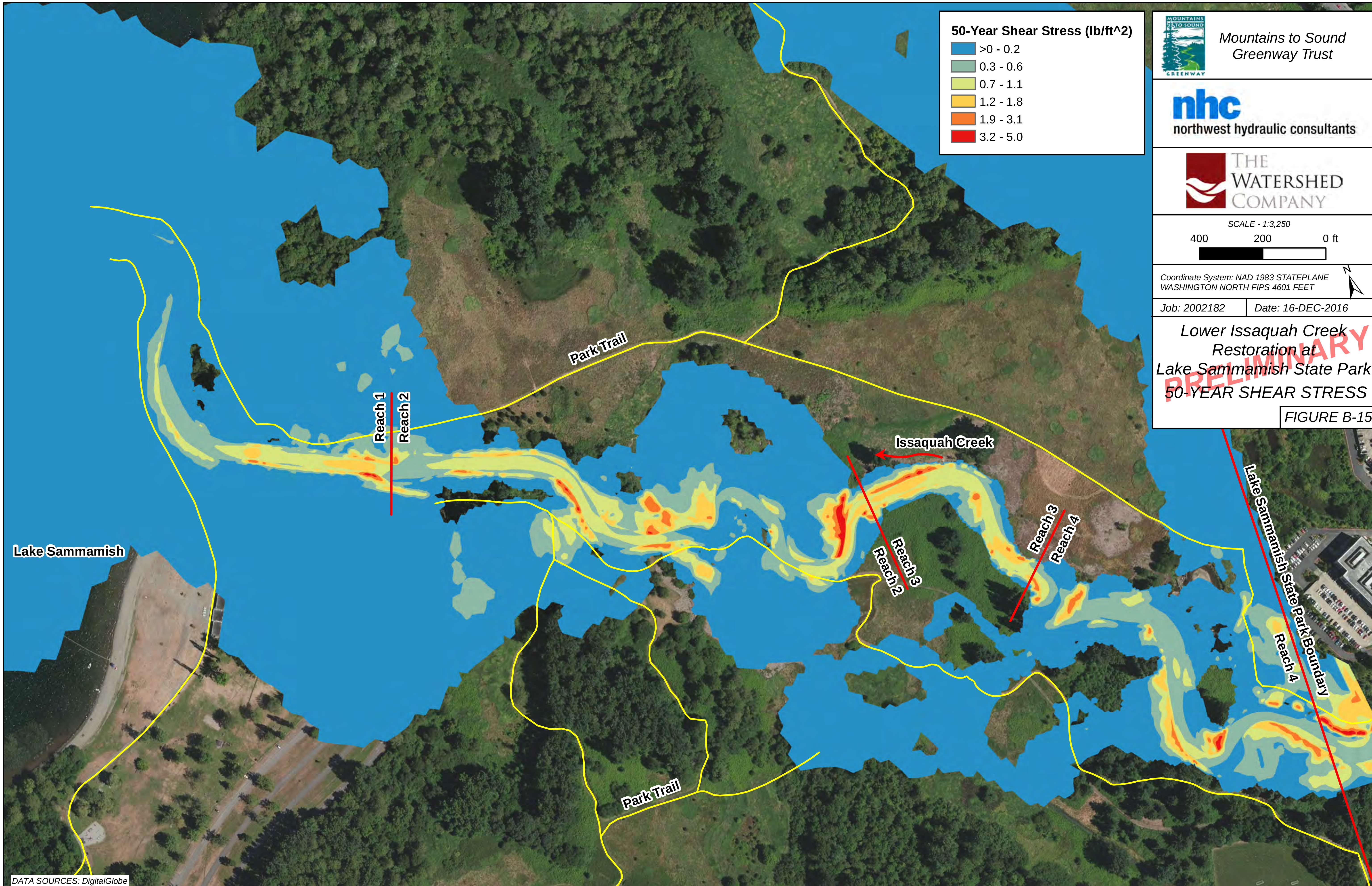
25-Year Shear Stress (lb/ft^2)
>0 - 0.2
0.3 - 0.6
0.7 - 1.1
1.2 - 1.8
1.9 - 3.1
3.2 - 5.0
Mountains to Sound Greenway Trust
nhc northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
N
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
25-YEAR SHEAR STRESS
PRELIMINARY
FIGURE B-12
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 2
Reach 3
Reach 3
Reach 4
Lake Sammamish State Park Boundary
Reach 4
Lake Sammamish
Park Trail
DATA SOURCES: DigitalGlobe



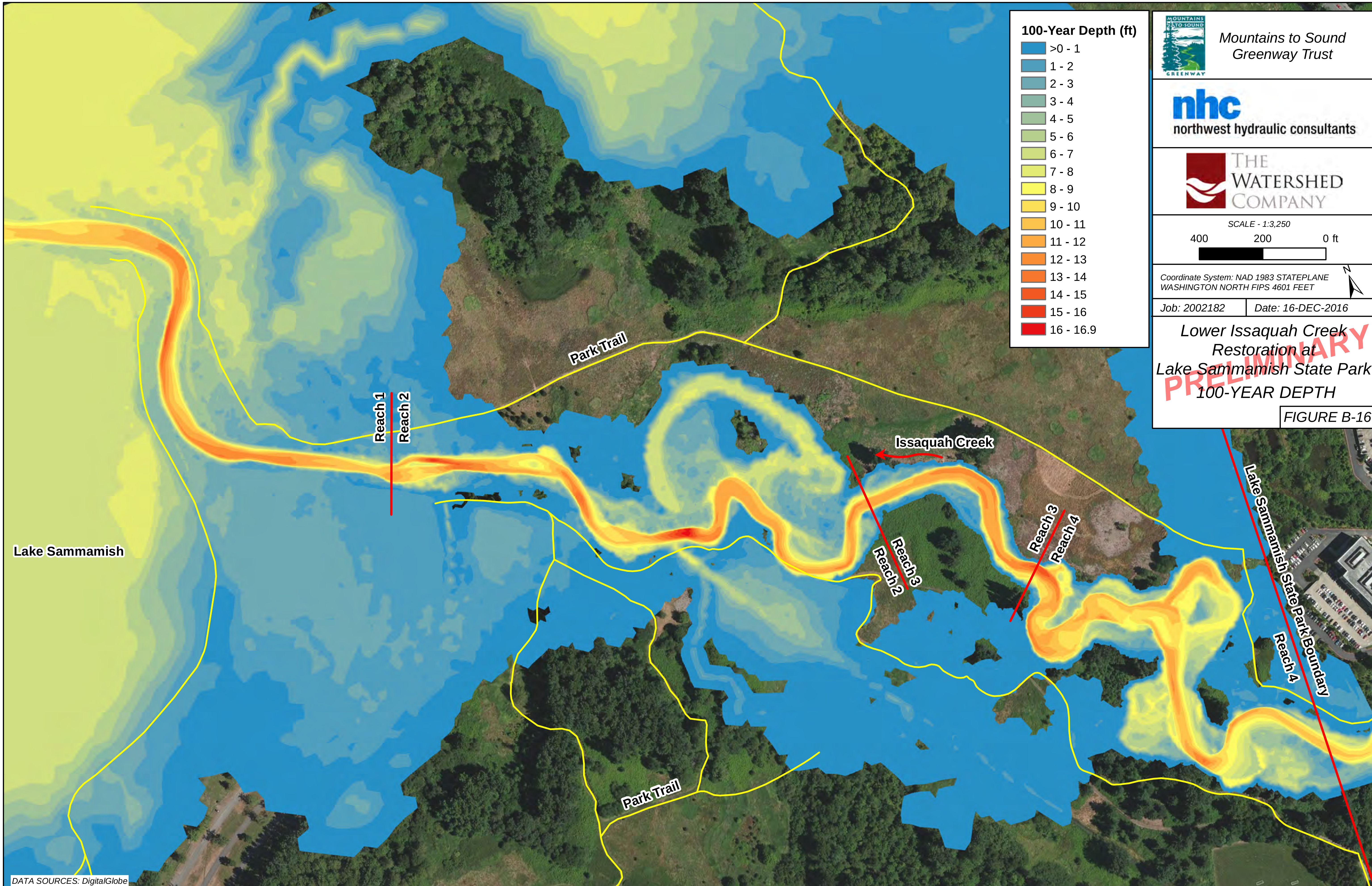
50-Year Depth (ft)
>0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9- 10
10 - 11
11 - 12
12 - 13
13 - 14
14 - 15
15 - 16
16 - 16.6
Mountains to Sound Greenway Trust
nhc northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400 200 0 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
50-YEAR DEPTH
PRELIMINARY
FIGURE B-13
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 3
Reach 2
Reach 3
Reach 4
Lake Sammamish
Lake Sammamish State Park Boundary
Reach 4
Park Trail
DATA SOURCES: DigitalGlobe
X:\PROJECTS\2002182 - Lower Issaquah Creek Restoration\GIS\MapsFigures\HydraulicMaps\HydraulicMaps-LowerIssaquah-50yrDepth.mxd

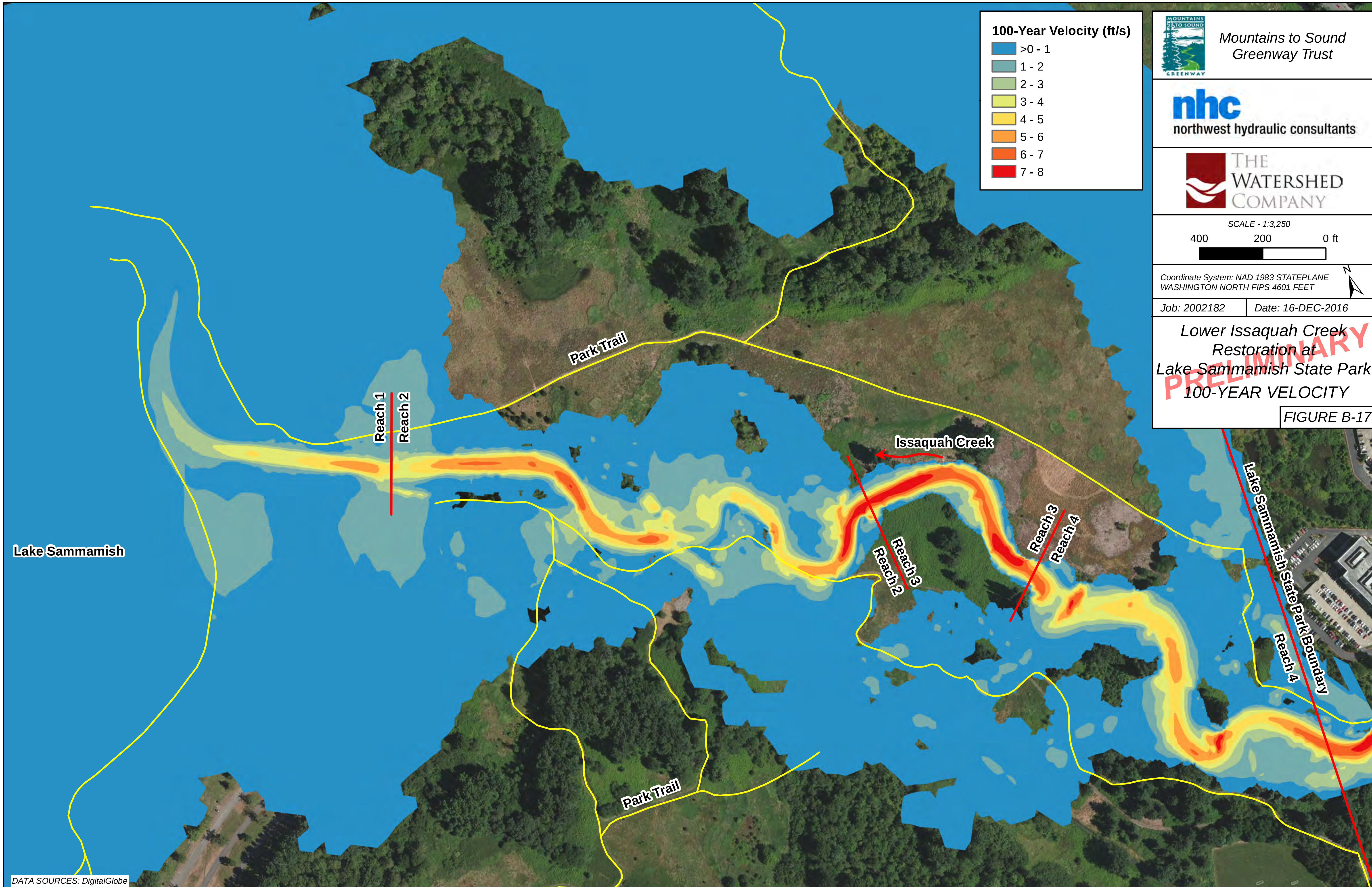


50-Year Velocity (ft/s)
>0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
N
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
50-YEAR VELOCITY
PRELIMINARY
FIGURE B-14
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 3
Reach 2
Reach 3
Reach 4
Lake Sammamish
Lake Sammamish State Park Boundary
Reach 4
Park Trail
DATA SOURCES: DigitalGlobe

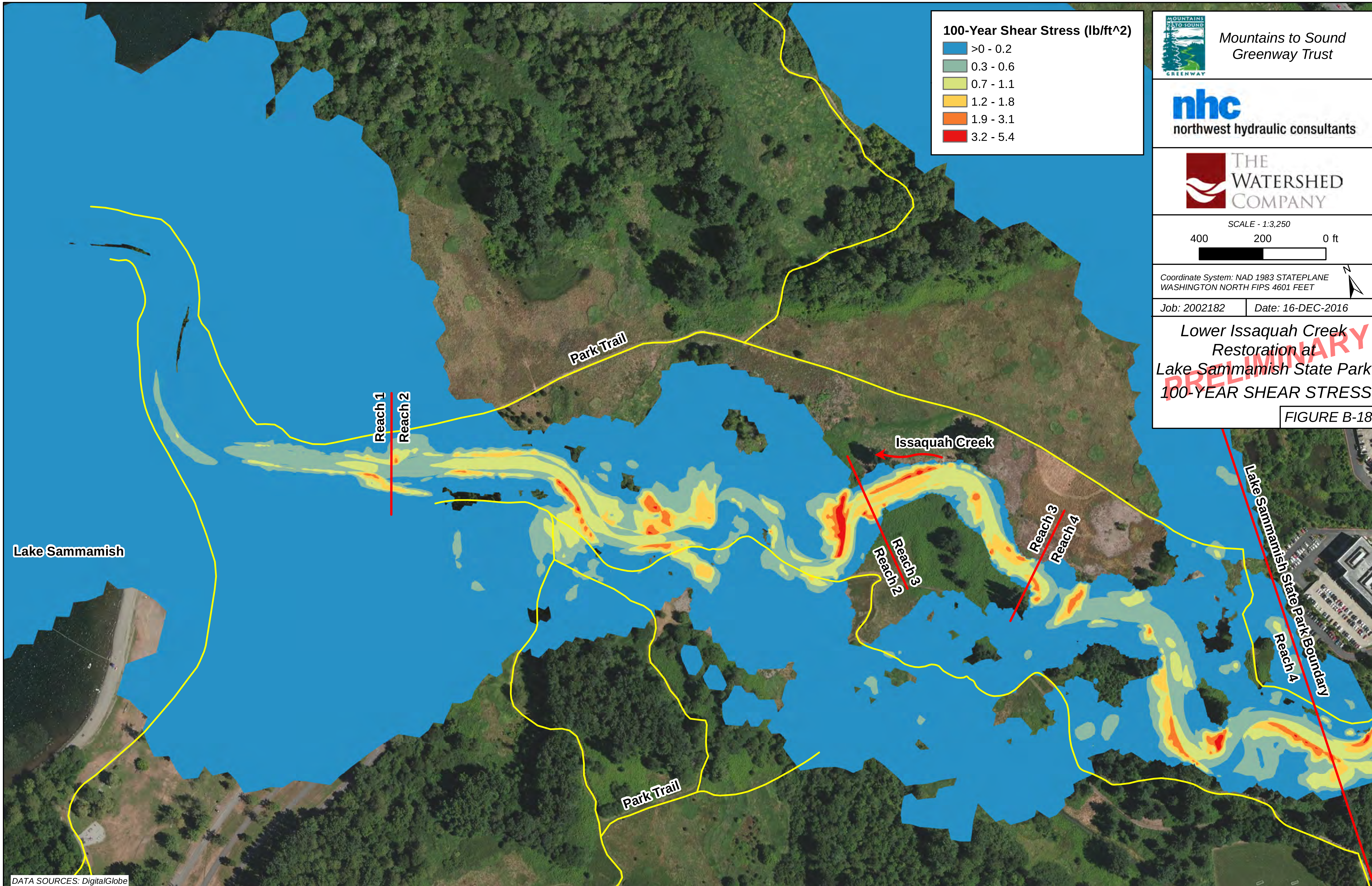


X:\PROJECTS\2002182 - Lower Issaquah Creek Restoration\GIS\MapsFigures\HydraulicMaps\HydraulicsMaps-LowerIssaquah-50yrShear.mxd

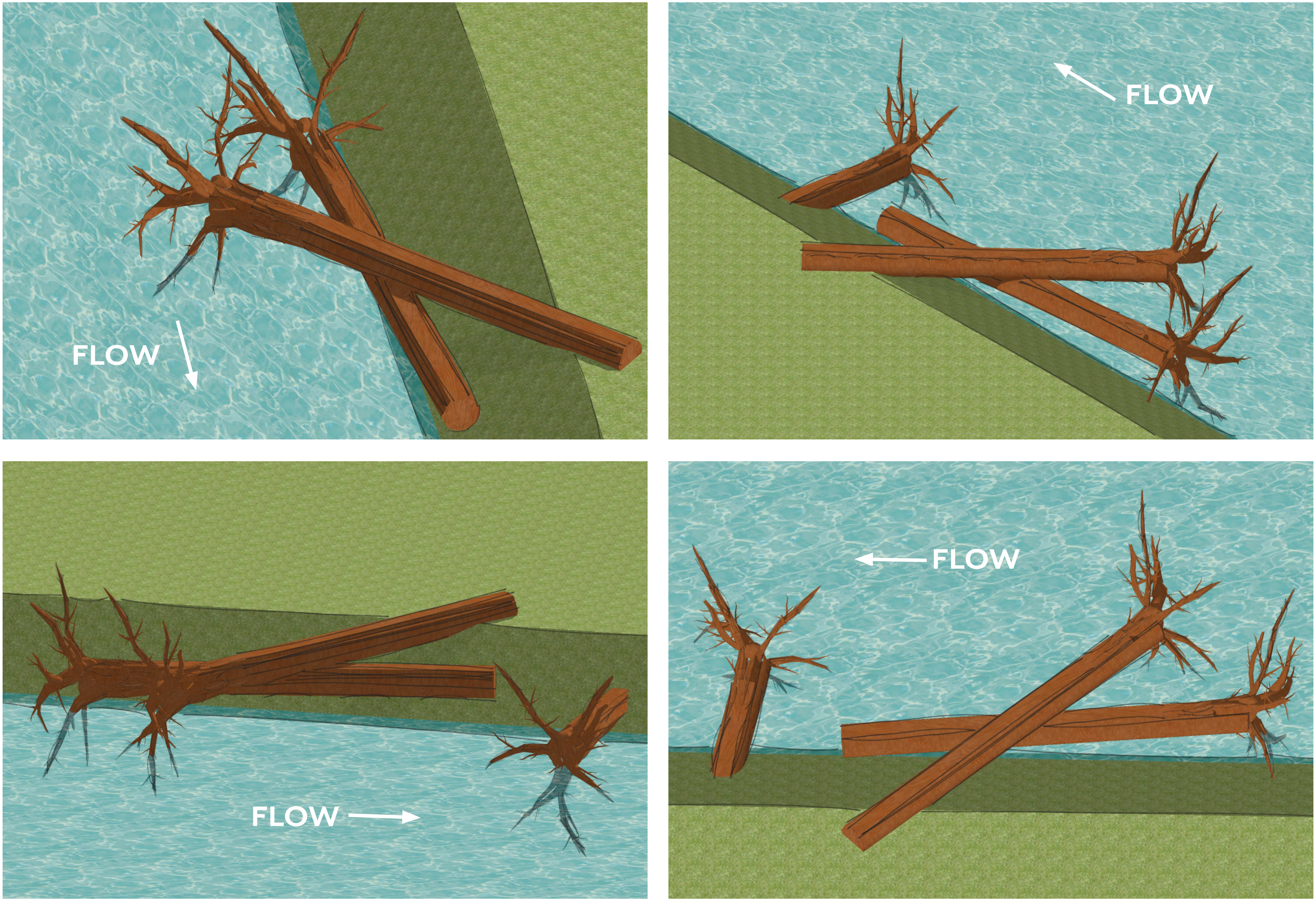

100-Year Depth (ft)
>0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 - 10
10 - 11
11 - 12
12 - 13
13 - 14
14 - 15
15 - 16
16 - 16.9
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
N
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
100-YEAR DEPTH
PRELIMINARY
FIGURE B-16
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 3
Reach 4
Lake Sammamish
Lake Sammamish State Park Boundary
Park Trail
DATA SOURCES: DigitalGlobe



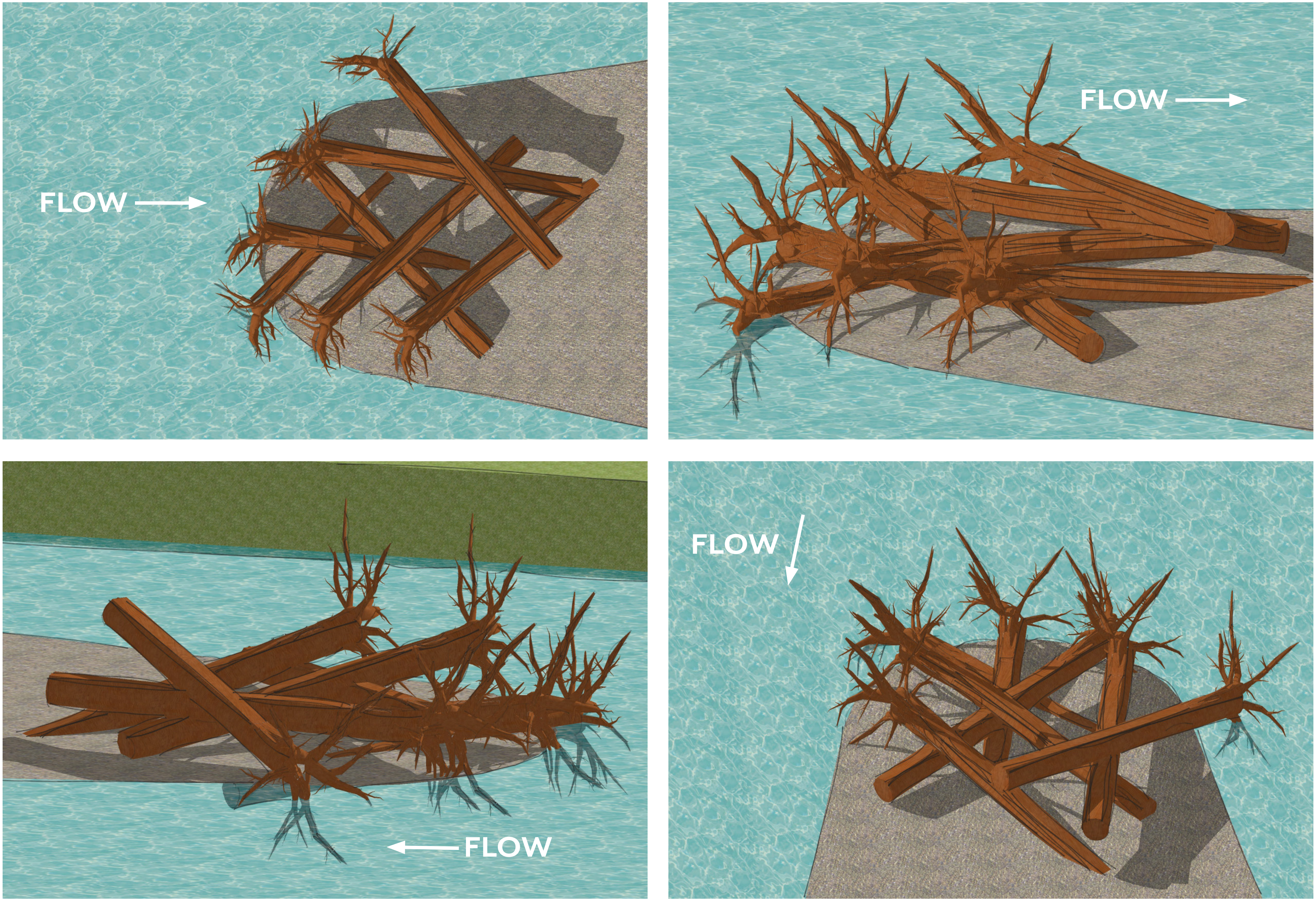
100-Year Velocity (ft/s)
>0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
Mountains to Sound Greenway Trust
nhc northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400 200 0 ft
N
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
100-YEAR VELOCITY
PRELIMINARY
FIGURE B-17
Park Trail
Reach 1
Reach 2
Issaquah Creek
Reach 3
Reach 2
Reach 3
Reach 4
Lake Sammamish
Lake Sammamish State Park Boundary
Reach 4
Park Trail
DATA SOURCES: DigitalGlobe


100-Year Shear Stress (lb/ft^2)
>0 - 0.2
0.3 - 0.6
0.7 - 1.1
1.2 - 1.8
1.9 - 3.1
3.2 - 5.4
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:3,250
400
200
0 ft
N
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 16-DEC-2016
Lower Issaquah Creek Restoration at Lake Sammamish State Park
100-YEAR SHEAR STRESS
PRELIMINARY
FIGURE B-18
Park Trail
Park Trail
Reach 1
Reach 2
Reach 2
Reach 3
Reach 3
Reach 4
Reach 4
Issaquah Creek
Lake Sammamish
Lake Sammamish State Park Boundary
DATA SOURCES: DigitalGlobe

APPENDIX C – Conceptual Wood Layouts



SINGLE PIECES

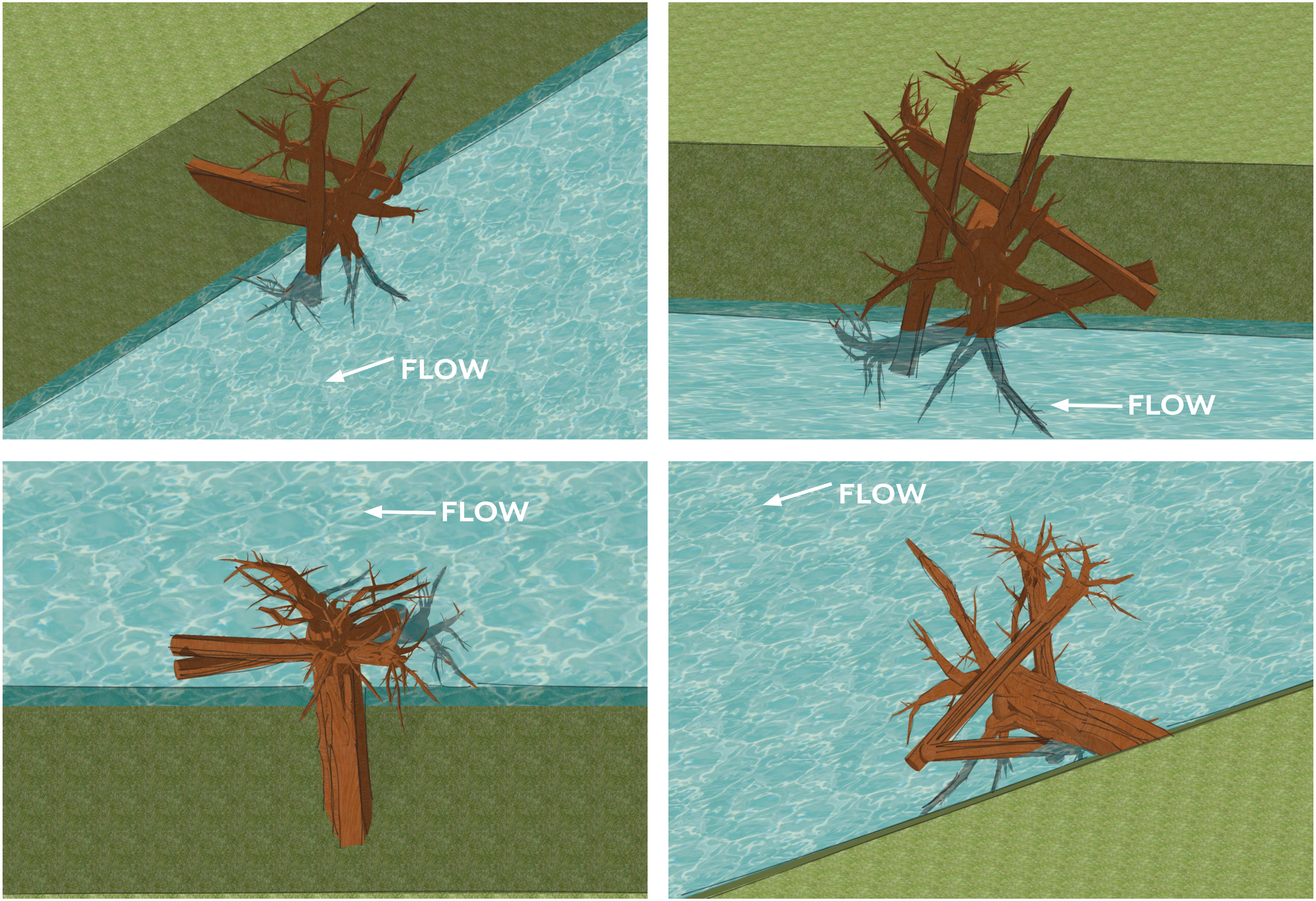


APEX LOG JAM

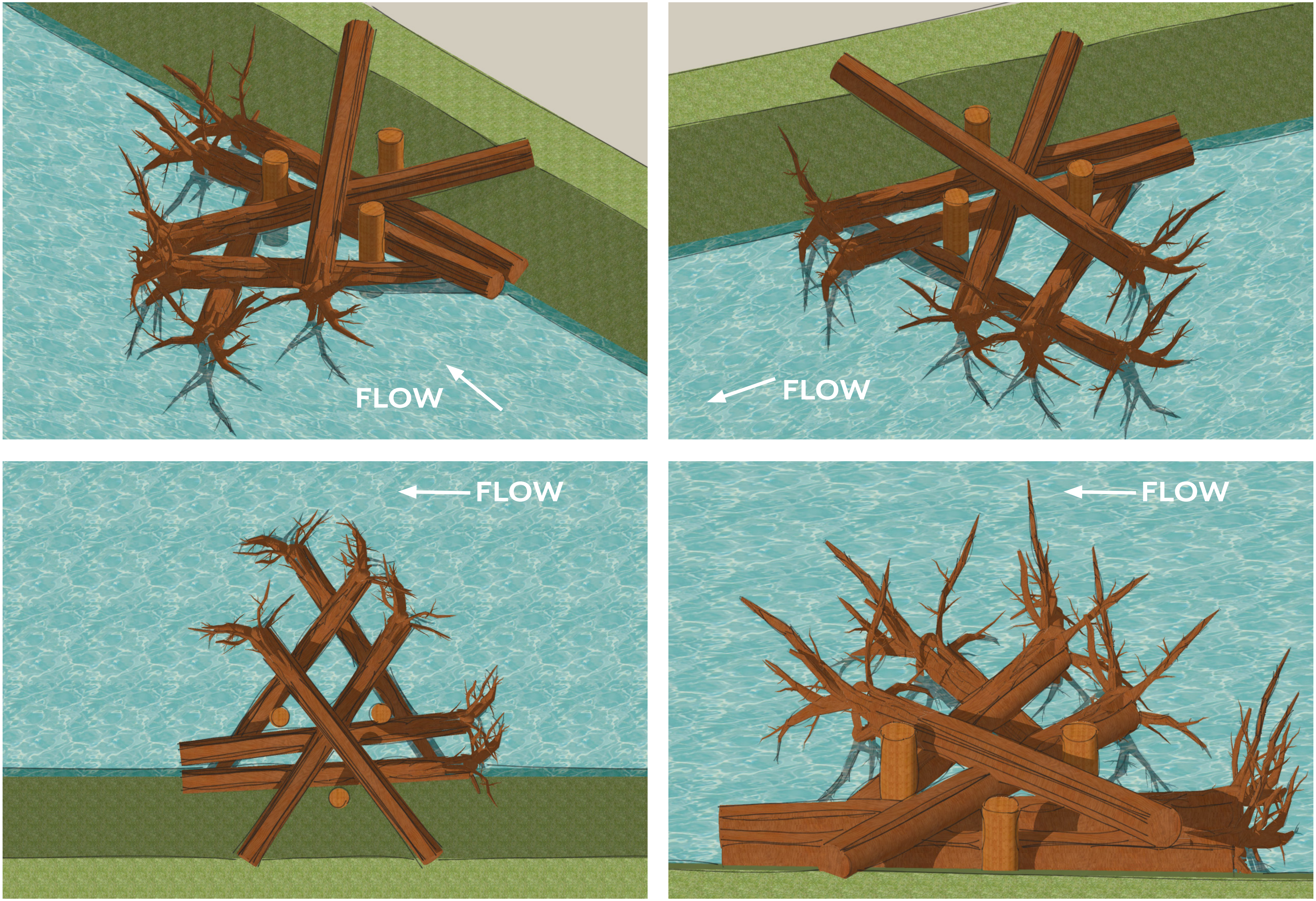
watershedco.com

nhc
northwest hydraulic consultants
water resource specialists

THE WATERSHED COMPANY

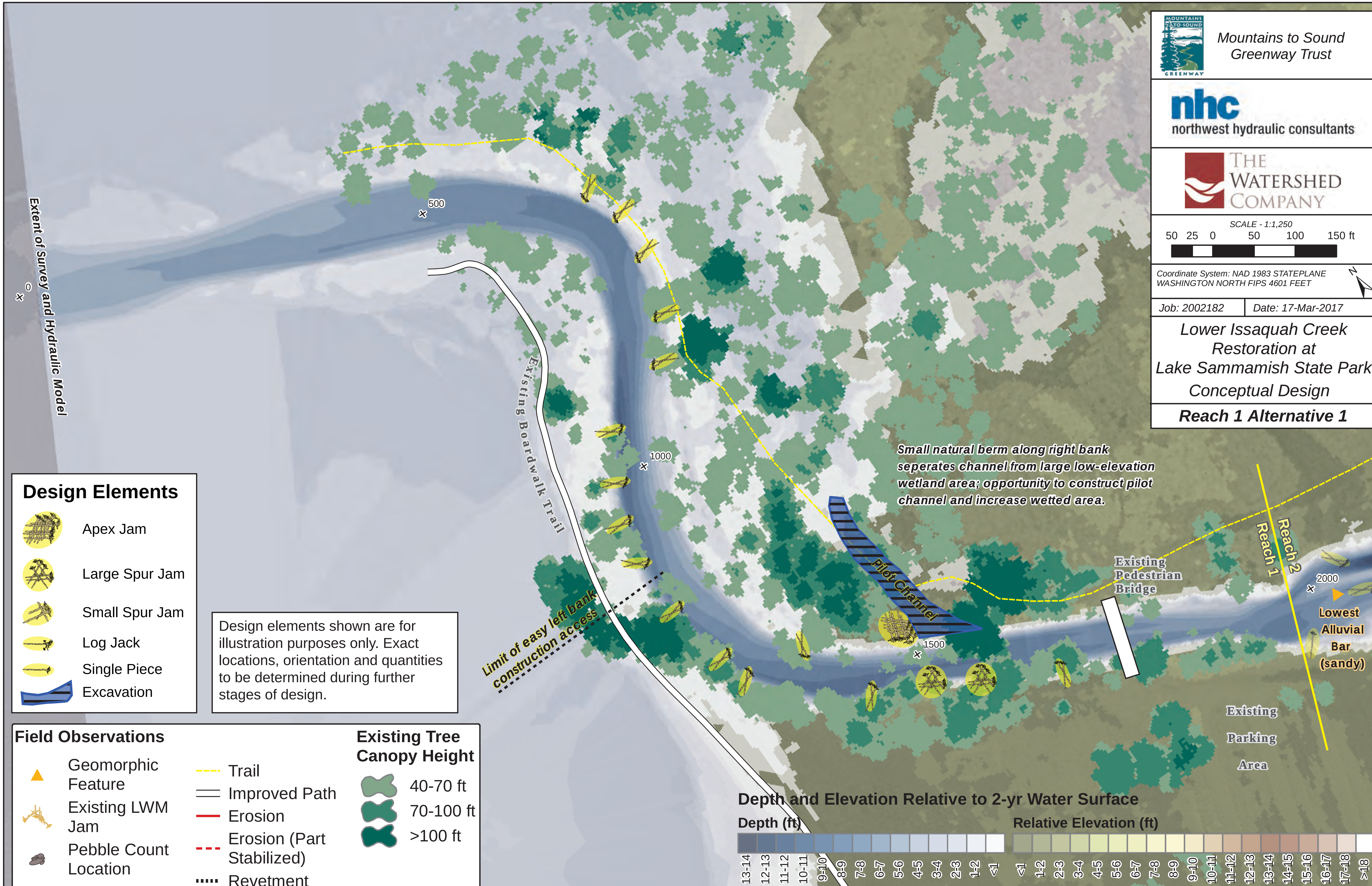


LOG JACK KEY MEMBER

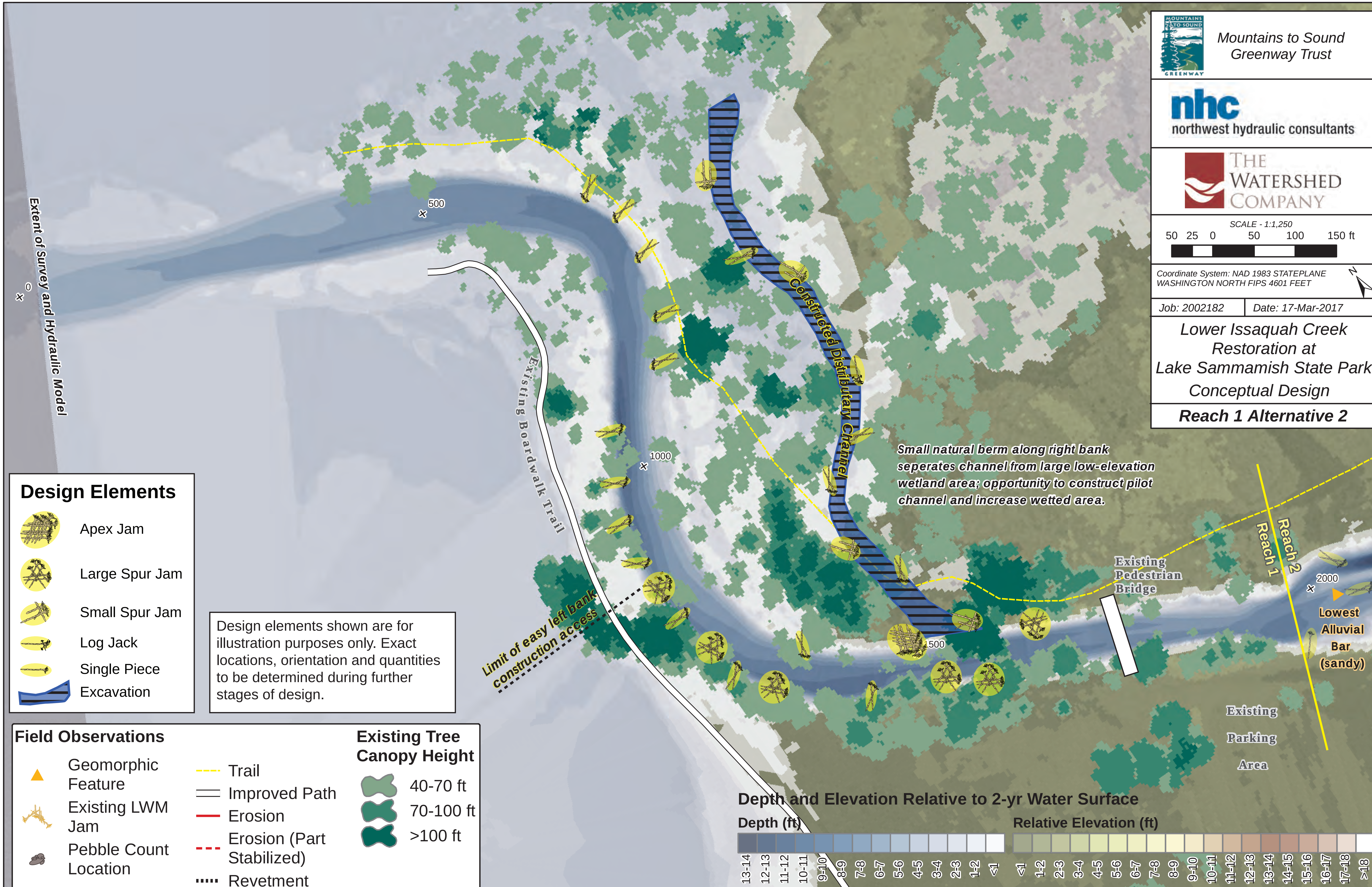


SPUR LOG JAM

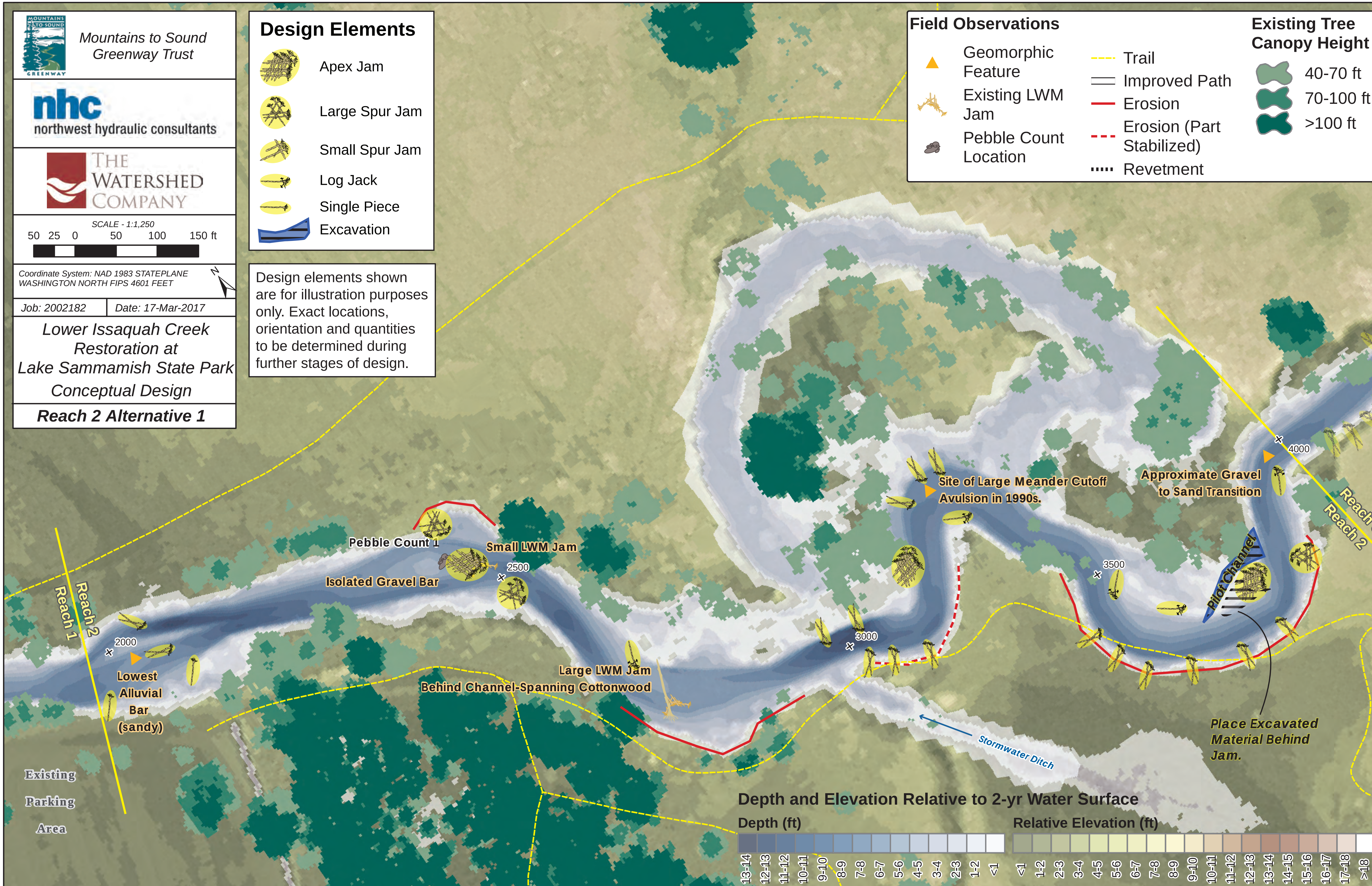
APPENDIX D – Conceptual Designs



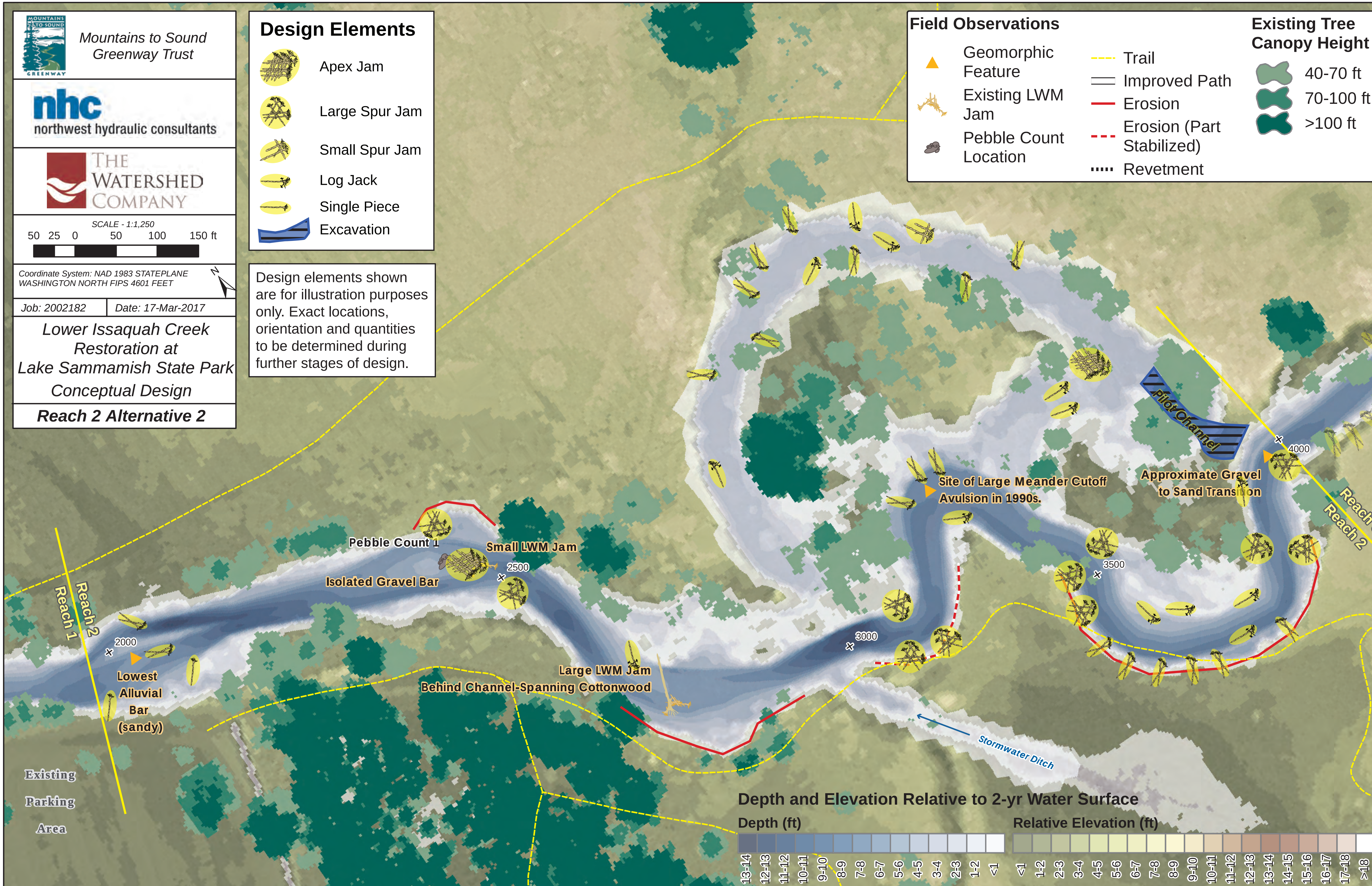
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:1,250
50 25 0 50 100 150 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Conceptual Design
Reach 1 Alternative 1
Extent of Survey and Hydraulic Model
0
500
1000
1500
2000
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.
Pilot Channel
Existing Pedestrian Bridge
Reach 1
Reach 2
Lowest Alluvial Bar (sandy)
Existing Parking Area
Limit of easy left bank construction access
Design Elements
Apex Jam
Large Spur Jam
Small Spur Jam
Log Jack
Single Piece
Excavation
Design elements shown are for illustration purposes only. Exact locations, orientation and quantities to be determined during further stages of design.
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



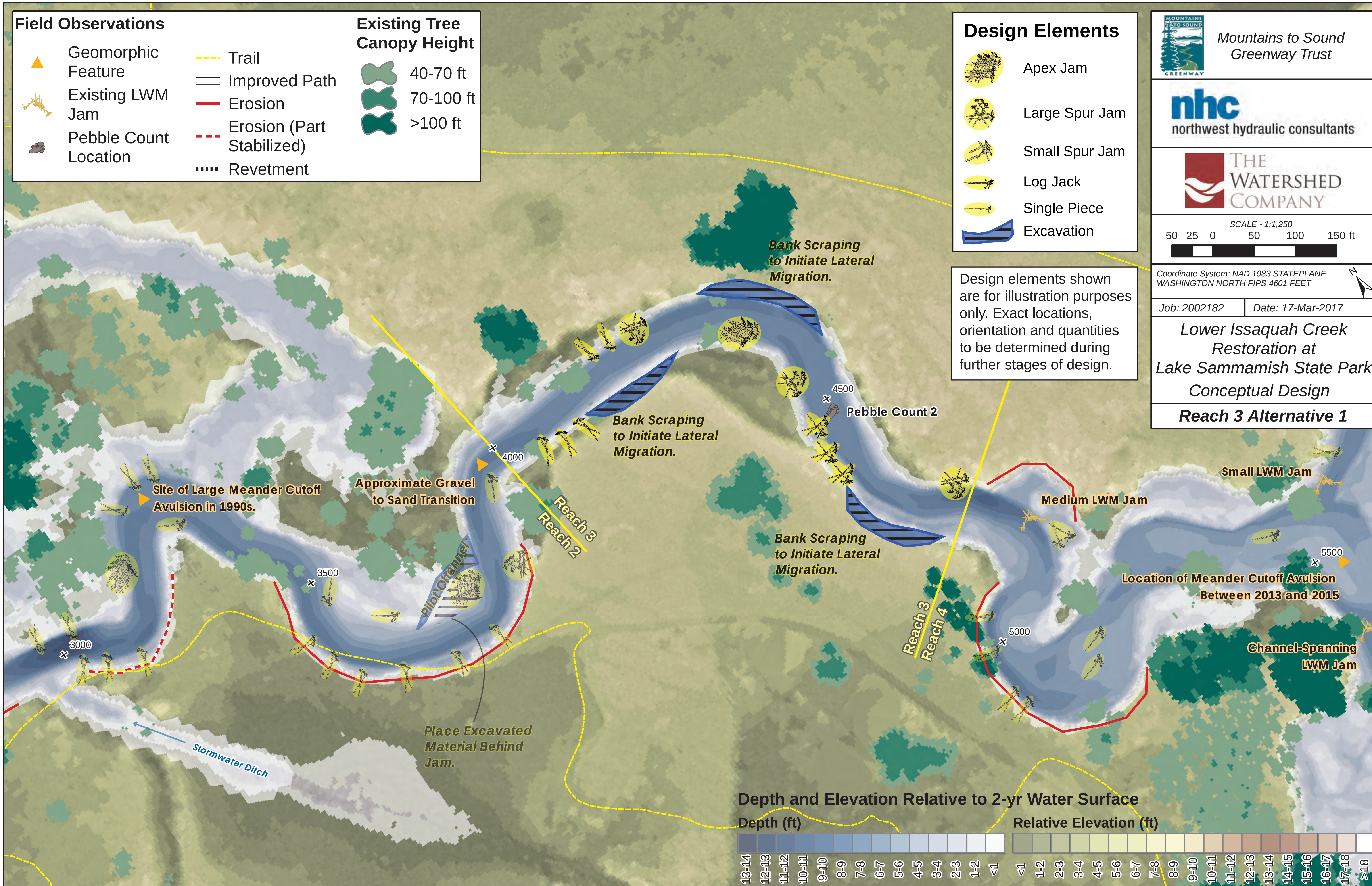
Mountains to Sound Greenway Trust
nhc northwest hydraulic consultants
The Watershed Company
SCALE - 1:1,250
50 25 0 50 100 150 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Conceptual Design
Reach 1 Alternative 2
Extent of Survey and Hydraulic Model
0
500
1000
1500
2000
Existing Boardwalk Trail
Constructed Distributary Channel
Small natural berm along right bank seperates channel from large low-elevation wetland area; opportunity to construct pilot channel and increase wetted area.
Limit of easy left bank construction access
Existing Pedestrian Bridge
Reach 1
Reach 2
Lowest Alluvial Bar (sandy)
Existing Parking Area
Design Elements
Apex Jam
Large Spur Jam
Small Spur Jam
Log Jack
Single Piece
Excavation
Design elements shown are for illustration purposes only. Exact locations, orientation and quantities to be determined during further stages of design.
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



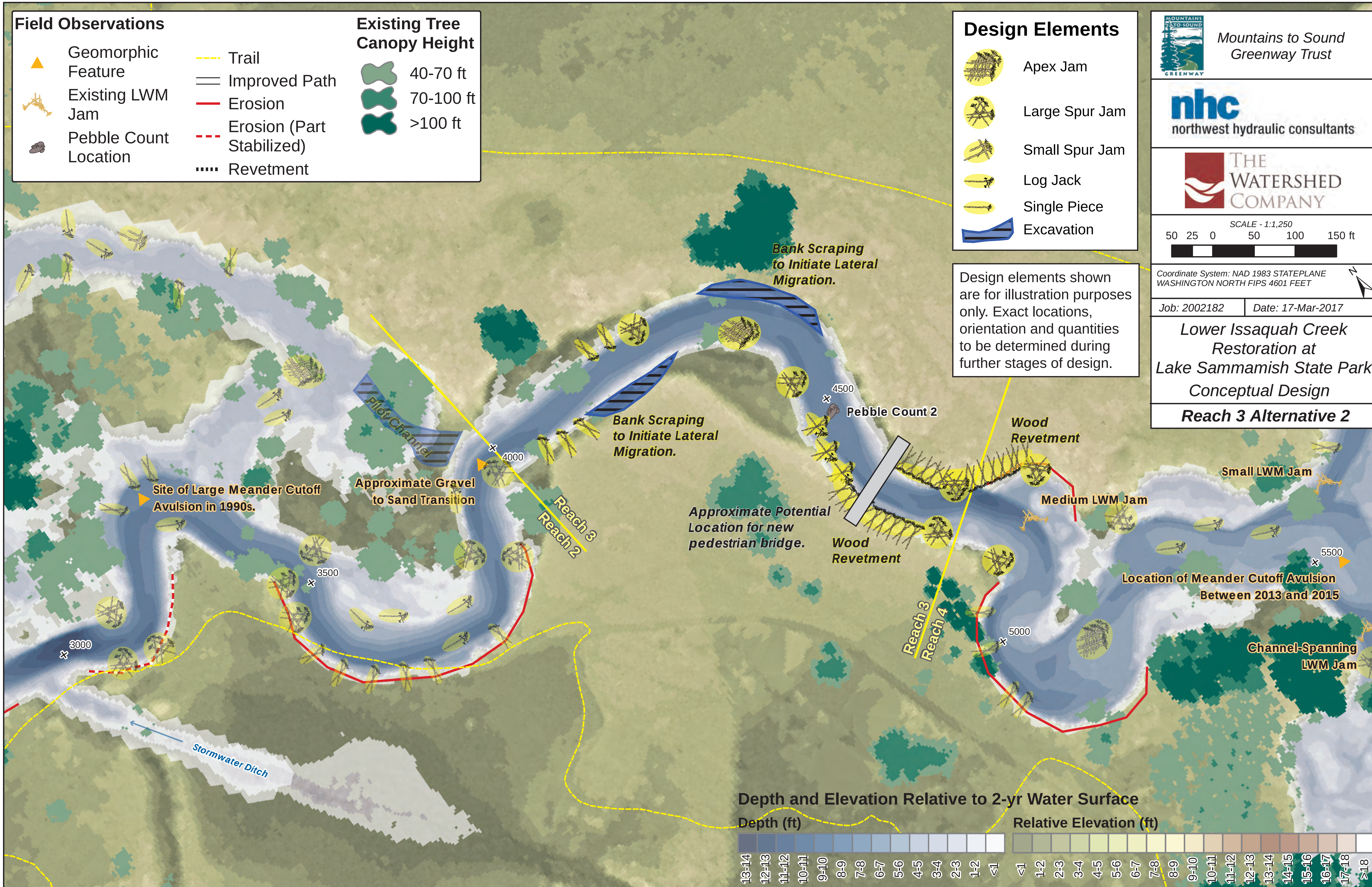
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
THE WATERSHED COMPANY
SCALE - 1:1,250
50 25 0 50 100 150 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
N
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Conceptual Design
Reach 2 Alternative 1
Design Elements
Apex Jam
Large Spur Jam
Small Spur Jam
Log Jack
Single Piece
Excavation
Design elements shown are for illustration purposes only. Exact locations, orientation and quantities to be determined during further stages of design.
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
Pebble Count 1
Small LWM Jam
Isolated Gravel Bar
2500
Reach 2
Reach 1
2000
Lowest Alluvial Bar (sandy)
Large LWM Jam
Behind Channel-Spanning Cottonwood
3000
Stormwater Ditch
Site of Large Meander Cutoff Avulsion in 1990s.
3500
Pilot Channel
Approximate Gravel to Sand Transition
4000
Reach 3
Reach 2
Place Excavated Material Behind Jam.
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
>18



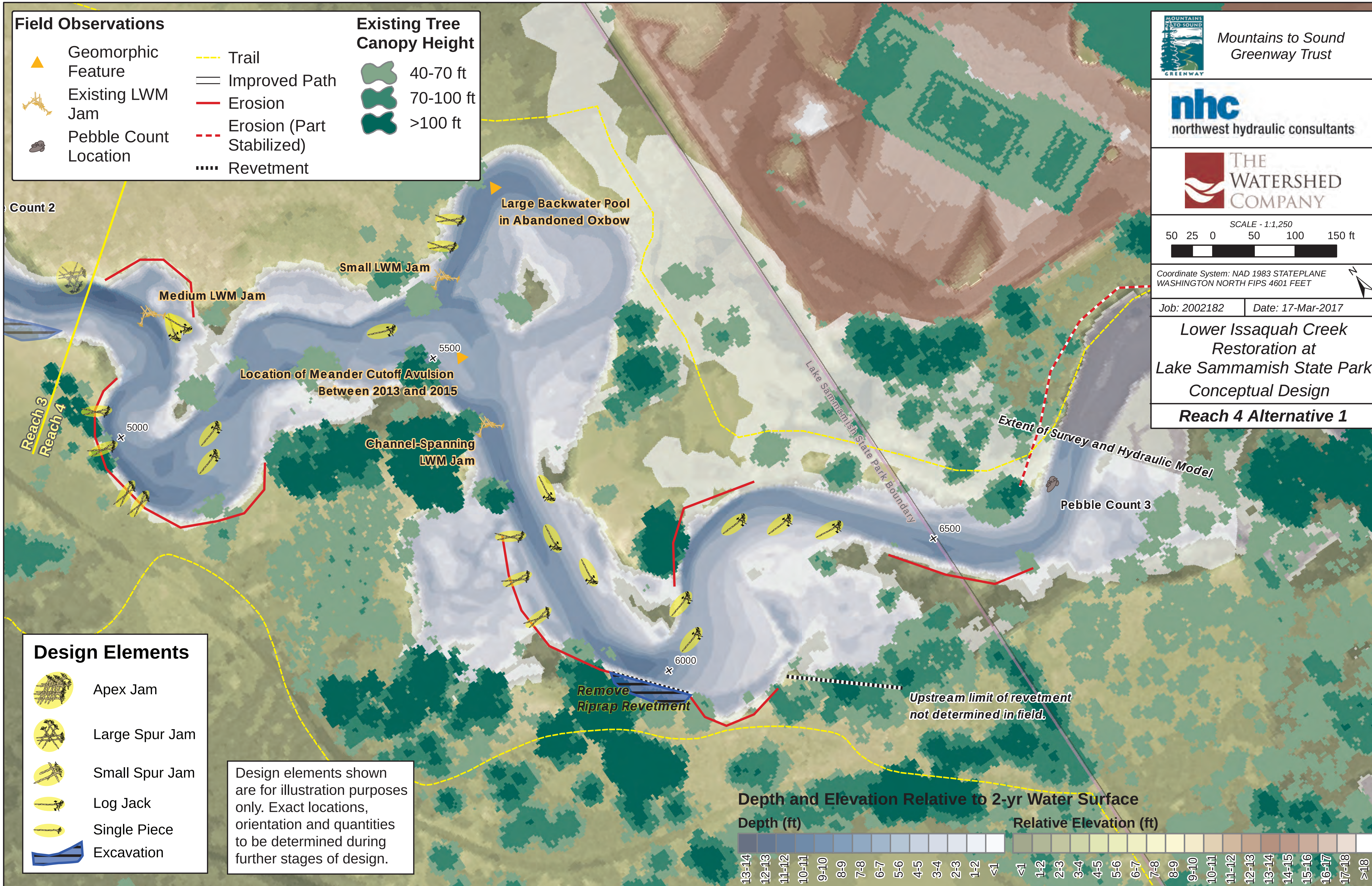
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:1,250
50 25 0 50 100 150 ft
Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
N
Job: 2002182
Date: 17-Mar-2017
Lower Issaquah Creek Restoration at Lake Sammamish State Park
Conceptual Design
Reach 2 Alternative 2
Design Elements
Apex Jam
Large Spur Jam
Small Spur Jam
Log Jack
Single Piece
Excavation
Design elements shown are for illustration purposes only. Exact locations, orientation and quantities to be determined during further stages of design.
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
Pilot Channel
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 >18



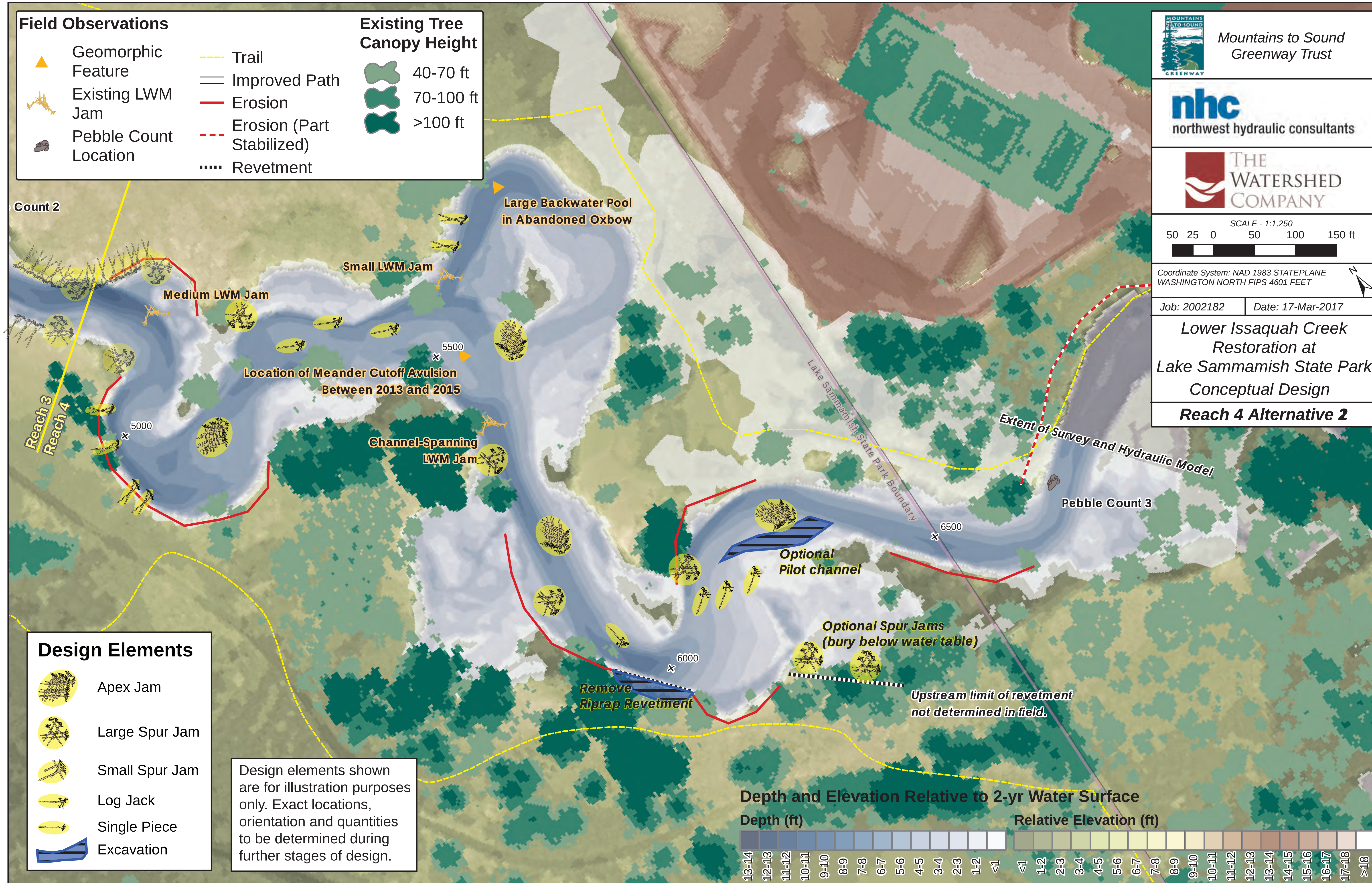
Field Observations
Geomorphic Feature
Existing LWM Jam
Pebble Count Location
Trail
Improved Path
Erosion
Erosion (Part Stabilized)
Revetment
Existing Tree Canopy Height
40-70 ft
70-100 ft
>100 ft
Design Elements
Apex Jam
Large Spur Jam
Small Spur Jam
Log Jack
Single Piece
Excavation
Design elements shown are for illustration purposes only. Exact locations, orientation and quantities to be determined during further stages of design.
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
THE WATERSHED COMPANY
SCALE - 1:1,250
50 25 0 50 100 150 ft
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
Conceptual Design
Reach 3 Alternative 1
Bank Scraping to Initiate Lateral Migration.
Bank Scraping to Initiate Lateral Migration.
Bank Scraping to Initiate Lateral Migration.
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
Pilot Channel
Place Excavated Material Behind Jam.
Stormwater Ditch
Small LWM Jam
Medium LWM Jam
Location of Meander Cutoff Avulsion Between 2013 and 2015
Channel-Spanning LWM Jam
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
Design Elements
Apex Jam
Large Spur Jam
Small Spur Jam
Log Jack
Single Piece
Excavation
Mountains to Sound Greenway Trust
nhc northwest hydraulic consultants
The Watershed Company
SCALE - 1:1,250
50 25 0 50 100 150 ft
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
Conceptual Design
Reach 3 Alternative 2
Design elements shown are for illustration purposes only. Exact locations, orientation and quantities to be determined during further stages of design.
Bank Scraping to Initiate Lateral Migration.
Bank Scraping to Initiate Lateral Migration.
Pilot Channel
Approximate Gravel to Sand Transition
Site of Large Meander Cutoff Avulsion in 1990s.
Approximate Potential Location for new pedestrian bridge.
Pebble Count 2
Wood Revetment
Wood Revetment
Medium LWM Jam
Small LWM Jam
Location of Meander Cutoff Avulsion Between 2013 and 2015
Channel-Spanning LWM Jam
Reach 3
Reach 2
Reach 3
Reach 4
3000
3500
4000
4500
5000
5500
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
Mountains to Sound Greenway Trust
nhc
northwest hydraulic consultants
The Watershed Company
SCALE - 1:1,250
50 25 0 50 100 150 ft
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
Conceptual Design
Reach 4 Alternative 1
Count 2
Large Backwater Pool in Abandoned Oxbow
Small LWM Jam
Medium LWM Jam
5500
Location of Meander Cutoff Avulsion Between 2013 and 2015
Reach 3
Reach 4
5000
Channel-Spanning LWM Jam
Lake Sammamish State Park Boundary
Extent of Survey and Hydraulic Model
Pebble Count 3
6500
6000
Remove Riprap Revetment
Upstream limit of revetment not determined in field.
Design Elements
Apex Jam
Large Spur Jam
Small Spur Jam
Log Jack
Single Piece
Excavation
Design elements shown are for illustration purposes only. Exact locations, orientation and quantities to be determined during further stages of design.
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
Mountains to Sound Greenway Trust
nhc northwest hydraulic consultants
The Watershed Company
SCALE - 1:1,250
50 25 0 50 100 150 ft
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
Conceptual Design
Reach 4 Alternative 2
Count 2
Large Backwater Pool in Abandoned Oxbow
Small LWM Jam
Medium LWM Jam
5500
Location of Meander Cutoff Avulsion Between 2013 and 2015
Reach 3
Reach 4
5000
Channel-Spanning LWM Jam
Lake Sammamish State Park Boundary
Extent of Survey and Hydraulic Model
Pebble Count 3
6500
Optional Pilot channel
Optional Spur Jams (bury below water table)
6000
Remove Riprap Revetment
Upstream limit of revetment not determined in field.
Design Elements
Apex Jam
Large Spur Jam
Small Spur Jam
Log Jack
Single Piece
Excavation
Design elements shown are for illustration purposes only. Exact locations, orientation and quantities to be determined during further stages of design.
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 E – Partner Feedback and Alternative Selection Memo

TO: Casey Kramer

FROM: Tor Bell

DATE: October 15, 2018

SUBJECT: Partner Feedback and Alternative Selection for Issaquah Creek In-stream Restoration Project at Lake Sammamish State Park

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NHC, The Watershed Company, and the Mountains to Sound Greenway Trust are nearing completion of the first phase of planning – Conceptual Design – for the Issaquah Creek In-stream Restoration Project at Lake Sammamish State Park. The final remaining step is to provide a brief overview of initial feedback from project partners and interested parties regarding the proposed design concepts, and to select a Preferred Alternative to investigate further in the Preliminary Design phase. The Greenway Trust contacted multiple partners to alert them to the project and solicit early feedback on concepts and alternatives. Specifically, the following partners were consulted:

- Nikki Fields, Washington State Parks & Recreation, Parks Design & Land Use Planner
- John Ernster, Washington State Parks & Recreation, Area Manager – Cascade Foothills
- Bob York, City of Issaquah, Public Works Engineering, Utilities Engineering Manager
- Jennifer Fink, City of Issaquah, Parks & Recreation, Parks Planner
- David Steiner, Snoqualmie Indian Tribe, Habitat Restoration Program Manager
- Casey Costello, Washington Department of Fish & Wildlife,
- Martin Fox & Karen Walter, Muckleshoot Indian Tribe
- David Kyle, Trout Unlimited, Lake Sammamish Kokanee Restoration Project Manager
- Barb Gronseth, Kayak Academy
- WRIA Technical Review Team
- Lake Sammamish Kokanee Work Group

After reviewing the two proposed alternatives, Alternative Two emerged as the consensus choice. Partners consistently voiced support for higher volumes of wood in the creek and the desire to more aggressively support in-stream habitat conditions for salmonids. The Muckleshoot Indian Tribe pointed to the Fox & Bolton report and emphasized the need for increased wood volumes. The WRIA 8 TRT highlighted the watershed goal of doubling wood volume in key WRIA 8 streams (including Issaquah Creek) by 2025 and noted that this project would support achieving salmon recovery objectives.

Several partners (WRIA 8 TRT, WDFW and the Snoqualmie Tribe) appreciated the effort to not over-engineer and anchor the LWD structures in place. There is an understanding that some anchoring may be necessary but where viable it is preferable to create and initiate natural, process-based, riverine function and habitat formation (rather than creating locked, fixed features in an otherwise dynamic system). It was noted that this project provides an unusual opportunity for extensive restoration in an otherwise urban environment.

Two primary reservations were voiced about both alternatives, though Alternative Two would likely have higher risks because of the higher wood volumes. These include:

> ***No Net Rise***: The City of Issaquah raised the concern that increasing wood volumes in Issaquah Creek in the State Park may raise flood levels upstream. Multiple public and private landowners could be impacted if the project causes upstream flooding. Of particular concern would be the entire Costco complex which is adjacent to Issaquah Creek upstream and has multiple ditches that drain directly into the park and Issaquah Creek. The Microsoft building immediately adjacent to the project site could also be impacted. The City wants to ensure that there is no net rise and the upstream infrastructure is protected. In the Preliminary Design phase, the Greenway Trust will work with the City and other landowners to clarify and address specific points of concern.

> ***Facilities Protection***: Washington State Parks' primary concern is that the few existing structures adjacent to the creek (specifically the Sunset Beach facilities, the boardwalk at the mouth of the creek and the existing bridge over the creek) not be impacted by instream restoration, regardless of the volume of wood. State Parks has provided NHC with shape files of the State's critical facilities. Additionally, State Parks anticipates building a second bridge over Issaquah Creek to provide a loop trail opportunity for park users. A proposed location has been provided to NHC and should be included in planning and study efforts moving forward.

Greenway Trust staff will continue to reach out to and update interested agency, tribal and non-profit partners as project planning continues. Formal outreach to broader stakeholders will be incorporated into the Preliminary Design phase of planning.