Type, Size and Location (TS&L) Study: Mill Creek Bridge (No. 40086, SID 08305200) Replacement and Savage Creek Culvert Replacement

Type, Size and Location (TS&L) Study

Skagit County Public Works

South Skagit Highway at Mill Creek (M.P. 18.3) and Savage Creek (M.P. 18.4)

April 25, 2025 | Report

kpff Consulting Engineers

Mill Creek Bridge (No. 40086, SID 08305200) Replacement and Savage Creek Culvert Replacement

Type, Size and Location (TS&L) Study

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1. Executive Summary

The existing Mill Creek Bridge and the Savage Creek culvert are located on South Skagit Highway at milepost 18.3. The Mill Creek Basin, with its very steep gradient, transports vast amounts of sediment and large cobbles resulting in severe aggradation, reducing the available conveyance under the bridge. This has caused the creek to migrate within the alluvial fan that the South Skagit Highway bisects. Since 1998, large rain events have resulted in the overtopping of the bridge. Ongoing maintenance efforts by the County are required several times a year to repair the bridge and road as a result of these flows.

The Mill Creek Bridge and Savage Creek Culvert Replacement project aims to reconstruct roughly 1.5 miles of the South Skagit Highway and relocate this critical infrastructure to prevent further degradation, restore natural processes within the floodplain, improve climate resiliency, and restore access for fish habitat. This study evaluates bridge replacement alternatives for two sites: Mill Creek and Savage Creek. The goal of the study is to identify preferred bridge configurations that balance structural performance, constructability, environmental protection, hydraulic efficiency, construction costs, and long-term maintenance.

In development of the project, two roadway alignments were considered. The chosen preferred alternative minimizes impacts to surrounding habitats, balances cut and fill, limits the need for walls, minimizes impacts to neighboring properties, and utilize existing logging roads when possible.

At Mill Creek, six bridge alternatives were developed and assessed, including single- and multi-span options with both prestressed concrete and steel girders. After thorough evaluation with the County and design team, two preferred alternatives emerged: a two-span and a three-span steel girder bridge. These options were selected due to their ability to span the full width of the ravine, minimize in-channel piers, accommodate expected channel migration, and reduce the need for tall abutments on steep slopes. The 424-ft long two-span steel girder alternative was selected by the County as the preferred alternative for its ability to be delivered in segments and assembled on-site, improving constructability in constrained terrain.

At Savage Creek, four single-span alternatives were evaluated, with the alternatives varying by span length and girder type. The 205-foot single-span steel girder bridge was identified as the preferred alternative, offering a balance of reduced abutment height, improved hydraulic opening, and feasible construction logistics.

The County has completed a detailed alternatives analysis and is currently preparing concept plans (approximately 15 percent level of design) for the bridges and road and preliminary design (approximately 30 percent level of design) for both channels. After concept and preliminary design phase, the next steps for the project will be finding funding for the final design and construction.

2. Introduction

This Type, Size, and Location (TS&L) study aims to evaluate and identify suitable structural design alternatives for the replacement of the Mill Creek Bridge and the Savage Creek Culvert. The structural analysis considers multiple factors, including structural feasibility, constructability, and cost estimation, to compare two alternatives. Key evaluation criteria include construction costs, future maintenance requirements, permitting requirements, and hydraulic considerations. Hydraulic considerations include the floodplain of the current channel, future channel migration uncertainty, limiting fill locations near the channel location, and scour. Other considerations such as roadway alignments, geotechnical data, and stakeholder support are also included.

3. Existing Structures

The existing Mill Creek Bridge (No. 40086, SID 08305200), built in 1969, is located on South Skagit Highway at milepost 18.3. Mill Creek flows south to north under the Mill Creek Bridge, and into the Skagit River approximately 900 feet downstream of the bridge. The existing bridge consists of prestressed concrete tub girders supported on concrete-filled steel pipe pile abutments. The bridge is 40 feet in length. Figure 3-1 shows the project vicinity map.

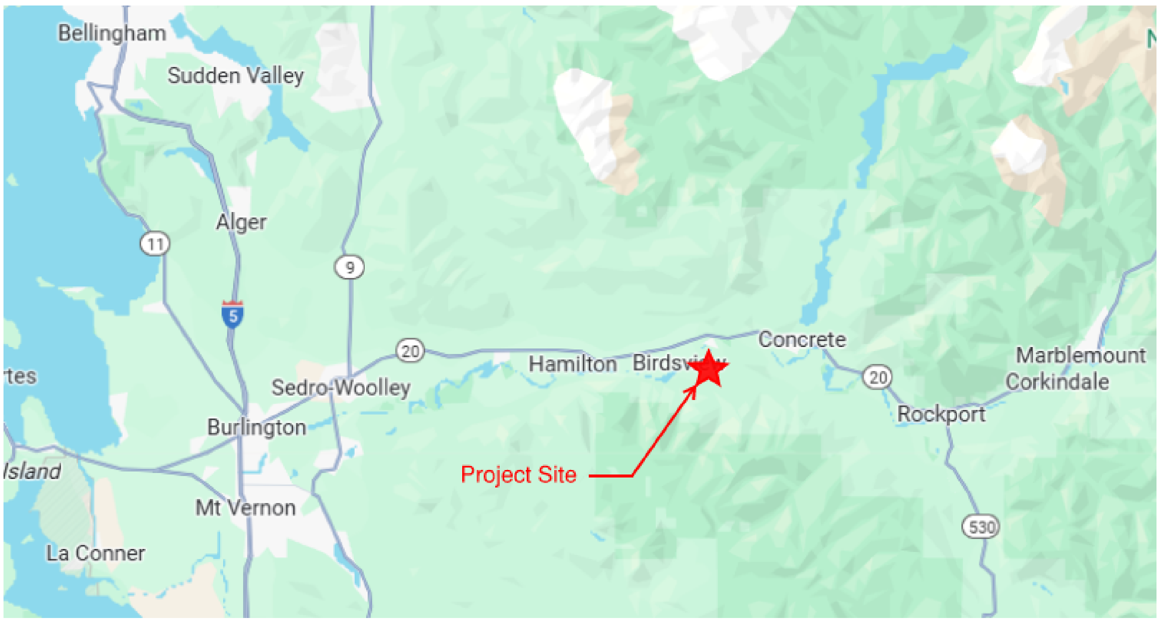

Figure 3-1: Project Vicinity Map

The Mill Creek Basin, with its very steep gradient, transports vast amounts of sediment and large cobbles resulting in severe aggradation and reducing the available conveyance under the bridge. Figure 3-2 shows the increase in aggradation from 1972 to 2024. This has caused the creek to migrate within the alluvial fan that the South Skagit Highway bisects. Since 1998, large rain events have resulted in the overtopping of the bridge, as shown in figure 3-3.

Figure 3-2: Mill Creek Bridge Aggradation Progression Since 1972

Figure 3-3: South Skagit Highway Overtopping at Mill Creek

Savage Creek crosses the South Skagit Highway approximately 300 feet east of Mill Creek. The crossing consists of a 12-foot-wide by 5-foot-high structural plate arch culvert; see figure 3-4. Both crossing structures are in the Skagit River watershed, along the southern banks of the river, approximately 20 miles east of the City of Sedro-Woolley and 6 miles west of the Town of Concrete.

Figure 3-4: Savage Creek Culvert at Low Flows

Historically the County has taken action to maintain the Mill Creek crossing, including annual sediment removal, installation of large wood to train the creek under the bridge, and armoring along the road shoulder to prevent damage. However, with the increase in sediment and cobbles, these occurrences have increased at an exponential rate (see table 3-1) with the potential damage exacerbated from Mill Creek flowing east into

Savage Creek and west along the highway until it overtops, as shown in figure 3-5. The South Skagit Highway overtops at this location multiple times per year. The overtopping results in an average of two partial road closures per year to address damage to the road.

Table 3-1: Last 10 years of road closures at or near Mill Creek Bridge

Date	Location	Status	Condition
12/08/2015	Mill Creek Bridge	Closed	Water Over Road
01/28/2016	Mill Creek Bridge	Closed	Water Over Road
10/14/2016	Mill Creek Bridge	Closed	Water Over Road
02/09/2017	Mill Creek Bridge	Closed	Water Over Road
11/23/2017	Mill Creek Bridge	Closed	Water Over Road
01/30/2018	East of Mill Creek	Closed	Water Over Road
09/26/2018	Milepost 18.32	Closed	Road Repairs
10/22/2019	Mill Creek Bridge	Closed	Water Over Road
12/20/2019	Mill Creek Bridge	Closed	Water Over Road
01/07/2020	Mill Creek Bridge	Closed	Water Over Road
01/04/2021	Mill Creek Bridge	Closed	Water Over Road
11/14/2021	Mill Creek Bridge	Closed	Water Over Road
11/28/2021	Mill Creek Bridge	Closed	Water Over Road
01/12/2022	Mill Creek Bridge	Closed	Water Over Road
12/05/2023	Mill Creek Bridge	Closed	Water Over Road
06/04/2024	Mill Creek Bridge	Closed	Water Over Road
11/13/2024	Mill Creek Bridge	Closed	Water Over Road
12/18/2024	Mill Creek Bridge	Closed	Water Over Road
02/25/2025	Mill Creek Bridge	Closed	Water Over Road
03/24/2025	Mill Creek Bridge	Closed	Water Over Road

Figure 3-5: Mill Creek flowing east into Savage Creek during overtopping event

4. Proposed Fish Passage and Roadway Realignment Project

The County is progressing the Mill Creek and Savage Creek Fish Passage project to restore fish passage and natural processes where Mill and Savage Creeks cross the South Skagit Highway within the Skagit River Floodplain for the benefit of anadromous fish and climate change resiliency.

Mill Creek and Savage Creek, which flow into the Skagit River, support federally threatened Puget Sound Chinook salmon, steelhead, and bull trout, as well as coho, chum, and pink salmon and resident trout. The Skagit River produces over 50 percent of the Chinook salmon consumed by the federally endangered Southern Resident Killer Whales (SRKW).

The South Skagit Highway bisects the alluvial fan of Mill Creek and has direct impacts on existing habitat conditions. According to a 2012 Habitat Scoping Report, the current alignment of South Skagit Highway disconnects the mainstem Skagit River from approximately 62 acres of floodplain, isolates 5.2 acres of wetland, and impairs fish access to 21.7 acres of slough and wetland habitat and 9.98 miles of upstream habitat in the project area.

PREVIOUS WORK

Skagit River System Cooperative (SRSC), with support from Skagit County, previously studied the project site to identify and evaluate critical areas (2012), and then to develop alternatives to improve habitat within the project area (2015). Developed alternatives included both moving the road (Alternatives 2 and 3 as shown in figure 4-1) and keeping the road in the existing location (Alternatives 1 and 1A as shown in figure 4-1).

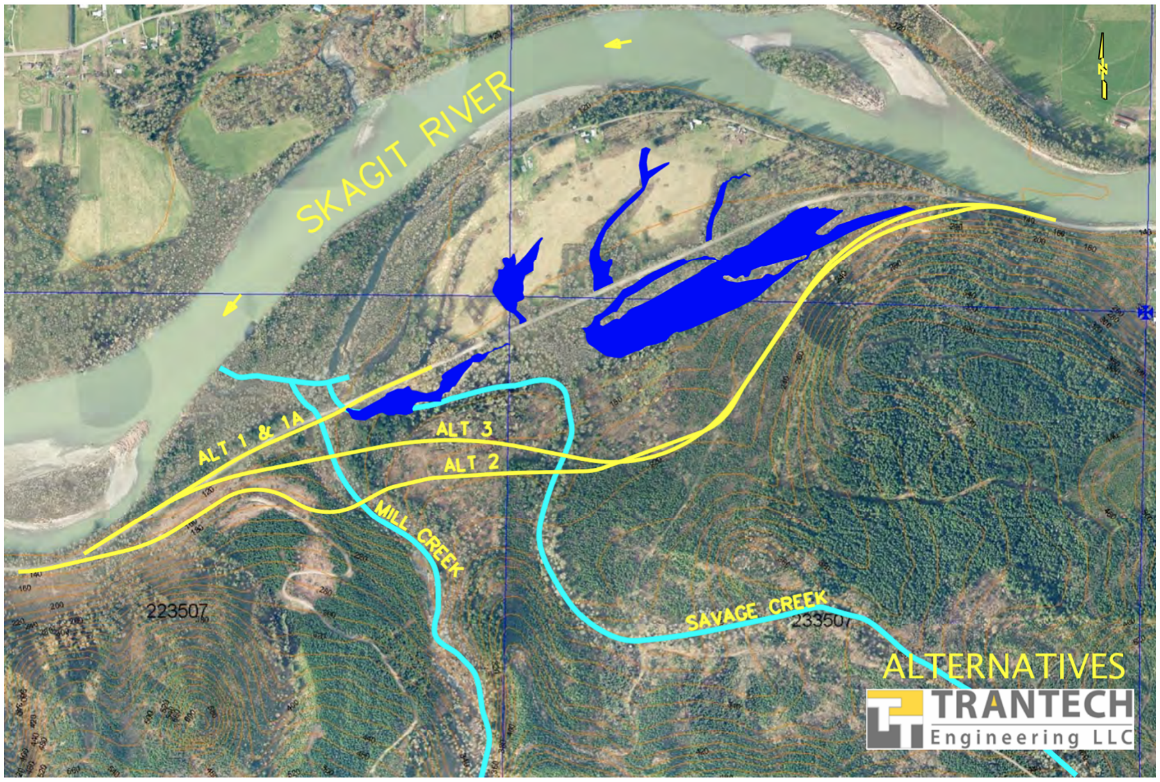

Figure 4-1: Roadway Alignments from 2015 SRSC Study

In the 2015 study, it was estimated that the existing road would need to be raised at least 11 feet or higher to provide for adequate clearance above estimated aggradation and water surfaces if the road were to remain in the same horizontal alignment and location as existing. This rise would require extensive fill in the Skagit River Floodplain and into the wetlands adjacent to the road. Retaining walls along the alignment could be used to minimize impacts, but would be expensive.

At the time of the 2015 report, leaving the roadway at the existing alignment was considered. However, permit requirements have become more strict, and it is assumed that fill inside the floodplain would not be permitted or be extremely costly to mitigate the environmental impacts. To minimize fill in the floodplain, a large section of the roadway would need to be elevated to maintain floodplain connectivity and wetland habitat. Estimated bridge lengths would need to be as long or longer than bridges constructed upstream, to span the Mill Creek alluvial fan. The 2015 study found that overall project infrastructure costs were similar for keeping the roadway alignment where it currently exists versus moving the roadway and bridges out of the floodplain, and there were no environmental or habitat benefits in keeping the roadway where it currently is. If the project were constructed today, more roadway would need to be elevated, and construction costs are expected to be higher to keep the roadway in the existing location.

In addition to the roadway alignment work, the following was provided in the 2015 study:

- High-level geotechnical field investigation and recommendations
- Preliminary hydrology and hydraulic design recommendations
- Concept-level bridge sizes

- High-level permitting/regulatory considerations
- Roadway and stormwater design criteria identified
- Estimated construction costs
- Alternatives comparison

Based on the results of the 2015 study, the County chose to move forward with relocating approximately 1.5 miles of the South Skagit Highway to the south, moving it upstream of the alluvial fans of Mill and Savage Creeks and outside of the Skagit River Floodplain. The resulting project will relocate critical infrastructure to prevent further degradation, restore natural processes within the floodplain, build climate resiliency into a key transportation corridor, involve the design of two new fish-passable bridges (at Mill Creek and at Savage Creek), improve climate resiliency for the underserved communities on both sides of the existing crossings, and restore access for adult and juvenile life stages of a variety of habitat species.

CURRENT WORK

In 2024, Skagit County hired the KPFF design team to progress the design of the project by refining the roadway alignment, progressing the design of the channels upstream of the existing roadway (to a preliminary level), progressing the design of the roadway and bridges (to a conceptual level), and supporting the County with stakeholder outreach and funding applications.

This work is currently funded by the Salmon Recovery Funding Board (SFRB). The channel designs will be at a preliminary (approximately 30 percent) level of design and the bridges and roadway at a conceptual (approximately 15 percent) level of design by June of 2025. The County is currently pursuing funding for final design and construction of the project from multiple sources, including NOAA (Fish Passage and Climate Resiliency Grants), SRFB (Fish Passage), and WSDOT/FHWA Local Bridge Program Funding, among other sources.

The work started with collecting new high-resolution LiDAR images of the proposed project site. Then, roadway designers evaluated the previous (2015) roadway alignments and proposed modifications to the alignments based on the updated LiDAR surface data. Considerations for the proposed new roadway alignment include balancing cut and fill, avoiding the large earth formation near Mill Creek, limiting impacts to surrounding properties, and minimizing roadway length.

Design alternatives workshops were held with representatives from several technical disciplines (hydraulic, structural, geotechnical, roadway/stormwater, and permitting) and agency staff. The work resulted in the two possible alignments. Figure 4-2 shows the two new alignment alternatives explored; the two alignments in green are the two alignments from the previous (2015) report for comparison.

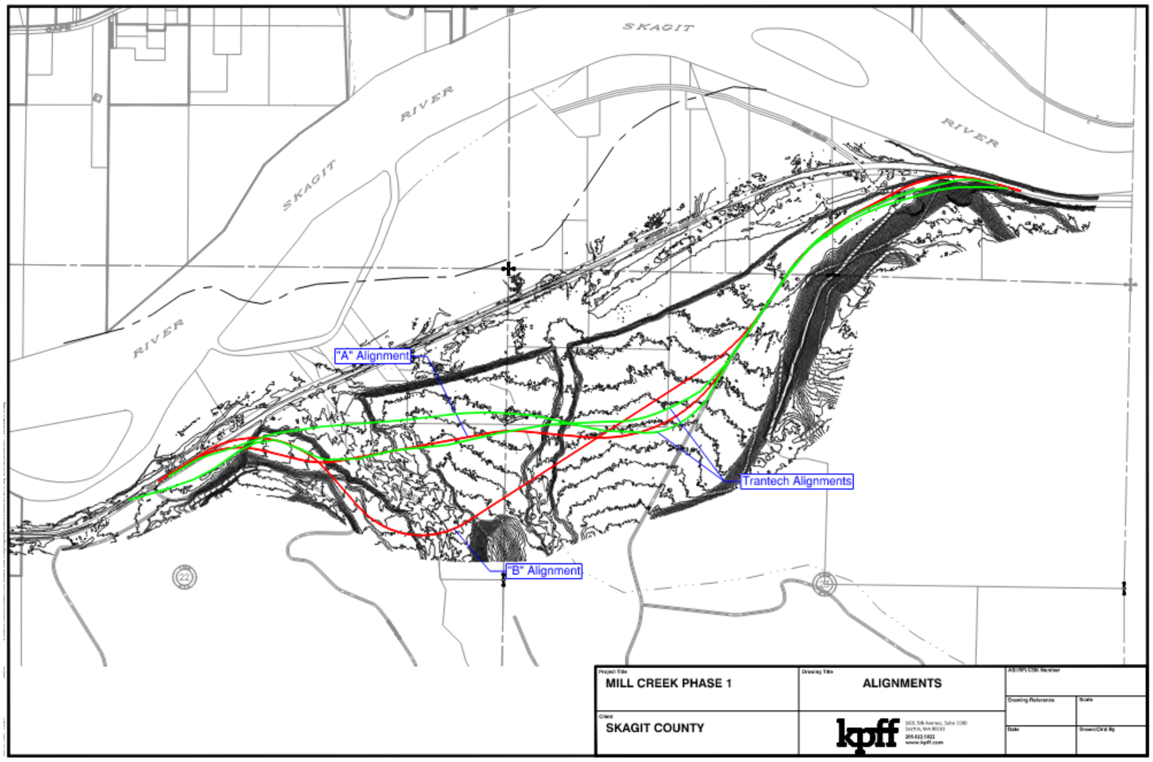

Figure 4-2: Proposed Future Roadway Alignments

Alignment A was chosen as the preferred alternative by the County because it ties into an existing logging road sooner and crosses Savage Creek perpendicularly. Figure 4-3 shows the preferred alignment and figure 4-4 shows the bridge locations for the Mill Creek and Savage Creek crossings.

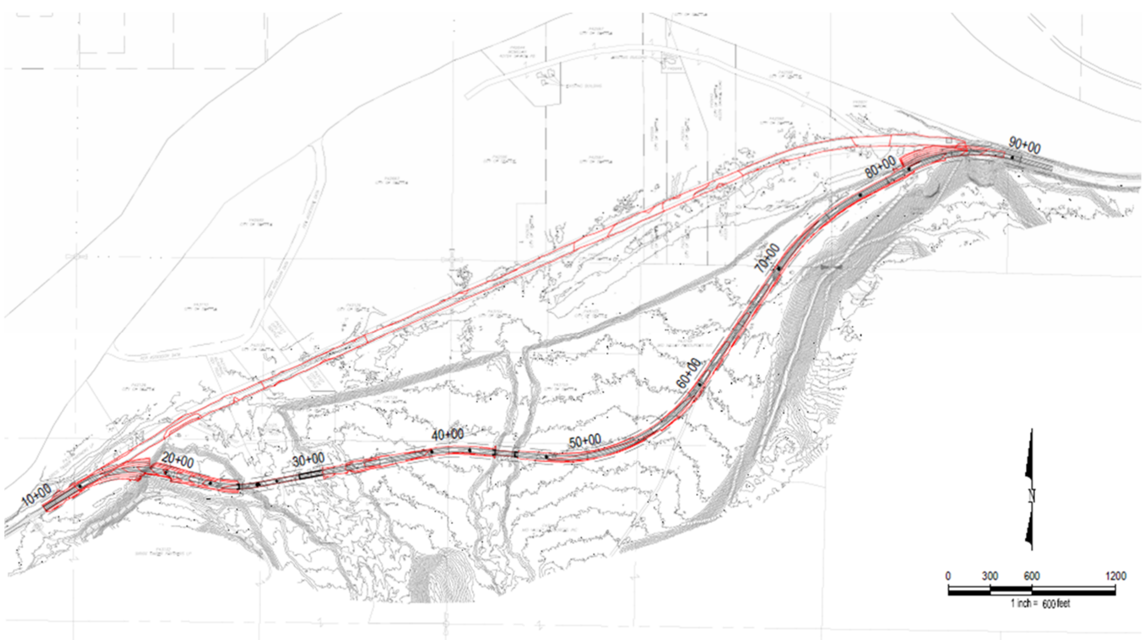

Figure 4-3: Preferred Alignment A

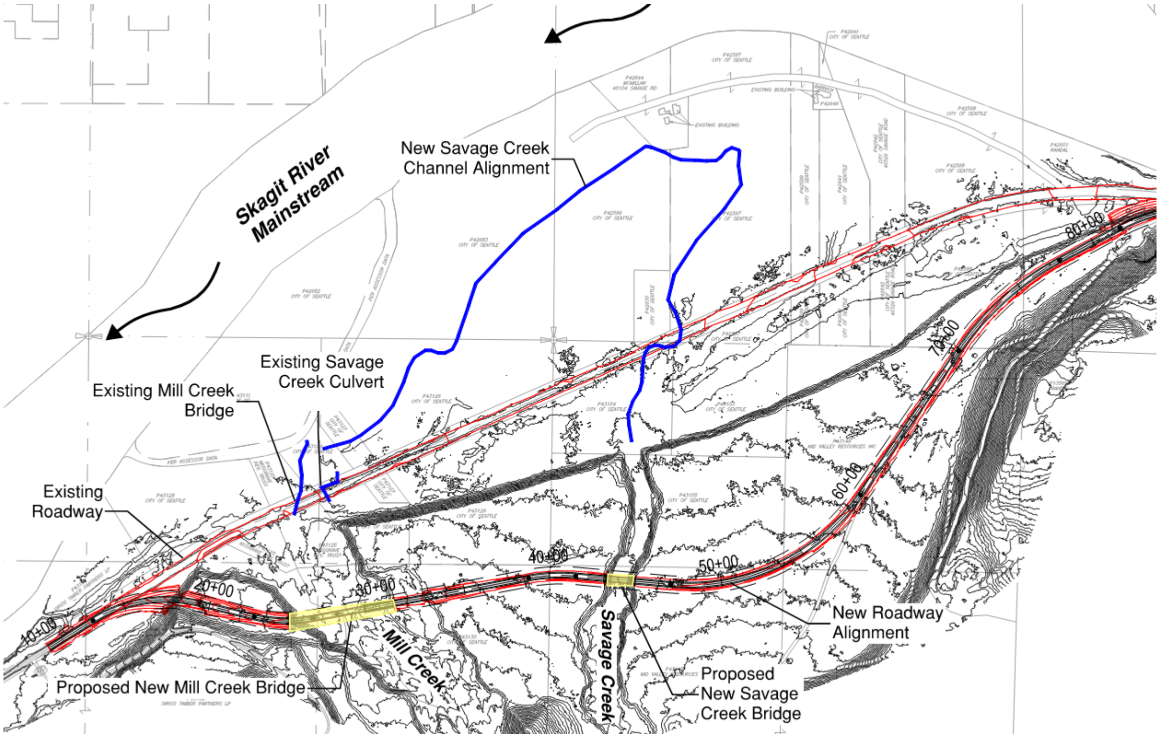

Figure 4-4: Proposed Mill Creek and Savage Creek Bridges in Yellow

5. Survey

A survey of the project site was conducted as part of the current contract to confirm and update the information provided from the 2015 work. This included LiDAR and ground survey mapping methods.

6. Technical Studies

Several technical studies have been completed for the full road relocation project, including locating bridges, to provide technical information for the bridge design. Additionally, environmental/permitting and cultural resources risks have been identified, and stakeholder engagement is ongoing to support the project. This section includes summaries of those studies.

7. Hydrologic and Hydraulic Engineering and Geomorphological Design

Mill Creek Site Geomorphic History

Rapid accumulation of sediment in Mill Creek at and downstream of the South Skagit Highway crossing has almost completely filled the bridge opening over the past four decades. This accumulation has resulted from interaction between channel changes in the Skagit River and high sediment supply from Mill Creek.

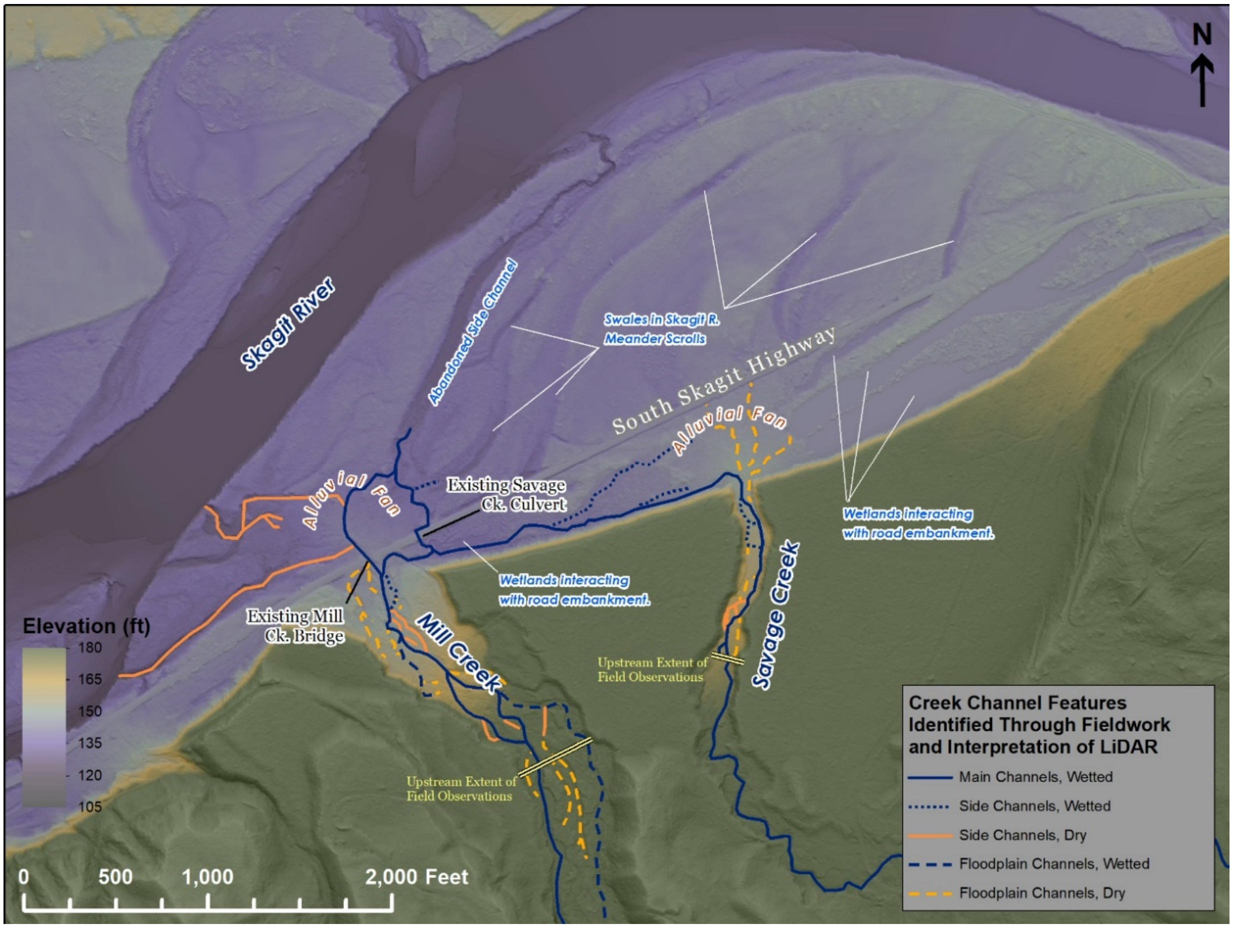

Figure 7-1: Overview map of Mill and Savage Creeks and Skagit River Floodplain between the creek fans and river

Mill Creek Interactions with Skagit River

Aerial photos of the site in 1972 (figure 7-2) show that a large (approximately 150 feet wide) side channel of the Skagit River meandered to a position about 240 feet northwest of the Mill Creek crossing location and that Mill Creek had built a small delta-fan bar into this side channel. Before this time, periodic high flows in the Skagit River likely transported most of the sediment supplied by Mill Creek out of this side channel, keeping it open. Between 1972 and 1985, however, the slow accumulation of sediment at the mouth of Mill Creek reduced the capacity of flow through the side channel to carry away sediment supplied by Mill Creek, creating a positive feedback cycle where sediment accumulation reduced the amount of flow through the side channel, further driving additional sediment accumulation. By 1985, the Mill Creek delta-fan had prograded completely across the side channel and blocked throughflow from the Skagit River (figure 7-2). After this, all the sediment supplied by Mill Creek was deposited locally and Mill Creek began building a larger alluvial fan through a sequence of avulsions downstream of the South Skagit Highway, driving aggradation of the bed at the crossing.

Comparison of aerial photos shows that sediment accumulation remains focused on the Mill Creek fan near and downstream of the crossing, with little channel profile change occurring from above about 600 feet upstream of the current crossing. The proposed Mill Creek bridge will be located upstream of this aggradation zone.

Figure 7-2: Aerial photos showing closure of the Skagit River side channel at Mill Creek confluence.

2002 HYDROGEOMORPHIC FLOOD

A particularly important flood occurred in 2002, when a rain-on-snow flood generated numerous landslides throughout the Mill Creek Basin, which introduced a large volume of sediment and large wood to the creek and generated a combined debris flow and bridge-dam failure outburst flood (Grizzel, 2002). In addition to supplying sediment to the South Skagit Highway crossing over the creek, wood entrained by the flood formed very large jams across the creek upstream of the crossing (Grizzel 2002; figure 7-3).

Preliminary estimates indicate that the peak discharge of the 2002 event was potentially an order of magnitude higher than the estimated 100-year recurrence interval flood generated solely from hydrometeorological processes. Field observations from 2024 and interpretation of LiDAR show this terrace (the T1 terrace on the right bank between RM 0.45 and 0.8 in figure 7-3) was located at an elevation of 6 to 8 feet above the channel. Published observations of the event do not include estimates of the debris flow volume or peak instantaneous discharge; however, using a hydraulic model and quantitative calculations, we estimate discharge could have been about 8,000 cubic feet per second ± 5,000 cubic feet per second. The proposed bridge will be designed to withstand such a discharge.

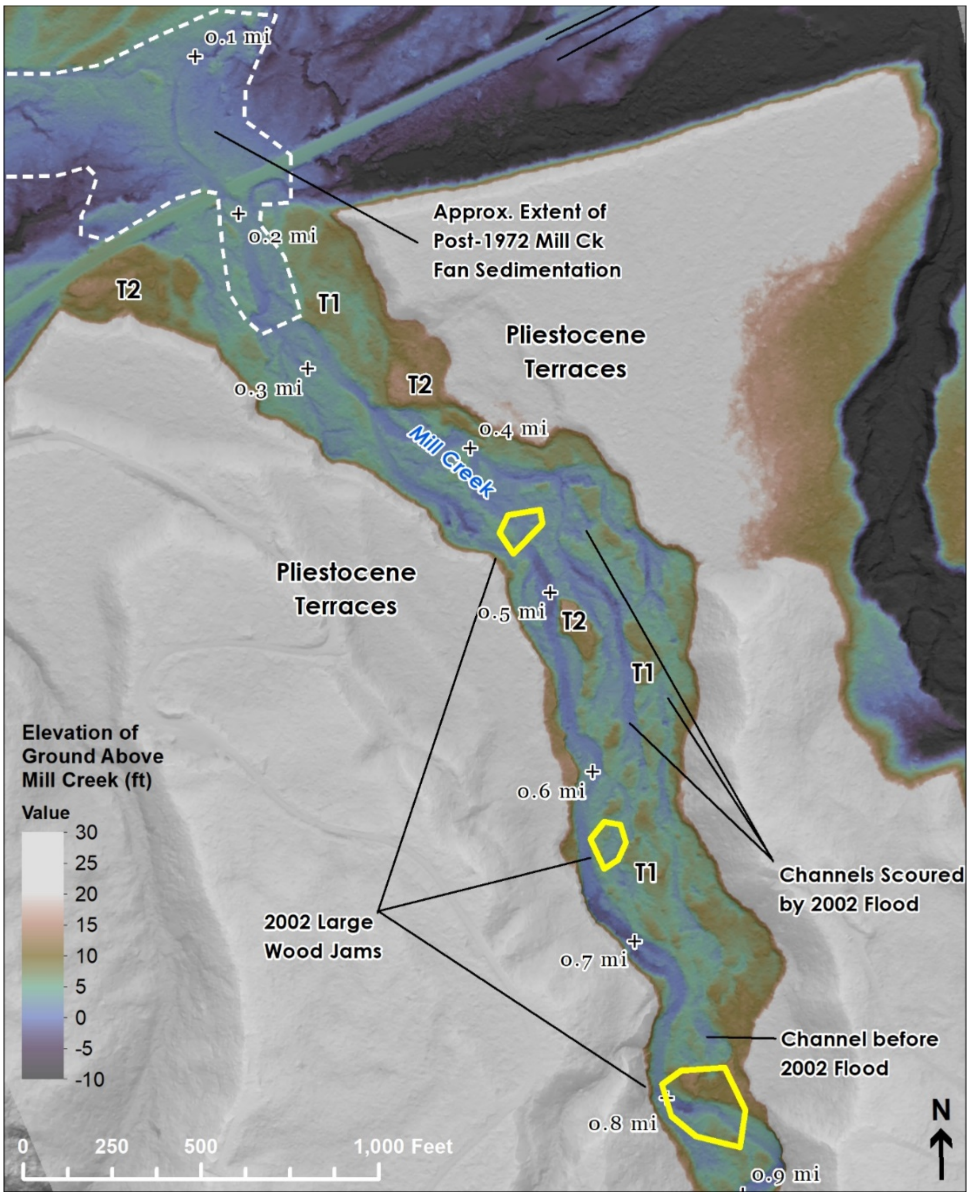

Figure 7-3: Relative elevation model of Mill Creek with key features from the 2002 hydrogeomorphic flood, identified by Grizzel (2002), and select other valley bottom geomorphic features annotated

SAVAGE CREEK AND SKAGIT RIVER FLOODPLAIN

Savage Creek debouches from an approximately 300- to 400-foot-wide valley that is deeply incised below Pleistocene terraces into the Skagit River Floodplain approximately 2,000 feet upstream of the current Savage Creek culvert under the South Skagit Highway. At this point, it has built up an alluvial fan (figure 7-1) that extends to the north. The South Skagit Highway cuts through this fan. In some places the fan was lowered to meet the highway grade, while in others fill was placed, blocking potential Savage Creek flow paths and impounding several large ponds and wetlands that lie between the Savage Creek alluvial fan, terrace escarpment, and South Skagit Highway. Presently, Savage Creek turns abruptly to the west at the fan apex and follows a westerly alignment before entering another pond and wetland that are controlled by interactions between the Mill Creek alluvial fan, South Skagit Highway embankment, and Savage Creek culvert (figure 7-1). Given this geomorphic and hydraulic setting, removing the South Skagit Highway embankment opens the possibility of Savage Creek occupying a large area of the Skagit River Floodplain where it may flow between various meander scroll swales across the floodplain.

In the valley upstream of the alluvial fan, the main stem and side channels of Savage Creek generally anabranch across the entire valley bottom (figure 7-2). In many areas, the channel is very wide (on the order of 40 to 60 feet), poorly defined, and surrounded by very low wet floodplain, while in some areas it is slightly more channelized and occupies a 25- to 35-foot-wide channel. Where the main channel abuts the valley wall, cutbanks readily erode into the valley wall toe, indicating the creek is actively expanding the valley bottom.

8. Proposed Bridge Site Locations

In February 2025 the design team, agency staff, and nearby property owners walked the preferred alignment. Figure 8-1 shows the alignment with approximate photo locations.

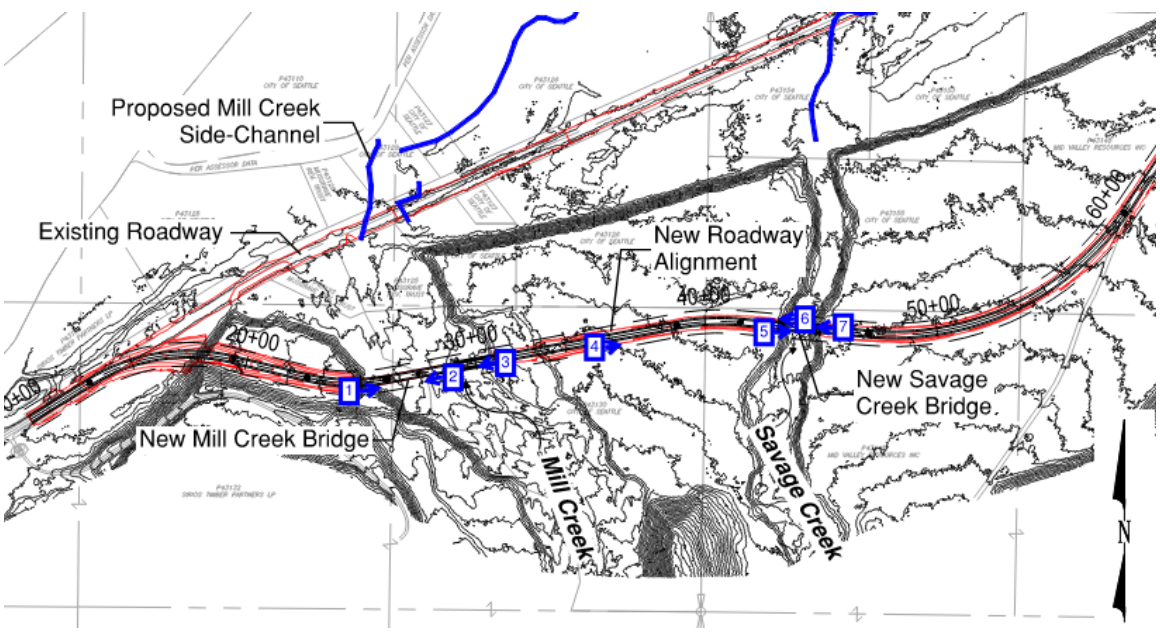

Figure 8-1: Mill and Savage Creeks Bridge Locations with Photo Locations

MILL CREEK

At the proposed crossing of Mill Creek, the west side of the creek bank is about 35 feet tall and inclined at about 1.2 to 1.3H:1V. The eastern bank, which the two-span bridge alternative proposes to fill in, is more gradually inclined and undulating. Figure 8-2 shows photos of the approximate bridge location at the west abutment looking east (1), at the east bank of Mill Creek looking west (2), at the east fill area looking west (3), and along the alignment between Mill and Savage Creeks looking west (4).

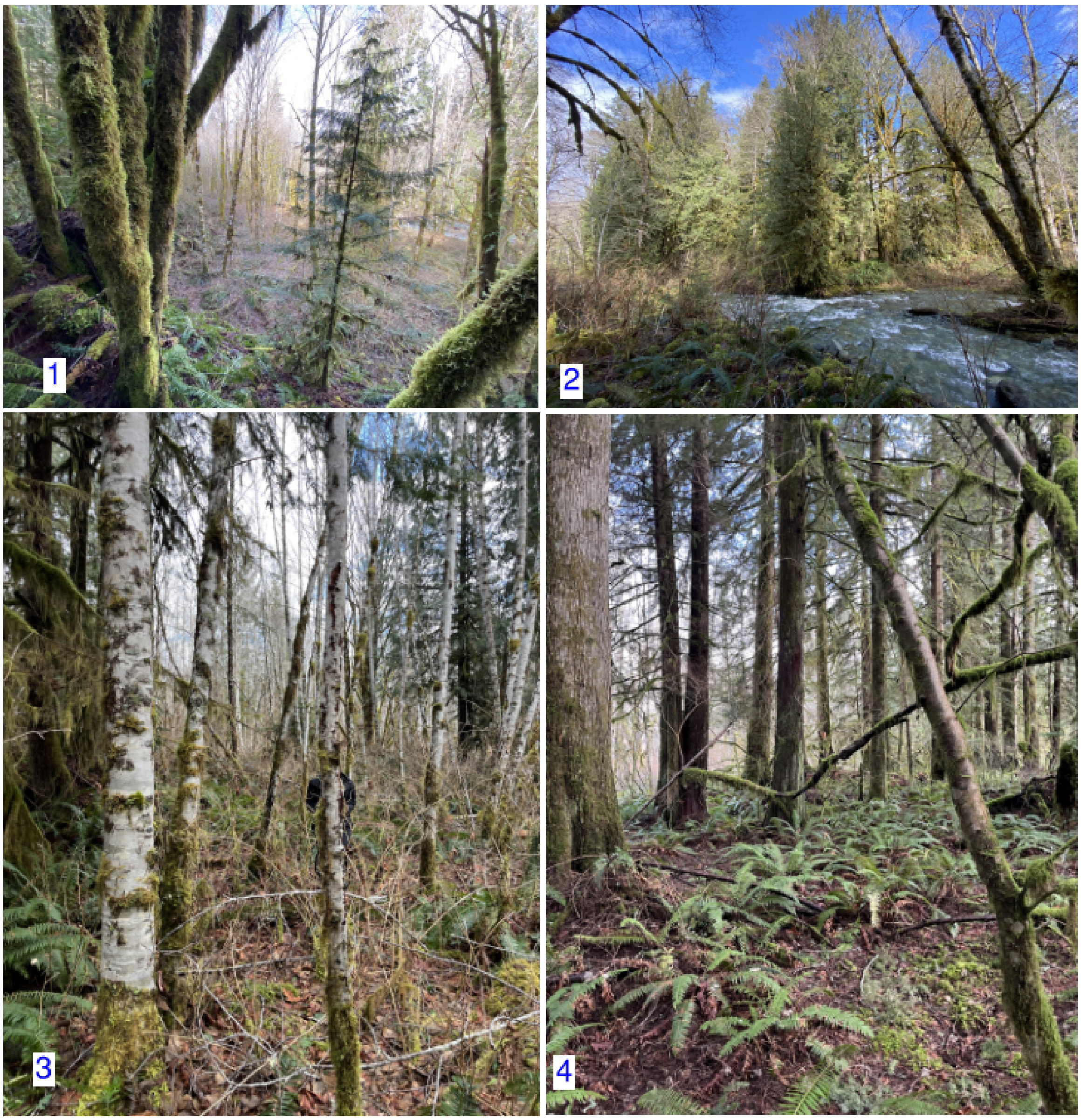

Figure 8-2: Mill Creek Photos from Site Visit

SAVAGE CREEK

At the proposed crossing of Savage Creek, the creek banks are about 30 feet tall on both sides and relatively steep with inclinations ranging from about 1.2 to 1.5H:1V. Approximate bridge location photos are shown in figure 8-3, which includes photos from the approximate west abutment looking east (5), from the west of

Savage Creek looking west toward the west abutment (6), and at the east abutment looking west (7). This site consists of steep approach slopes on both the east and west sides.

Figure 8-3: Savage Creek Photos from Site Visit

9. Geotechnical Engineering

GEOLOGIC SETTING

In the project area, hillsides rising above the floodplain of the Skagit River are composed of recessional glacial outwash that forms a broad and undulating terrace generally to the south of most of the alignment. Post glacial (Holocene) incision and meander of the Skagit River and its tributary drainages have eroded this glacial outwash terrace and created a series of successively lower terraces of recent alluvium that step down to the north into the modern river channel. Meander of the Skagit River also created a number of now-abandoned incised flood channels, many of which are now the wetlands adjacent to the highway.

SUBSURFACE CONDITIONS

As part of a past study for the project (Aspect, 2015), we completed three borings at the approximate locations shown in figure 9-1. The locations of the borings were selected based upon previously considered roadway alignments (different than the current proposed alignment) and where access was feasible. Borings B-2 and B-3 were each drilled to 21.5 feet below ground surface (bgs) using hollow stem auger. Boring B-1 (next to Mill Creek) was drilled using hollow stem auger for the first 25 feet, and then it was completed to 51.5 feet bgs using rotary wash methods. Disturbed samples were obtained from all three borings at 5-foot intervals in each of the borings using non-standard penetration test (NSPT) methods.

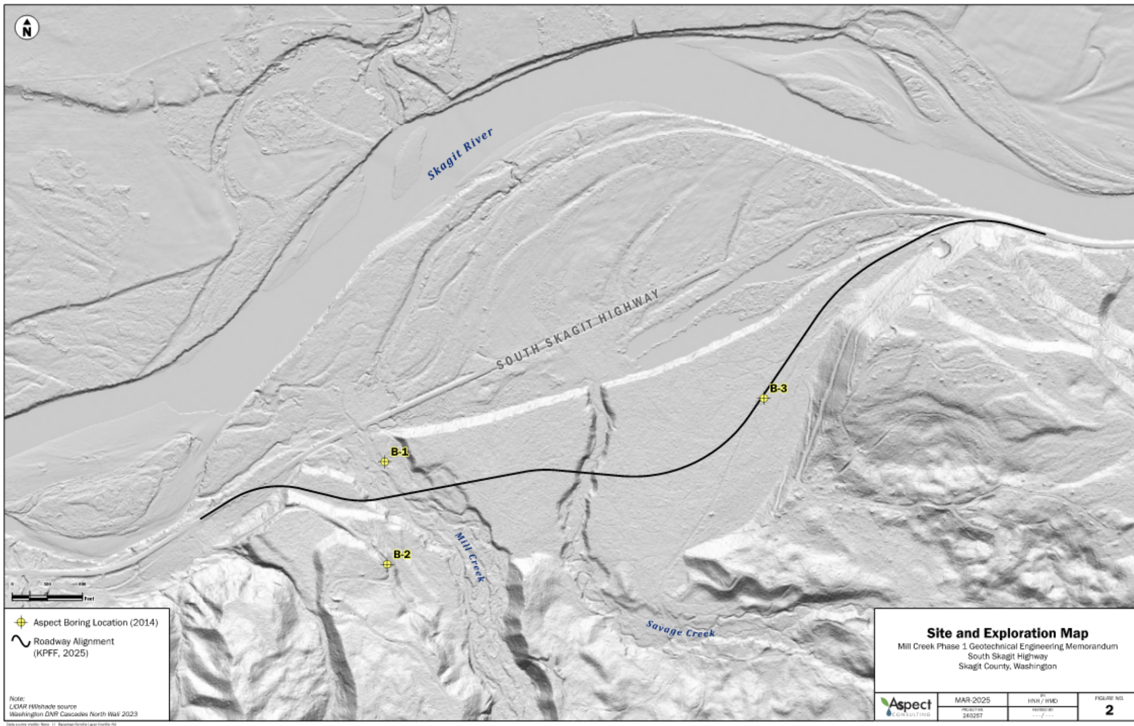

Figure 9-1: Boring Log Locations from 2014

The three borings encountered topsoil and alluvium, which can be subdivided into two units: coarse-grained channel deposits and fine-grained floodplain overbank deposits. Boring B-1, located on the east side of Mill Creek, encountered alluvium extending to the bottom of the boring at a depth of 51.5 feet bgs. Alluvium in B-1 was interpreted as a channel bed deposit. It included sandy gravel (GW and GP), slightly silty gravelly sand (SM-SW), slightly silty sandy gravel (GM-GP), and silty sandy gravel (GM). Broken coarse gravel in the sampler indicate that cobbles were present in this deposit. Groundwater was encountered in B-1 at about 10 feet bgs, which corresponds to approximately the level of surface water in nearby Mill Creek. Soil densities ranged from very loose in the upper approximately 5 feet, grading medium dense to the bottom of the borehole, with interbeds of dense to very dense strata.

Boring B-2, located on an alluvial terrace near the western end of the alignment, encountered alluvial channel bed deposits from the ground surface to the bottom of the borehole at 21.5 feet bgs. Soils in this borehole consisted of medium dense, slightly silty sand gravel (GM-GW). A several-inch-thick bed of clayey silt was encountered at 6 feet bgs. Groundwater was not encountered.

Boring B-3, located on an alluvial terrace near the eastern end of the alignment, encountered recent alluvium consisting of interbedded channel bed deposits and floodplain overbank deposits. The upper approximately 8 feet was interpreted to be channel bed alluvium and consisted of medium dense, slightly moist, slightly silty gravelly sand (SM-SW). Broken coarse gravel suggests that cobbles were present in this deposit. From about 8 to 18 feet bgs, a bed of floodplain overbank deposits was encountered. This was composed of soft grading to medium stiff, moist, slightly sandy silt (ML). Below 18 feet, channel deposits resumed with a layer of medium dense, moist sand (SP). Groundwater was not encountered in this boring.

Boulders and cobbles were not directly observed in the channel bed samples, but our observations of site conditions and understanding of the site setting suggest that they may be present in these deposits. Logs, wood, and organic deposits may also be present, particularly in the floodplain deposits.

GEOTECHNICAL CONSIDERATIONS

The soils conditions at the site are generally favorable for new road and bridge construction along the proposed alignment. General and preliminary geotechnical engineering conclusions for foundations, approaches, walls, and site earthwork are presented in the following paragraphs.

- **Bridge Foundations** – The saturated sandy gravel alluvium encountered in B-1 has medium dense zones above 25 feet bgs that are susceptible to liquefaction during an extreme (design-level) earthquake. New bridge foundations will need to penetrate liquefiable soils and extend a sufficient distance into the underlying more competent and non-liquefiable alluvium. For the single-span bridge over Savage Creek, we conclude that heavy-walled open- or closed-ended steel pipe piles are a potentially suitable deep foundation type. For planning purposes, 24-inch diameter, 1/2-inch wall thickness, steel pipe piles may be considered feasible. For the multi-span bridge over Mill Creek, 4- to 6-foot diameter, cast-in-place concrete drilled shafts are likely suitable. Depending upon construction staging and mobilization, it may be beneficial to use the same foundation type at both bridges, in which case we recommend drilled shafts be assumed. Driven pile and drilled shaft foundation embedment depths on the order of 60 feet should be considered for preliminary purposes. More detailed geotechnical explorations are required to further explore and evaluate bridge-pier-specific subsurface conditions, liquefaction hazard, and depth to suitable bearing soils, and to perform design-level geotechnical and structural engineering evaluations for the new bridges.

- **Bridge Approaches** – Depending on the crossing (Mill or Savage Creek) and location, approach embankments of varying thickness are anticipated. Where cantilevered bridge approaches and abutments are too tall to be designed as cantilevered walls, mechanically stabilized earth (MSE)/structural earth wall (SEW) approach embankments/walls can be used. MSE/SEWs should be protected against scour either via appropriately sized riprap, concrete facing extending below the scour elevation, or other methods determined by the design team. For permanent slopes below bridge abutments and walls, we recommend planning for a maximum slope inclination of 2H:1V. Permanent slopes inclined as steep as 1.5H:1V may be feasible where they are not directly supporting structures and are protected from erosion and scour. For the Mill Creek two-span bridge alternative, up to about 20 feet of fill will be required. This fill may be sloped with side slopes as steep as 2H:1V or, alternatively, SEWs could be used to limit the footprint of the approach fill.

- **Cut Retaining Walls** – A permanent cut wall is proposed on the western roadway alignment that will be about 150 feet long with exposed heights on the order of 15 to 20 feet. For permanent walls up to 20 feet tall, anchored/tied-back drilled soldier piles and lagging are recommended. Soil nail walls can be evaluated as a cheaper option with targeted subsurface explorations. Cantilevered drilled soldier piles and lagging may be feasible for permanent cut walls with exposed heights on the order of 10 to 15 feet. Lower cut walls can be designed and constructed using cast-in-place concrete cantilever, gravity blocks, and MSE (if temporary excavations are allowed).

- **Fill Retaining Walls** – Fill retaining walls can be designed and constructed using MSE systems. A variety of wall fascia options are suitable, including sculpted shotcrete, pre-cast concrete panels/blocks, and rock-filled wire gabions. Aesthetic or other non-geotechnical considerations may drive the required wall fascia. Additional subsurface data at targeted wall locations are required to determine feasible wall types and design parameters.

- **Stormwater Infiltration Feasibility** – The proposed alignment is underlain by alluvium and elevated above the Skagit River Floodplain. Thus, we expect the soils will be feasible for infiltration of stormwater and there will be sufficient separation from the base of infiltration facilities to seasonal high groundwater and/or bedrock or impermeable layers. One boring (B-3) did encounter low-energy floodplain overbank soil consisting of soft to medium stiff sandy silt, which will have a lower infiltration rate in comparison to more granular (sand and gravel) alluvium. More detailed explorations and testing are required to evaluate feasible infiltration rates and best management practices (BMPs).

- **General Earthwork Considerations** – Construction of the new bridge approaches and tie-in points to the existing roadway will involve significant earthwork. In general, much of the existing alluvium along the project alignment appears suitable for reuse as structural fill. Permanent cut and fill slopes should be planned at 2H:1V. One boring (B-3) encountered low-energy floodplain overbank soil consisting of soft to medium stiff sandy silt. These fine-grained soils are moisture sensitive and will be difficult to place and compact if they are exposed to rainfall and become wet of optimum. To that point, site earthwork should generally occur during the relatively dry season, from late spring through early fall.

10. Tribal and Stakeholder Engagement

Public engagement for this project has and continues to employ multiple types of outreach, including mailers, meetings, and attendance at local events, all aimed at providing opportunities for various groups to understand project information and impacts. Topics of engagement will surround potential design alternatives, notices of roadway impacts, and consideration of cultural resources.

GOALS

- Provide benefit to and engagement with project stakeholders, tribes, property owners, and resource managers.
- Identify preferences and community concern for proposed alignments.
- Keep interested parties informed of project status through phases of design and construction.
- Promote environmental stewardship among stakeholders.
- Partner with stakeholders for successful project implementation, supporting improved road access for the Justice40 community.

KEY AUDIENCES

Skagit County: Continued engagement with the County departments will ensure that project goals are aligned with regional efforts.

Landowners on the west of the project site, including those listed below. All parcels with landowners are identified on the right of entry (ROE) map, attached as an appendix.

- Timber/lumber company
- Seattle City Light
- Residential properties

Tribal Groups

- Samish Indian Nation
- Sauk-Suiattle Indian Tribe (represented by SRSC)
- Skagit River System Cooperative (SRSC)
- Swinomish Indian Tribal Community (represented by SRSC)

- Upper Skagit Indian Tribe

Permitting Agencies and Resource Managers

- SRSC (refer to Tribal Group section)
- Washington State Department of Fish and Wildlife (WDFW)
- National Oceanic and Atmospheric Administration (NOAA)
- Washington State Department of Natural Resources (DNR) – logging
- United States Army Corps of Engineers (USACE)
- Department of Ecology

Stakeholders

- Skagit Fisheries Enhancement Group
- Skagit Culvert Working Group
- Schools
- Emergency response
- Logging industry representatives
- WSDOT Local Programs (Funding Administration)
- WSDOT Mt Baker Region (South Skagit Highway is an emergency detour to US20)

COMMUNITY SUPPORT

In March, the design team, along with County staff, several potentially impacted landowners, and a representative from WDFW, walked the full proposed roadway alignment. Not only was the design team able to collect valuable information for the design, but spending an entire day with all attendees talking about the project and helping each other across the creeks and down and up the steep slopes proved invaluable to developing trust and understanding with the landowners.

As part of the engagement and outreach, the project has received 10 letters of support from surrounding property owners and stakeholders.

11. Permitting Approach

Existing habitats at the site consist of extensive wetland and riverine habitats where the South Skagit Highway crosses the lower floodplain; sandy soils and forested habitats up on the terrace where the realignment is proposed; and braided channels with probable riverine wetlands in the Mill Creek and Savage Creek ravines.

The relocation of the South Skagit Highway will result in net positive habitat gains. Demolition of the highway will result in re-creation/restoration of wetlands, restoration of natural fluvial processes for Mill and Savage

Creeks, and removal of fill and an obstruction in the Skagit River 100-year floodplain. The combined Mill/Savage Creek crossings under the highway are identified fish passage barriers during certain flows and when sediment builds up and blocks much of the crossing.

The proposed new South Skagit Highway alignment is on a terrace above the 100-year floodplain in an area managed for silviculture. Soils along the alignment are generally sandy upland soils with good potential for infiltration. Therefore, relocation of the highway will minimize wetland impacts and allow for infiltration of stormwater from the new road, thus improving water quality along this section of the highway.

Some wetland impacts will occur at the tie-in points (estimated to be just under 0.5 acres), but mitigation sequencing will be implemented during design to avoid and minimize impacts to the extent practicable.

Table 11-1, below, summarizes approximate impacts of the new road and area that will be restored by removing the old road. Impact square footages from the new road without the bridges and the overlap with the existing logging road is approximately twice the area of the road demolition. However, the road impact square footage estimate includes clearing/grubbing 5 feet beyond the proposed grading limits, and so it is a conservative number compared to the road demolition, which does not account for the impacted areas adjacent to the existing road prism (those areas maintained for safety). The new road will be built primarily within upland forested areas, while the old road is located within a floodplain surrounded by streams and wetlands. In addition, the realignment of Savage Creek and removal of the old road will create more natural floodplain and fluvial processes.

Table 11-1: Rough Summary of Impacts

Project Element	Impact (square feet)	Restoration (square feet)	Notes
Existing South Skagit Highway demolition		300,000	Area of roadway and prism that will be removed
New roadway permanent impact	655,000		
Existing road that overlaps with proposed new road	45,000		Existing disturbed area in the new road footprint
Mill Creek – approx. overwater bridge area	3,800		
Savage Creek – approx. overwater bridge area	2,500		
Wetland fill	20,000		Where new road alignment ties into the old highway (west and east)
New road area minus bridges and existing logging road	603,700		

We anticipate the following required environmental permit reviews and authorizations:

- Washington Department of Fish and Wildlife – HPA
- Washington State Department of Ecology (Ecology)
    - Section 401 Water Quality Certification
    - Coastal Zone Management Consistency

- National Pollutant Discharge Elimination System (NPDES) Construction Stormwater General Permit (CSWGP)

- United State Army Corps of Engineers (USACE) – Section 404
  - Cultural Section 106
  - ESA Section 7
  - Wild and Scenic Section 7
- NEPA
  - Wetlands and Fish and Wildlife Habitat Conservation Areas Assessment
  - NEPA Environmental Justice (EJ) Documentation
  - Hazardous Material Technical Report
  - Biological Assessment (BA)
  - Mitigation Restoration Plan
- Skagit County
  - SEPA Checklist
  - Shoreline/Critical Areas Permit
  - Floodplain Review
- Washington State Department of Natural Resources (DNR)
  - Forest Practices Permit
  - Aquatic Use Authorization (or email from DNR stating that it is not required)
- United States Coast Guard
  - Bridge Permit: We anticipate that this will not be required because the proposed bridges are not over navigable waters. We recommend obtaining documentation in the form of an email from USCG stating that a bridge permit is not required.

12. Cultural Resources

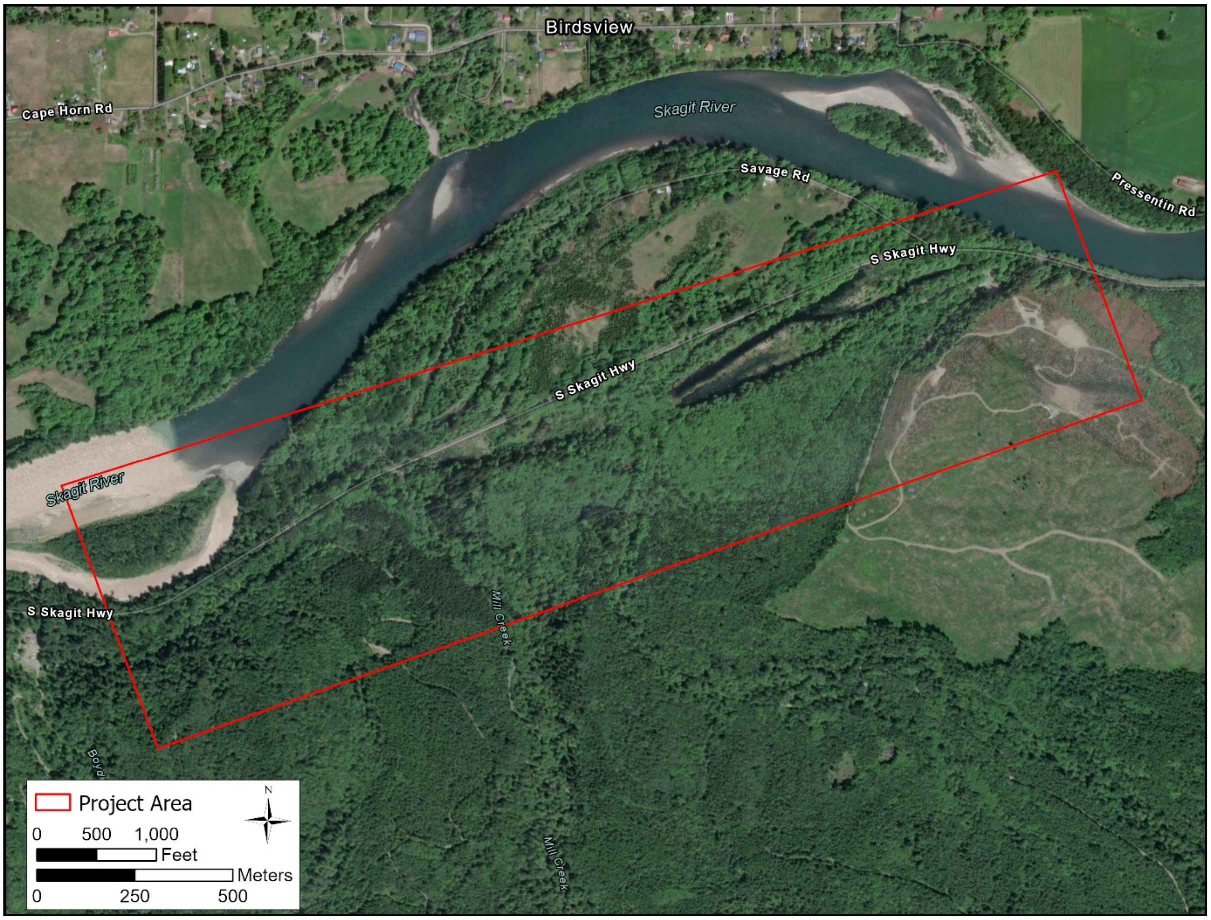

Figure 12-1: Aerial photograph showing Project area in red.

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Physical Environment

The Project area is to the south of the Skagit River, and in portions, directly adjacent to it. Elevation in the Project area varies but is generally between 120 to 130 feet. Surface sediment in the Project area is younger Holocene alluvium (Tabor et al., 2003).

Most of the terrace is covered by mature mixed western hemlock, douglas fir, and western red cedar forest and is easily accessible. Ground visibility is zero off the existing access road due to low lying vegetation like Salal and ferns.

Previous Archaeological

The closest archaeological site to the Project area is 45MB170, Presenting Ferry and Ferry Landing, a historic debris scatter related to historic ferry activity (Hollenbeck 1980; Taylor 1989).

Principal Investigator Kelly R. Bush has walked the proposed alignment and determined that much of the footprint is in a high to very-high probability area for containing cultural resources, as it is near the Skagit River on an old terrace, similar to where many precontact sites have already been recorded.

Additionally, from past discussions with Upper Skagit Indian Tribe elders, that this hillside was a popular access corridor for higher elevation blueberry fields and other medicinal plants and animal resources, which also raises the probability of finding precontact, protohistoric, and historic Native American cultural resources within the Project area.

The area of highest probability for encountering cultural resources include the top of the terrace where the proposed road will cross both Mill Creek and Savage Creek. The current plans include installing bridge crossings, and as such will require extensive ground disturbance. The eastern-most segment of the proposed alignment follows an existing unimproved road that provides access to private lands above the proposed alignment.

13. Bridge Design Criteria

The design criteria for the structural work are as follows:

- Governing Design Codes
  - Washington State Department of Transportation (WSDOT) Bridge Design Manual (BDM), M 23-50.20 (July 2024)
  - AASHTO LRFD Bridge Design Specifications, Tenth Edition
  - AASHTO Guide Specifications for LRFD Seismic Bridge Design, Second Edition (2011), with 2012, 2014, and 2015 Interims.
- The bridges shall provide at least 3 feet of freeboard above the 100-year flood elevation.
- The minimum roadway width is 34 feet (two 11-foot lanes and two 6-foot shoulders) per Skagit County's Standard Rural Minor Collector Roadway Detail.

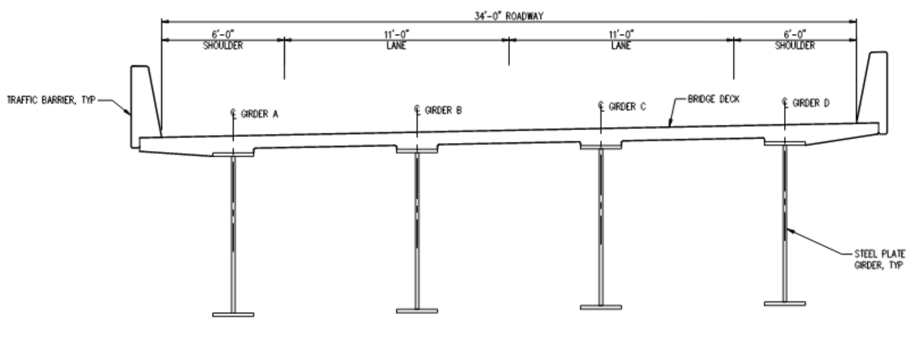

Figure 13-1: Bridge Typical Section

14. General Considerations

The span lengths for the bridges were influenced by a variety of site-specific factors, including topography, hydraulic conditions, and environmental constraints. Key considerations included steep slopes at the bridge approaches, anticipated debris flow (e.g., large woody material), channel migration potential, floodplain geometry, and scour susceptibility. The full opening from bluff to bluff is approximately 550 feet at Mill Creek and 100 feet at Savage Creek, to provide context for the scale and structural demands of each site.

Seasonal weather conditions and in-water work windows (fish windows) may also affect construction timelines and methodology.

MILL CREEK BRIDGE

Alternatives Developed

Several bridge alternatives were explored for Mill Creek, including the following options:

1. Single-span prestressed concrete girder bridge (Span: 175 feet)
2. Single-span steel girder bridge (Span: 235 feet)
3. Three-span prestressed concrete girder bridge (Spans: 130, 133, and 158 feet)
4. Two-span steel girder bridge (Spans: 212 and 212 feet) **(Preferred)**
5. Four-span prestressed concrete girder bridge (Spans: 145, 129, 168, and 168 feet)
6. Three-span steel girder bridge (Spans: 208, 192, and 214 feet) **(Preferred)**

After evaluating alternatives with the design team and County staff, Options 4 and 6 (two-span and three-span steel girder bridges) were selected as the preferred alternatives. These were chosen due to their effective balance of cost efficiency, structural performance, resiliency to channel and climate changes, and ease of constructability. They minimize the number of piers, accommodate longer spans, reduce fill requirements, and better adapt to potential channel migration.

Due to the long bridge length, initial evaluation of bridge design alternatives included steel truss and arch options. While these structures offer high strength and aesthetic appeal, several drawbacks led to their elimination. These include higher material and fabrication costs and increased long-term maintenance (often two to three times greater than that of steel plate girders) due to more frequent inspections and corrosion protection needs. Additionally, the complexity of constructing a truss or arch structure at this site, which has access limitations and would require large cranes, made them less feasible. For these reasons, both were ruled out early in the process.

Key factors such as cost, constructability, logistics, long-term maintenance, environmental impact, and hydraulic performance were thoroughly assessed during the decision-making process. All six alternatives considered (Options 1 through 6) were evaluated against these criteria.

Option 1 was not considered feasible because the minimum required span length at the site is approximately 235 feet, based on channel migration and hydraulic constraints. Prestressed concrete girders are limited to maximum spans of around 180 feet, making them unsuitable for a single-span configuration at this location.

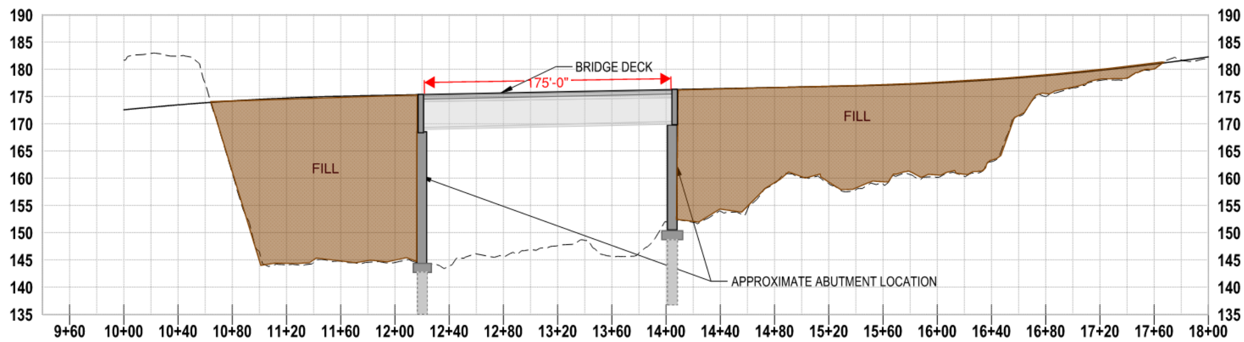

Figure 14-1: Option 1 – Single 175-Foot-Span Prestressed Concrete Girder Bridge Elevation

A single 235-foot span design (Option 2) was initially considered for its potential superstructure cost savings. However, it was eliminated primarily due to the requirement for tall abutment walls and extensive fill, which would be needed to reach the necessary height at the approaches. The left bank, in particular, was not ideal for filling, as this would increase abutment heights and eliminate a location the creek could migrate into, which is a key concern from a floodplain and scour standpoint. Substructure stability may be a concern, particularly in areas prone to settlement. Abutment wall heights are estimated to be over 40 feet due to existing site slopes at approaches, and estimated scour depths range from 20 to over 30 feet. Secant pile walls or a hybrid of secant piles and structural earth walls (SEW) were explored as part of the geotechnical mitigation strategy to enhance resilience against long-term channel migration and scour. The use of tall structural earth walls and significant fill volumes would introduce stability risks and require substantial foundation supports.

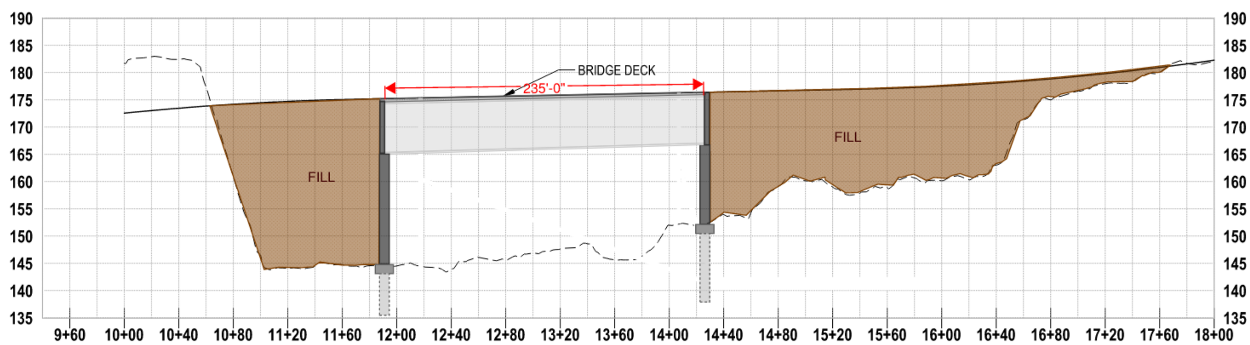

Figure 14-2: Option 2 – Single 235-Foot-Span Prestressed Concrete Girder Bridge Elevation

Multi-span designs (Options 3 through 6) introduce intermediate piers that help reduce the height of abutment walls and approach fills, thereby improving global stability and reducing abutment/approach costs. These designs, however, add substructure costs and potential in-stream environmental impacts, especially if piers are placed near or within the active creek channel. To mitigate these risks, pier locations were selected to avoid the main creek channel, balancing structural needs with environmental protection.

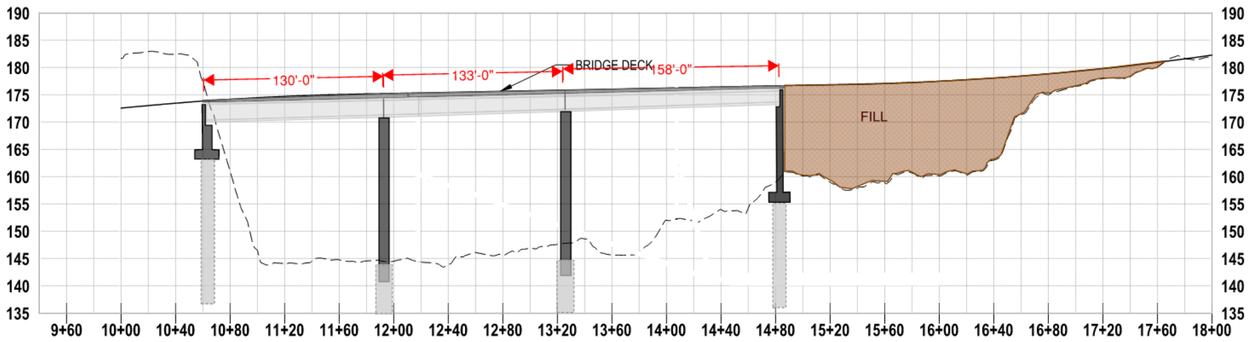

Figure 14-3: Option 3 – Three-Span Prestressed Concrete Girder Bridge Elevation (Spans: 130, 133, and 158 feet)

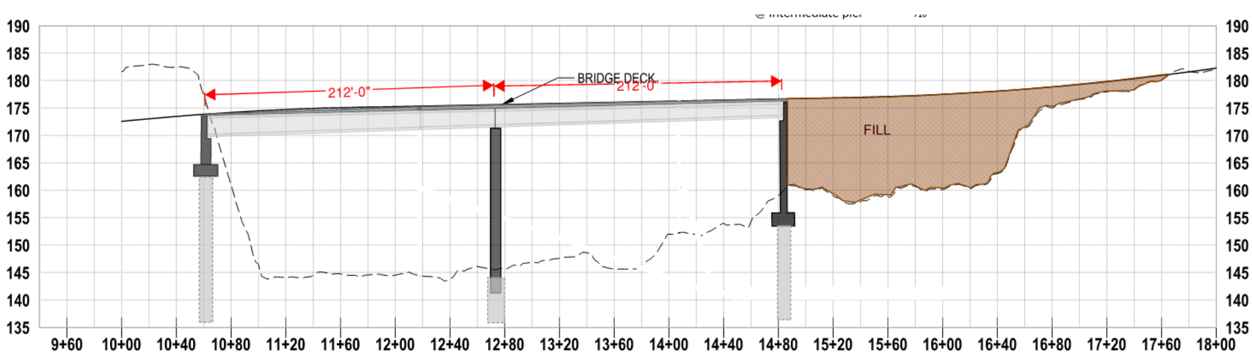

Figure 14-4: Option 4 – Two-Span Girder Bridge Elevation (Spans: 212 and 212 feet)

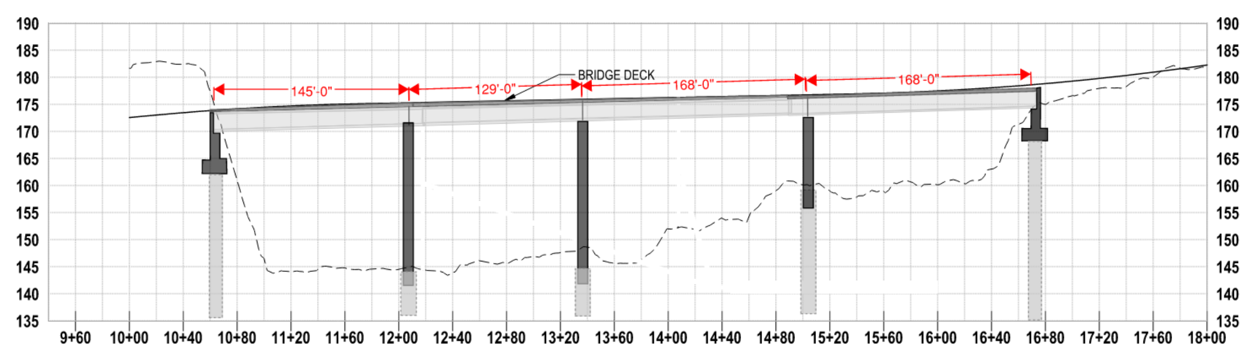

Figure 14-5: Option 5 – Four-Span Prestressed Concrete Girder Bridge Elevation (Spans: 145, 129, 168, and 168 feet)

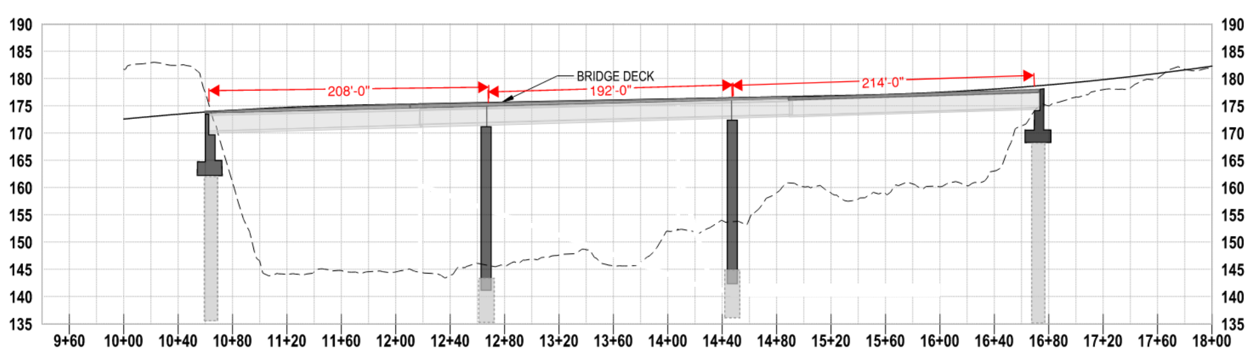

Figure 14-6: Option 6 – Three-Span Steel Girder Bridge Elevation (Spans: 208, 192, and 214 feet)

After discussions with the multidisciplinary design team and the County, it was determined that steel spans are preferred. The longer span lengths reduce the number of intermediate piers and the lighter delivery loads reduce the impacts from overloads on other bridges along the delivery route.

At the Mill Creek site, the inclusion of intermediate piers was considered necessary to support longer spans, as filling on the left bank was avoided to both preserve potential channel migration zones and minimize abutment heights. However, careful consideration was given to the placement of these piers to minimize environmental impact. It was essential to avoid placing a pier within the main creek channel to prevent disruption to water flow and aquatic habitats and potential scour issues. As a result, the spans were designed to span the main creek channel, achieving the longest possible clear span while balancing structural efficiency and environmental protection.

Additionally, constructability considerations play a significant role in the selection process. Site access for equipment, temporary work zones, and staging areas must be considered to avoid costly delays. Seasonal weather conditions may also impact construction timelines, particularly for concrete curing and steel coating applications.

From a long-term maintenance perspective, multi-span structures require periodic inspections of bearings, joints, and piers, while single-span structures eliminate the need for intermediate pier maintenance. However, single-span options may require more robust foundation systems and higher initial costs due to the increased girder length and weight.

When comparing prestressed concrete girders and steel plate girders, material logistics played a significant role. Concrete girders are heavier and often require dual cranes for placement, while also presenting transportation challenges due to delivery length and weight. Steel girders, while more expensive per foot, can be delivered in smaller segments, reducing transport impacts and improving constructability in confined site conditions. Steel girders also allow for launching or staged assembly techniques that reduce crane size and footprint requirements. On the downside, steel options require more frequent maintenance (painting, inspection, corrosion control), adding life-cycle cost considerations.

Steel girders were selected over concrete because of their ability to span longer distances, thus minimizing the number of piers and accommodating the site's geometry and environmental constraints. Despite the higher upfront and maintenance costs, their flexibility in transport and construction proved advantageous.

Finally, when considering scour protection, the costs appear to be similar across all alternatives, making it a consistent consideration in each option. Additional mitigation measures, such as riprap, may be necessary depending on hydraulic analysis results.

After a comprehensive evaluation of these factors, including discussions with senior County staff, the six alternatives were narrowed down to two: Option 4, the two-span steel girder bridge, and Option 6, the three-span steel girder bridge. These selections offer the best balance of cost efficiency, constructability, and long-term maintenance while also minimizing environmental impact.

ALTERNATIVE 1: TWO-SPAN STEEL PLATE GIRDER WITH CAST-IN-PLACE DECK (OPTION 4)

This option features a two-span steel plate girder bridge spanning Mill Creek, supported by an intermediate pier. The total bridge length is 424 feet, with two 212-foot spans. The superstructure consists of steel plate girders and a composite reinforced concrete deck. The girders can either be field-spliced and launched or lifted into place using large cranes without temporary supports or assembled in segments with smaller cranes and temporary supports before final splicing. The abutments are designed with footings supported by drilled shafts to minimize scour and adapt to changing water levels, while riprap protection at both the abutments and pier helps prevent erosion.

Advantages

- Reduced abutment height and fill requirements, lowering substructure costs.
- Shorter overall bridge length, making it the most cost-effective option.
- Lighter steel components allow for easier transportation and on-site splicing.
- Efficient construction methods improve project timelines.

Disadvantages

- Requires an intermediate pier, which may require channel protection.
- Additional permitting may be needed for fill placement.
- Steel requires ongoing maintenance and inspections to prevent corrosion, increasing long-term costs.

ALTERNATIVE 2: THREE-SPAN STEEL PLATE GIRDER WITH CAST-IN-PLACE DECK (OPTION 6)

This option consists of a three-span steel plate girder bridge with a composite reinforced concrete deck, 614 feet long with spans of 208, 192, and 214 feet. The structure is supported by two intermediate piers. The steel plate girders can be field-spliced and launched or lifted into place using large cranes without temporary supports or installed in segments with smaller cranes and temporary supports before final splicing. The abutments are designed with footings supported by drilled shafts to mitigate scour and adapt to fluctuating water levels, while riprap protection at the abutments and piers helps prevent erosion.

Advantages

- Shorter abutment walls and minimal fill requirements reduce substructure costs.
- Lighter steel components facilitate transportation and on-site assembly.
- Improved launching efficiency accelerates project timelines.

Disadvantages

- Requires two intermediate piers.
- Increased bridge length leads to higher superstructure and pier costs, offsetting abutment and fill savings.
- Regular maintenance and inspections are necessary to prevent steel corrosion, increasing long-term costs.

15. Cost

The bridge costs for each alternative are summarized in table 15-1. This comparison provides valuable insight into the cost differences among the alternatives, with a breakdown illustrating the approximate cost distribution for each project component. A more detailed cost analysis is available in Appendix B. It is important to note that this report estimate only includes superstructure cost, substructure cost, and a 40 percent contingency. Costs associated with operation and maintenance, drainage, and signage are not included.

Table 15-1: Cost Comparison Summary

	Alternative 1 (2-span)	Alternative 2 (3-span)
Superstructure	$ 6,472,200	$ 8,910,300
Foundations	$ 3,361,950	$ 4,151,183
Subtotal	$ 9,834,150	$ 13,061,483
Contingency, 15%	$ 1,475,123	$ 1,959,222
Mobilization, 10%	$ 983,415	$ 1,306,148
Total	**$ 12,292,688**	**$ 16,326,854**

Notes: The costs are in 2025 dollars; do not include inflation, sales tax, engineering, construction administration, or permitting; and do not include approach grading or road construction.

ALTERNATIVE COMPARISON AND PREFERRED ALTERNATIVE

Table 15-2 summarizes the additional considerations of the alternatives using a rating system (more stars represent a better value, up to three stars).

Table 15-2: Alternative Comparison

	Alternative 1 (2-span)	Alternative 2 (3-span)
Superstructure Cost	* * *	* *
Superstructure Constructability	* *	* * *
Substructure Cost	* * *	* *
Substructure Constructability	* * *	* *
Maintenance	* * *	* *
Environmental Impact	* * *	* *

After evaluating the alternatives across multiple qualitative criteria, a weighted star rating system was also used to assess overall value. While each category was rated up to three stars, greater emphasis was placed on cost, constructability, and maintenance due to their long-term impact on project feasibility and lifecycle performance. Alternative 1, the two-span steel girder bridge, consistently demonstrated higher performance in key areas such as superstructure cost, substructure constructability, and maintenance. Based on this comparative assessment, Alternative 1 emerged as the preferred alternative. This decision was reached through a collaborative process involving both KPFF and Skagit County, ensuring that technical, economic, and community factors were thoroughly evaluated. The higher cost associated with constructing an extra bridge span was a key factor in the decision-making process, making the two-span option the most practical and economical choice.

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Appendix A

Conceptual Plans

Appendix B

Estimated Construction Costs

Appendix C

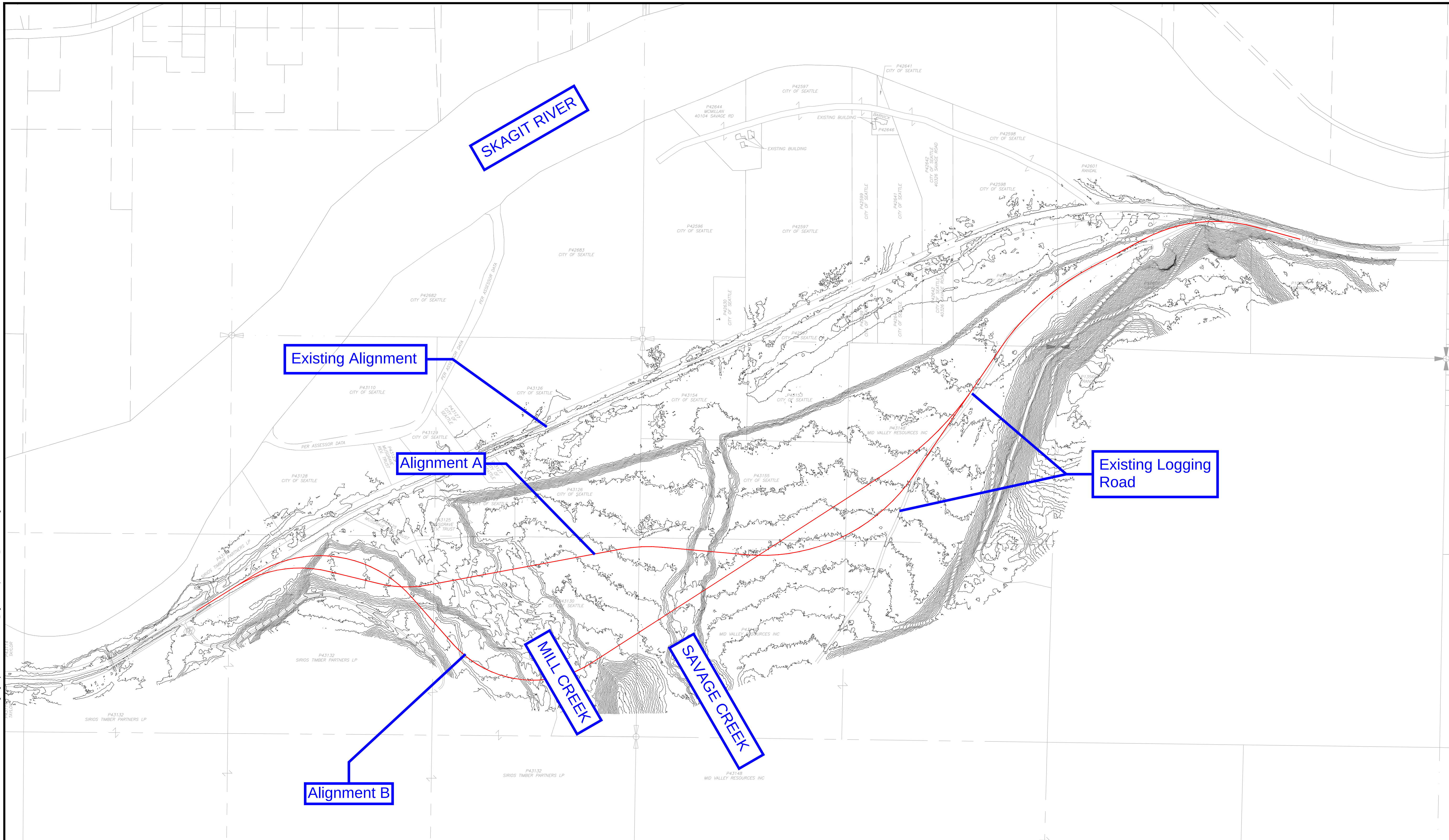
Draft Hydraulic and Hydromorphic Report

Appendix D

Draft Geotechincal Memorandum

Appendix E

Draft Permitting Matrix



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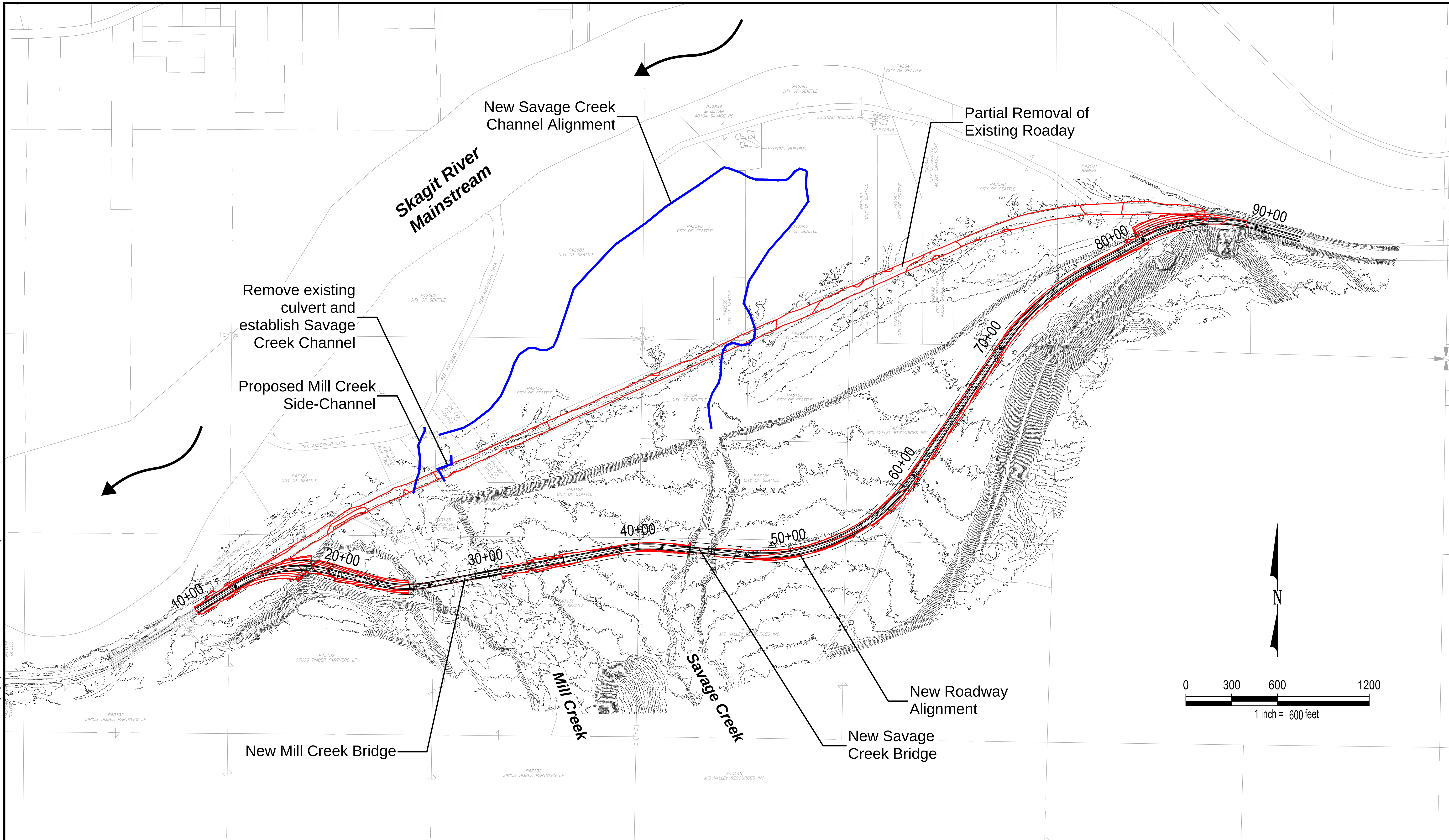

Project Title
MILL CREEK PHASE 1

Drawing Title
ROADWAY ALIGNMENT & GRADING

ASI/RFI/CSK Number

Drawing Reference

Scale

Client
SKAGIT COUNTY

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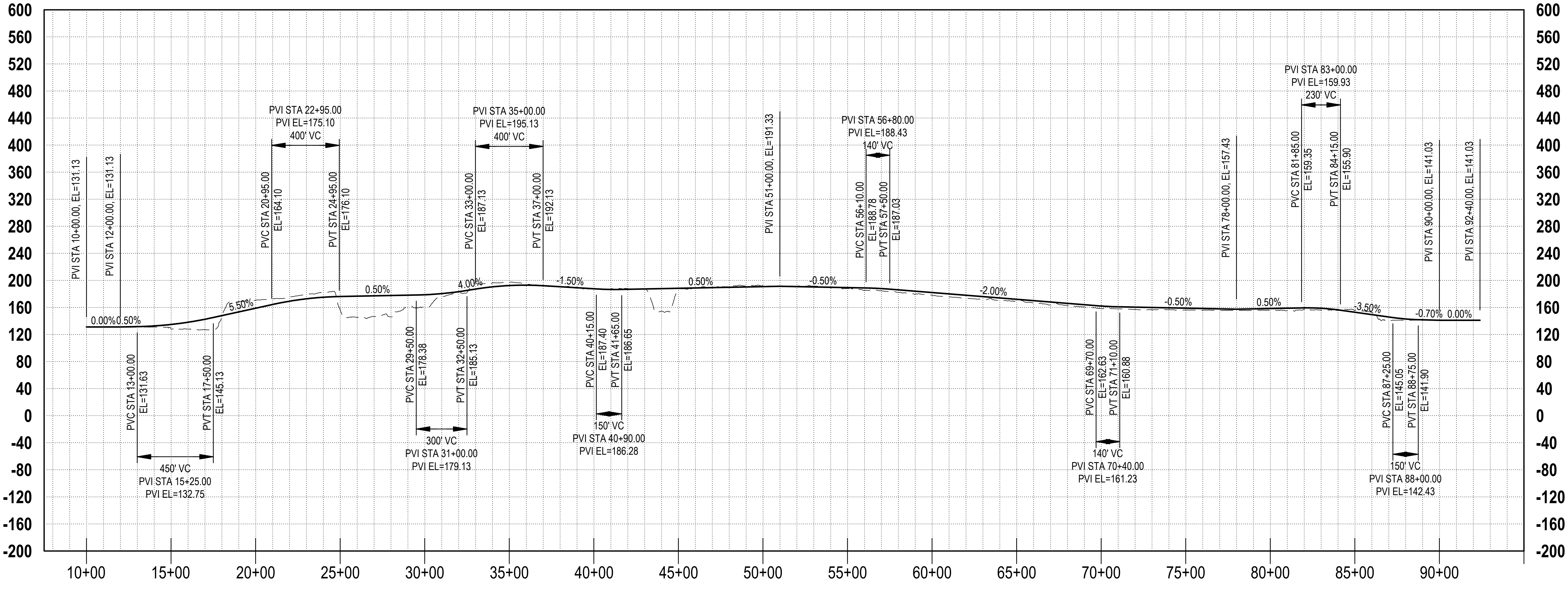

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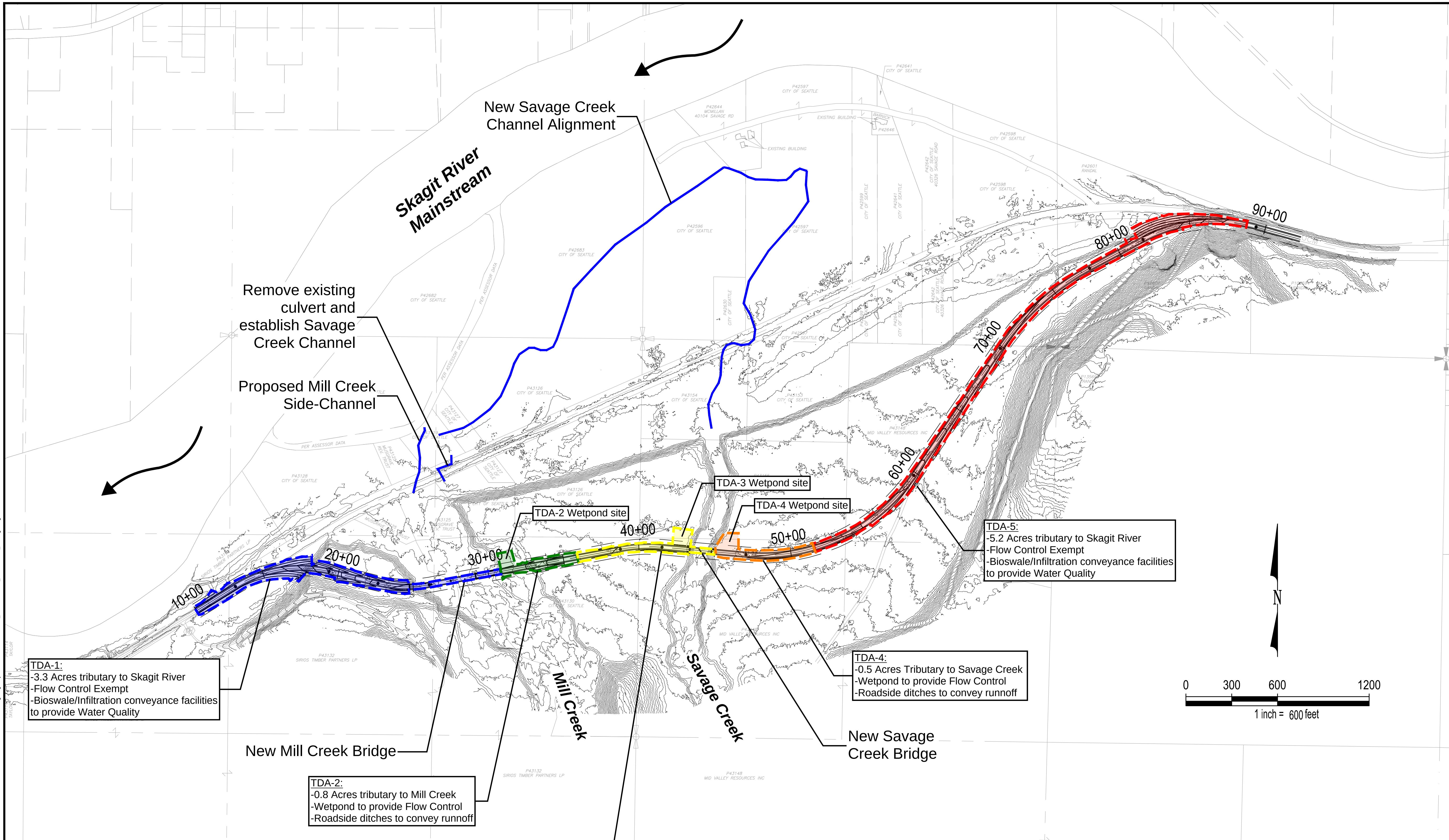
SKAGIT COUNTY			



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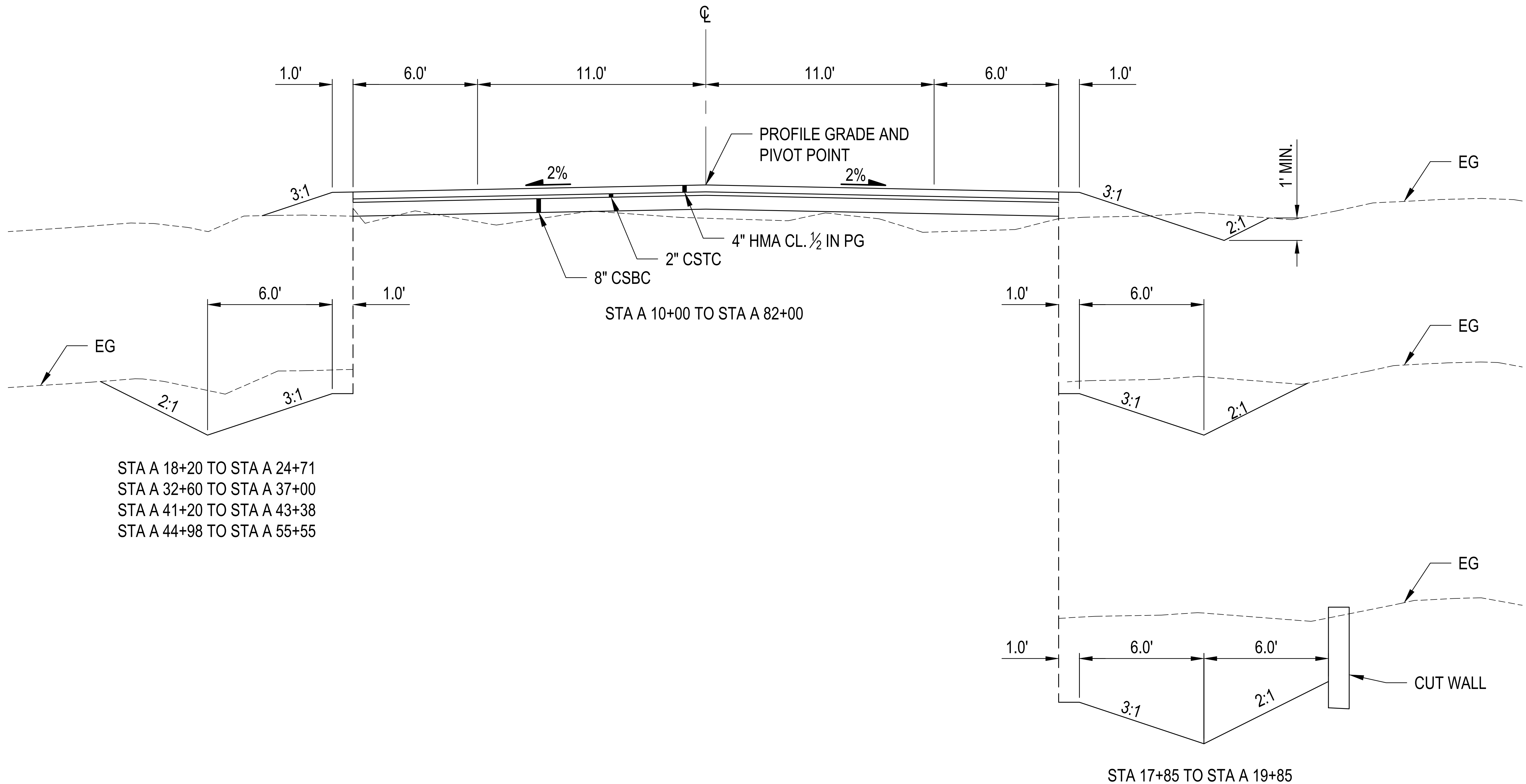

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MCP1_100-SCALE
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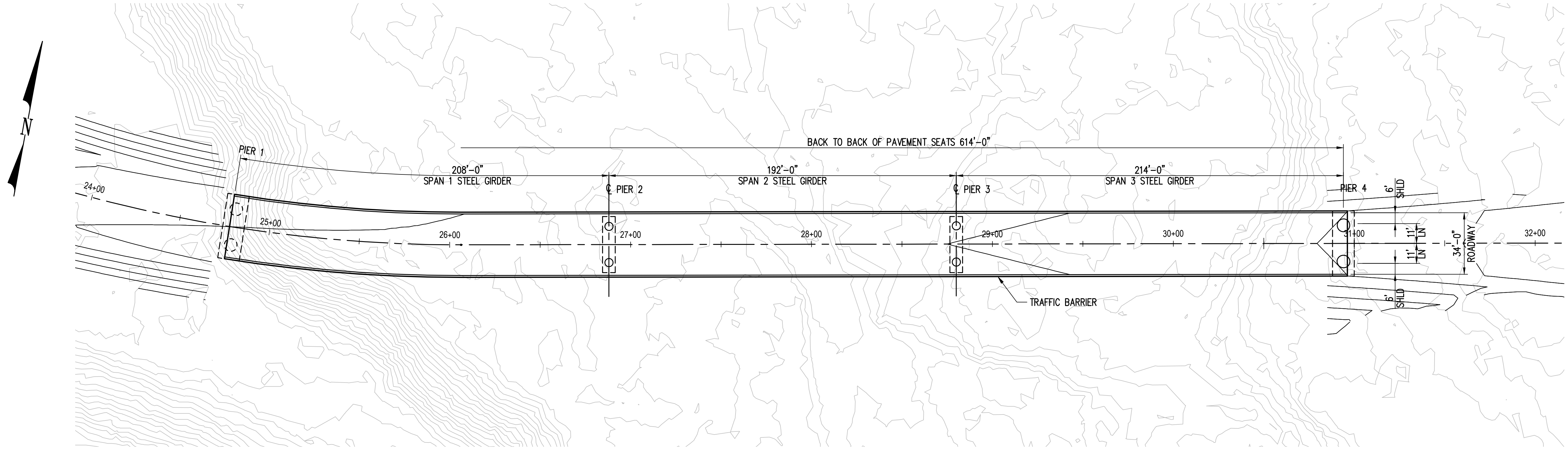

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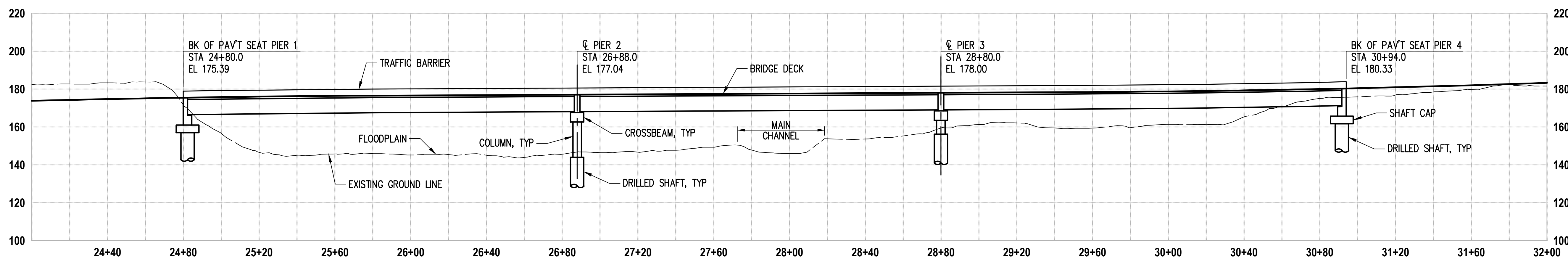

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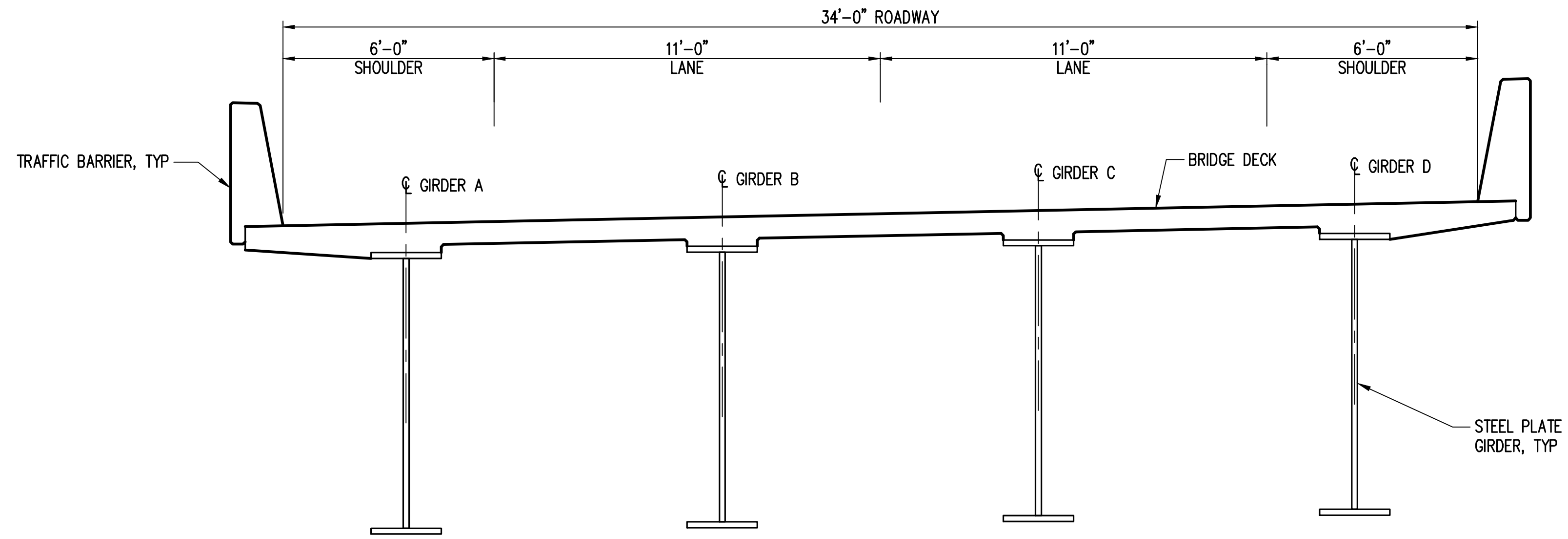
NO.	DATE	BY	REVISION

MILL CREEK BRIDGE
--
MILL CREEK BRIDGE OPTION 6
THREE SPAN STEEL GIRDER BRIDGE
BRIDGE LAYOUT

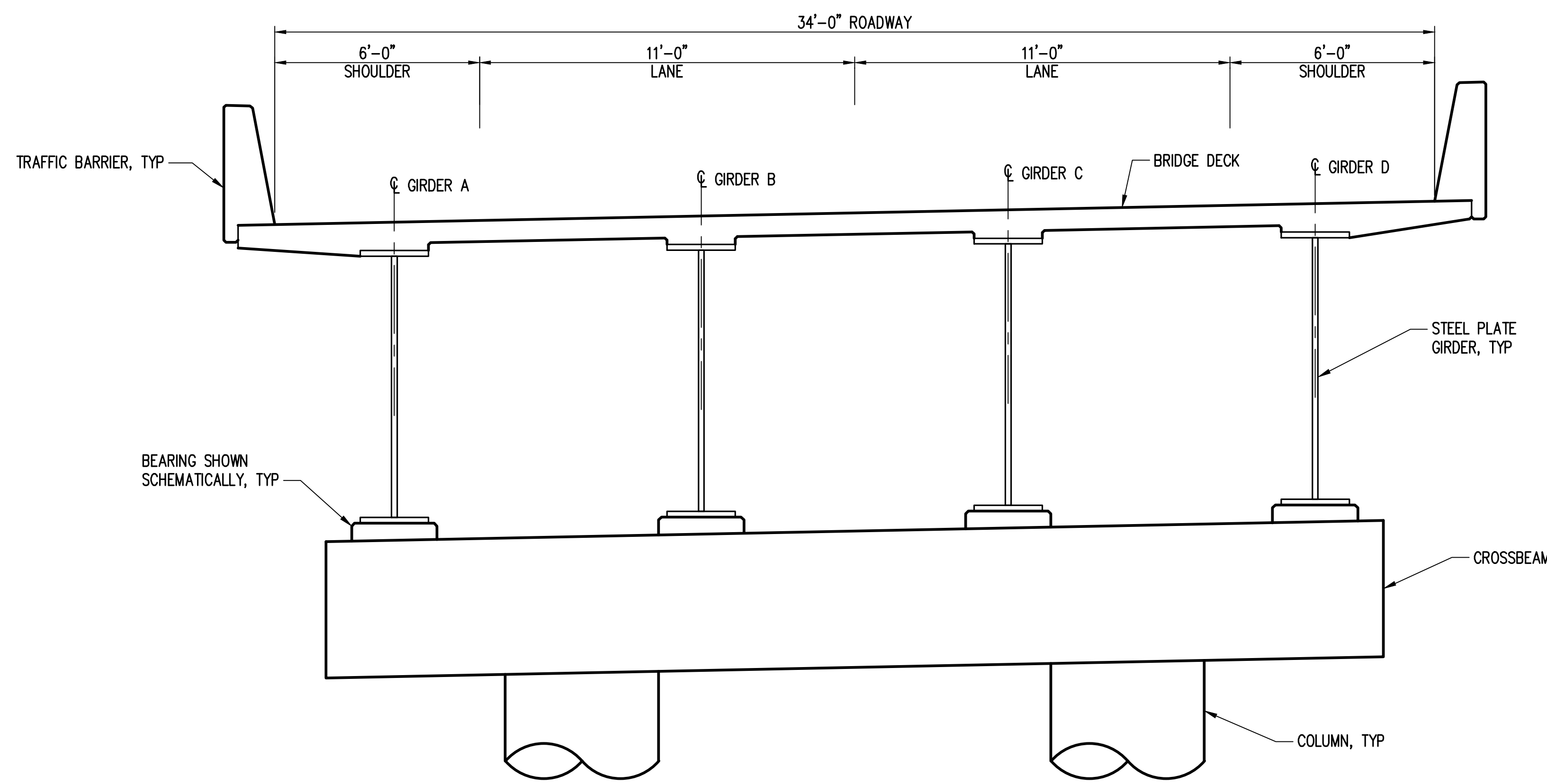
DRAWN: HT	PROJECT NO.: 2400576
DESIGN: --	SCALE: AS SHOWN
CHECKED: --	DATE: --
DRAWING NO.	S01
SHEET NO.	- OF -

Xrefs:
xMC-KPFF-2234xtb



TYPICAL SECTION – AT MIDSPAN

SCALE: 3/8" = 1'-0"



TYPICAL SECTION – AT INTERMEDIATE PIER

SCALE: 3/8" = 1'-0"

CAD USER: RICKT PLOT DATE: Jan 23, 2025-04:34pm
PATH: V:\2400576 (Mill Creek-S Skagit Highway)\02_Design (v2022)\MC-OPT6-S02.dwg

kpff
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Seattle, WA 98101
206.622.5822
www.kpff.com

NO.	DATE	BY	REVISION

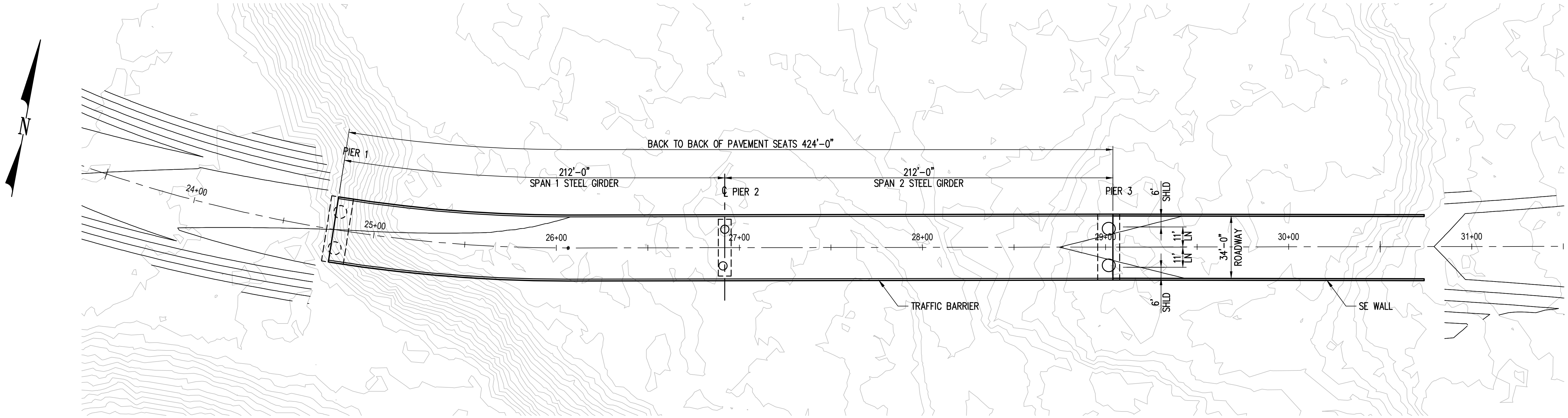
MILL CREEK BRIDGE

--

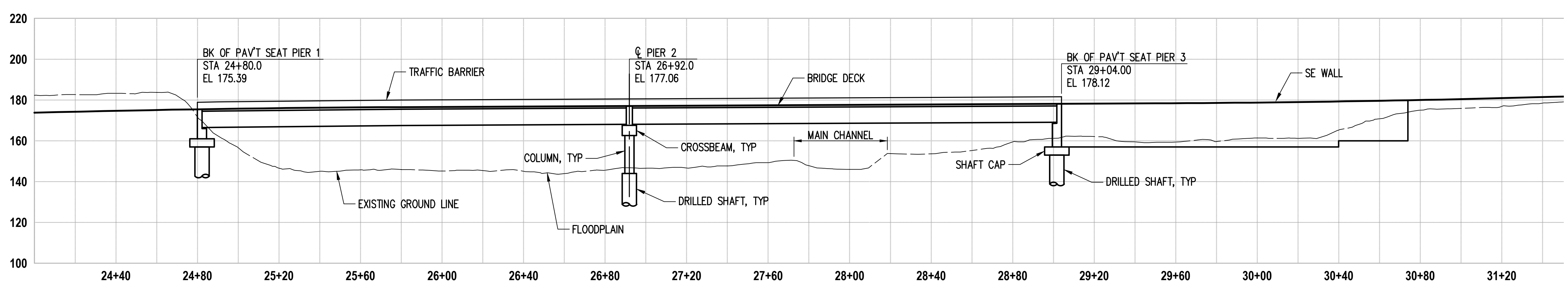
MILL CREEK BRIDGE OPTION 6
THREE SPAN STEEL GIRDER BRIDGE
TYPICAL SECTIONS

DRAWN: HT	PROJECT NO.: 2400576
DESIGN: --	SCALE: AS SHOWN
CHECKED: --	DATE: --
DRAWING NO.	S02
SHEET NO.	- OF -

Xrefs:
MCP1_Wall Profiles
MCP1_100-SCALE
xMC-KPFF-2234xtb



PLAN
SCALE: 1" = 30'



ELEVATION
SCALE: 1" = 30'

CAD USER: RICKT PLOT DATE: Jan 23, 2025-01:12pm
PATH: V:\2400576 (Mill Creek-S Skagit Highway)\02_Design (v2022)\MC-OPT4-S01.dwg

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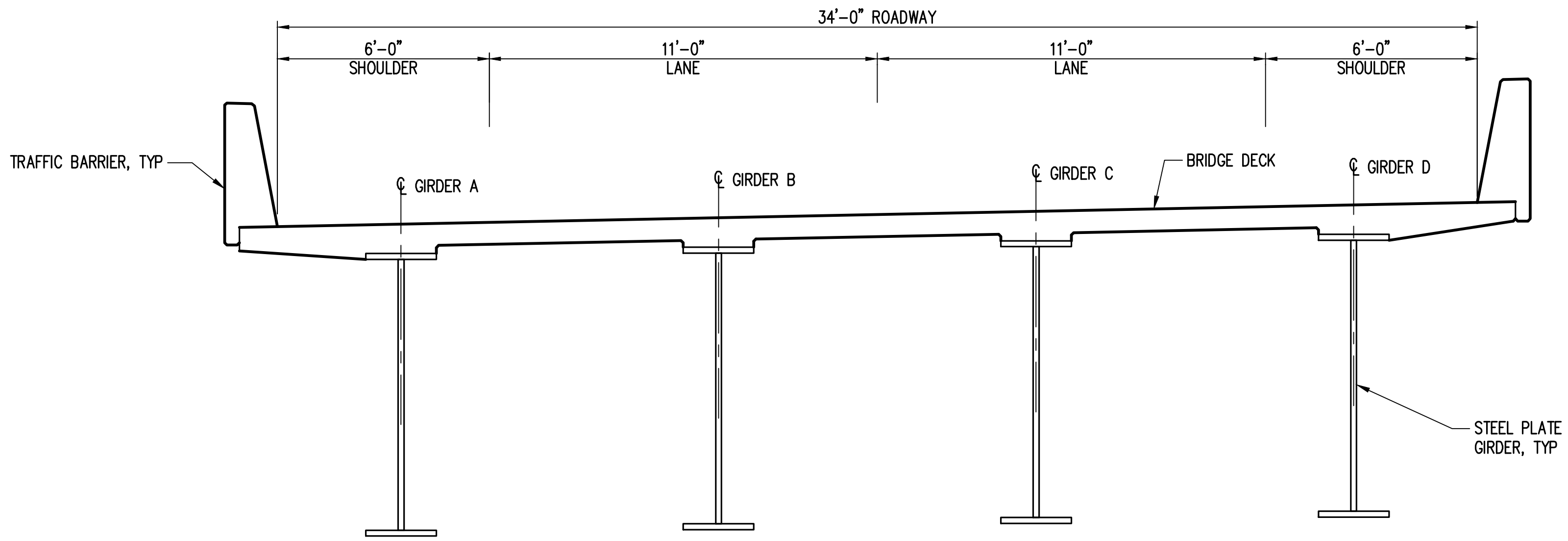
NO.	DATE	BY	REVISION

MILL CREEK BRIDGE
--
MILL CREEK BRIDGE OPTION 4
TWO SPAN STEEL GIRDER BRIDGE
BRIDGE LAYOUT

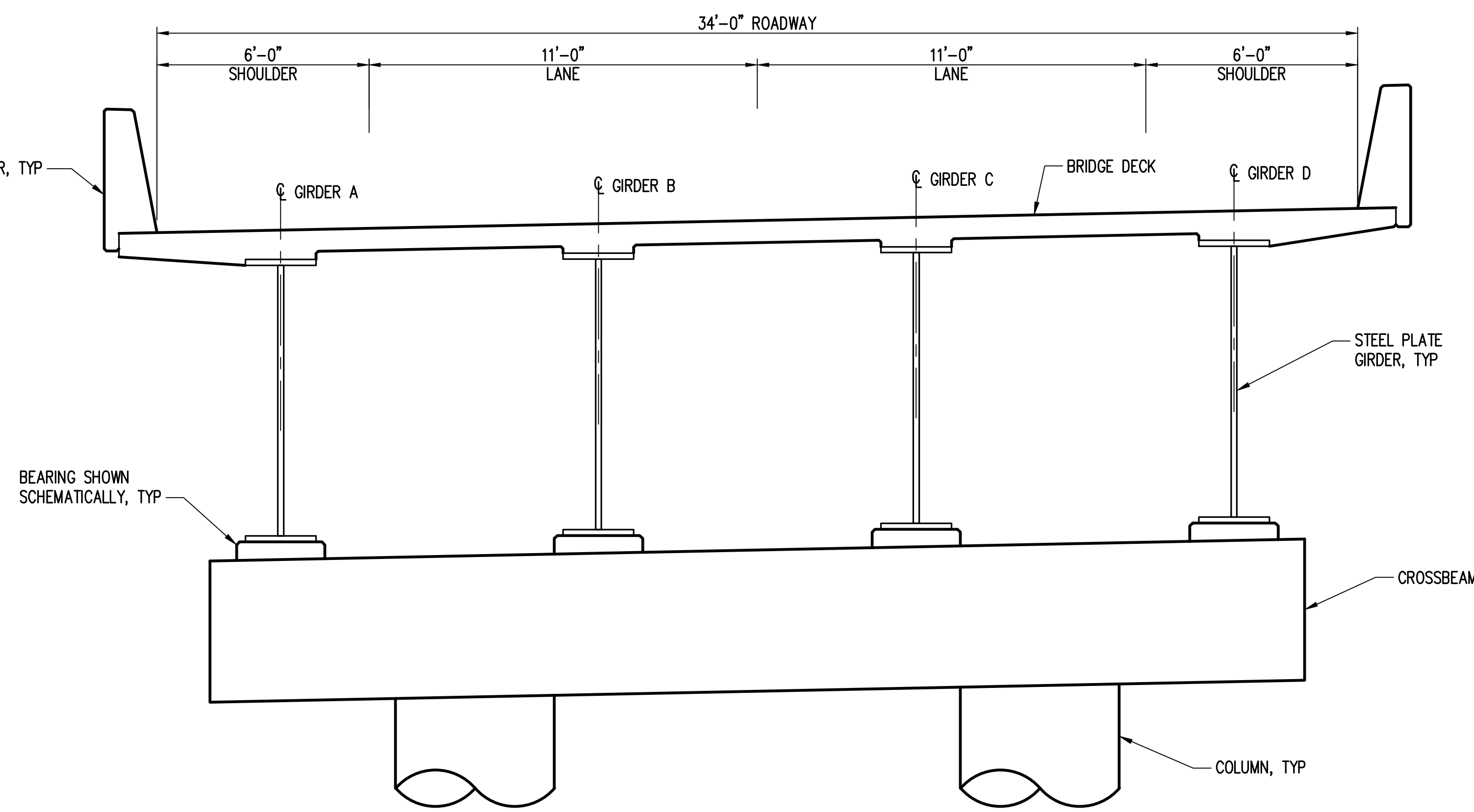
DRAWN: HT	PROJECT NO.: 2400576
DESIGN: --	SCALE: AS SHOWN
CHECKED: --	DATE: --
DRAWING NO.	S01
SHEET NO.	- OF -

Xrefs:
xMC-KPFF-2234xtb



TYPICAL SECTION – AT MIDSPAN

SCALE: 3/8" = 1'-0"



TYPICAL SECTION – AT INTERMEDIATE PIER

SCALE: 3/8" = 1'-0"

CAD USER: RICKT PLOT DATE: Jan 23, 2025–02:05pm
PATH: V:\2400576 (Mill Creek–S Skagit Highway)\02_Design (v2022)\MC–OPT4–S02.dwg

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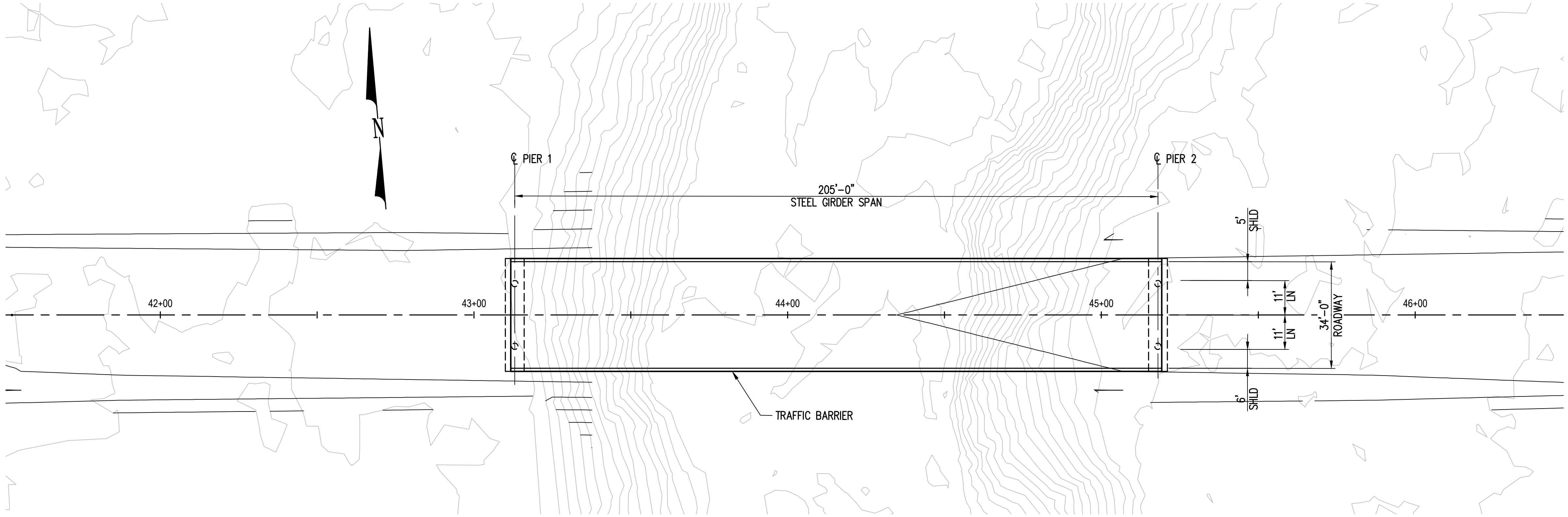
NO.	DATE	BY	REVISION

MILL CREEK BRIDGE
--

MILL CREEK BRIDGE OPTION 4
TWO SPAN STEEL GIRDER BRIDGE
TYPICAL SECTIONS

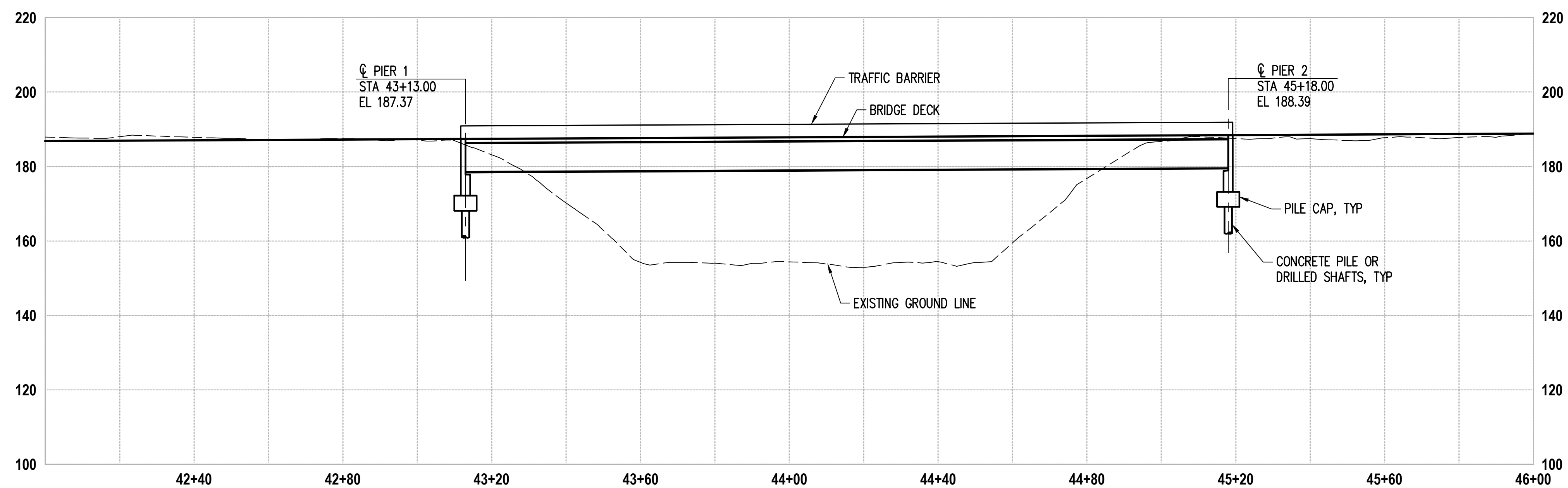
DRAWN: HT	PROJECT NO.: 2400576
DESIGN: --	SCALE: AS SHOWN
CHECKED: --	DATE: --
DRAWING NO.	S02
SHEET NO.	- OF -

Xrefs:
MCP1_Wall Profiles
MCP1_100-SCALE
xSC-KPFF-2234xtb



PLAN

SCALE: 1" = 20'



ELEVATION

SCALE: 1" = 20'

CAD USER: RICKT PLOT DATE: Apr 10, 2025-11:15am
PATH: V:\2400576 (Mill Creek-S Skagit Highway)\02_Design (v2022)\SC-OPT5-S01.dwg

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Seattle, WA 98101
206.622.5822
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NO.	DATE	BY	REVISION

SAVAGE CREEK BRIDGE

--

SAVAGE CREEK BRIDGE OPTION 5
SINGLE SPAN STEEL GIRDER BRIDGE
BRIDGE LAYOUT

DRAWN: HT	PROJECT NO.: 2400576
DESIGN: --	SCALE: AS SHOWN
CHECKED: --	DATE: --
DRAWING NO.	S01
SHEET NO.	- OF -

By: KPFF
Date: 4/25/2025

ENGINEER'S QUANTITIES ESTIMATE

MILL CREEK BRIDGE ESTIMATE

OPTION 1: SINGLE PRESTESSED CONCRETE SPAN (TOTAL LENGTH = 175')	**TOTAL=**	$	8,073,111	
OPTION 2: SINGLE STEEL SPAN (TOTAL LENGTH = 235')	**TOTAL=**	$	9,059,681	
OPTION 3: 3 - PRESTRESSED CONCRETE SPANS (TOTAL LENGTH = 421')	**TOTAL=**	$	12,113,813	
OPTION 4: 2 STEEL GIRDER SPANS (TOTAL LENGTH = 424')	**TOTAL=**	$	12,292,688	Preferred Alternative (USED FOR FLBP GRANT)
OPTION 5: 4 - PRESTRESSED CONCRETE SPANS (TOTAL LENGTH = 610')	**TOTAL=**	$	15,348,292	
OPTION 6: 3 - STEEL GIRDER SPANS (TOTAL LENGTH = 614')	**TOTAL=**	$	16,326,854	Preferred Alternative

SAVAGE CREEK BRIDGE ESTIMATE

OPTION 1: SINGLE PRESTESSED CONCRETE SPAN (TOTAL LENGTH = 205')	**TOTAL=**	$	5,811,885	
OPTION 2: SINGLE STEEL SPAN (TOTAL LENGTH = 205')	**TOTAL=**	$	6,341,391	Preferred Alternative
OPTION 3: SINGLE PRESTESSED CONCRETE SPAN (TOTAL LENGTH = 175')	**TOTAL=**	$	5,295,729	
OPTION 4: SINGLE STEEL SPAN (TOTAL LENGTH = 175')	**TOTAL=**	$	5,708,064	Preferred Alternative

Note:

1. Estimates only include bridge construction costs. They include scour protection, mobilization and 15% contingency, but do NOT include design or construction engineering, inflation or ROW costs.
2. At this early stage in the design, a contingency of 30% is likely more appopriate. However, 15% contingency was used to be consistent with the Federal Local Agency Bridge Program Grant Appli

Project: Mill Creek
By: KPFF
Date: 4/25/2025

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ENGINEER'S QUANTITIES ESTIMATE

ITEM NO.	ITEM NAME	QUANTITY	UNIT	UNIT COST	TOTAL COST	NOTES/ASSUMPTIONS:
OPTION 1: SINGLE PRESTESSED CONCRETE SPAN (TOTAL LENGTH = 175')						
1	PRESTRESSED CONCRETE GIRDER	6300	SF	$ 350	$ 2,205,000	BDM APPENDIX 12.3-A1
2	SE WALL - PRECAST CONC. PANELS OR CONC. BLOCK	21800	SF	$ 60	$ 1,308,000	BDM APPENDIX 12.3-A1
3	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	400	LF	$ 2,500	$ 1,000,000	ASPECT INPUT
4	QA SHAFT TEST	6	EA	$ 1,000	$ 6,000	BDM APPENDIX 12.3-A2
5	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 50,300	BDM APPENDIX 12.3-A2
3	BRIDGE APPROACH SLAB	2058	SY	$ 350	$ 720,300	BDM APPENDIX 12.3-A1
4	GRAVEL BORROW FOR STRUCTURAL EARTH WALL	16148	CY	$ 60	$ 968,889	WSDOT UBA
5	SCOUR PROTECTION	200000	LS	1	$ 200,000	costs provided by NHC (rounded up)
6	MOBILIZATION	1	LS	1	$ 645,849	
				15 % CONTINGENCY	$ 968,773	
				TOTAL=	$ 8,073,111	
OPTION 2: SINGLE STEEL SPAN (TOTAL LENGTH = 235')						
1	STEEL GIRDER	8460	SF	$ 400	$ 3,384,000	BDM APPENDIX 12.3-A1
2	SE WALL - PRECAST CONC. PANELS OR CONC. BLOCK	19000	SF	$ 60	$ 1,140,000	BDM APPENDIX 12.3-A1
3	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	400	LF	$ 2,500	$ 1,000,000	ASPECT INPUT
4	QA SHAFT TEST	6	EA	$ 1,000	$ 6,000	BDM APPENDIX 12.3-A2
5	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 50,300	BDM APPENDIX 12.3-A2
3	BRIDGE APPROACH SLAB	1780	SY	$ 350	$ 623,000	BDM APPENDIX 12.3-A1
4	GRAVEL BORROW FOR STRUCTURAL EARTH WALL	14074	CY	$ 60	$ 844,444	WSDOT UBA
5	SCOUR PROTECTION	200000	LS	1	$ 200,000	costs provided by NHC (rounded up)
6	MOBILIZATION	1	LS	1	$ 724,774	
				15 % CONTINGENCY	$ 1,087,162	
				TOTAL=	$ 9,059,681	
OPTION 3: 3 - PRESTRESSED CONCRETE SPANS (TOTAL LENGTH = 421')						
1	PRESTRESSED CONCRETE GIRDERS	15120	SF	$ 350	$ 5,292,000	BDM APPENDIX 12.3-A1
2	STRUCTURE EXCAVATION CLASS A INCL. HAUL	1037	CY	$ 12	$ 12,444	BDM APPENDIX 12.3-A2
3	ST. REINF. BAR	64800	LB	$ 1	$ 64,800	BDM APPENDIX 12.3-A1
4	CONC. CLASS 4000 (COLUMNS)	1800	CY	$ 250	$ 450,000	BDM APPENDIX 12.3-A1
5	CONC. CLASS 4000 (ABUT. & RET. WALLS)	260	CY	$ 450	$ 117,000	BDM APPENDIX 12.3-A1
6	SE WALL - PRECAST CONC. PANELS OR CONC. BLOCK	8000	SF	$ 60	$ 480,000	BDM APPENDIX 12.3-A1
7	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	850	LF	$ 2,500	$ 2,125,000	ASPECT INPUT
8	QA SHAFT TEST	12	EA	$ 1,000	$ 12,000	BDM APPENDIX 12.3-A1
9	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 106,850	BDM APPENDIX 12.3-A1
10	BRIDGE APPROACH SLAB	1044	SY	$ 350	$ 365,400	BDM APPENDIX 12.3-A2
11	GRAVEL BORROW FOR STRUCTURAL EARTH WALL	5926	CY	$ 60	$ 355,556	WSDOT UBA
12	SCOUR PROTECTION	310000	LS	1	$ 310,000	costs provided by NHC (rounded up)
13	MOBILIZATION	1	LS	1	$ 969,105	
				15 % CONTINGENCY	$ 1,453,658	
				TOTAL=	$ 12,113,813	

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Project: Mill Creek
By: KPFF
Date: 4/25/2025

ENGINEER'S QUANTITIES ESTIMATE

ITEM NO.	ITEM NAME	QUANTITY	UNIT	UNIT COST	TOTAL COST	NOTES/ASSUMPTIONS:
OPTION 4: 2 STEEL GIRDER SPANS (TOTAL LENGTH = 424')						
1	STEEL GIRDER	15120	SF	$ 400	$ 6,048,000	BDM APPENDIX 12.3-A1
2	STRUCTURE EXCAVATION CLASS A INCL. HAUL	1037	CY	$ 12	$ 12,444	BDM APPENDIX 12.3-A2
3	ST. REINF. BAR	58800	LB	$ 1	$ 58,800	BDM APPENDIX 12.3-A2
4	CONC. CLASS 4000 (COLUMNS)	1200	CY	$ 250	$ 300,000	BDM APPENDIX 12.3-A2
5	CONC. CLASS 4000 (ABUT. & RET. WALLS)	260	CY	$ 450	$ 117,000	BDM APPENDIX 12.3-A2
6	SE WALL - PRECAST CONC. PANELS OR CONC. BLOCK	8000	SF	$ 60	$ 480,000	BDM APPENDIX 12.3-A1
7	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	700	LF	$ 2,500	$ 1,750,000	ASPECT INPUT
8	QA SHAFT TEST	9	EA	$ 1,000	$ 9,000	BDM APPENDIX 12.3-A2
9	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 87,950	BDM APPENDIX 12.3-A2
10	BRIDGE APPROACH SLAB	1044	SY	$ 350	$ 365,400	BDM APPENDIX 12.3-A1
11	GRAVEL BORROW FOR STRUCTURAL EARTH WALL	5926	CY	$ 60	$ 355,556	WSDOT UBA
12	SCOUR PROTECTION	250000	LS	1	$ 250,000	costs provided by NHC (rounded up)
13	MOBILIZATION	1	LS	1	$ 983,415	
				15 % CONTINGENCY	$ 1,475,123	
				TOTAL=	$ 12,292,688	
OPTION 5: 4 - PRESTRESSED CONCRETE SPANS (TOTAL LENGTH = 610')						
1	PRESTRESSED CONCRETE GIRDERS	21960	SF	$ 350.00	$ 7,686,000	BDM APPENDIX 12.3-A1
2	STRUCTURE EXCAVATION CLASS A INCL. HAUL	444	CY	$ 12	$ 5,333	BDM APPENDIX 12.3-A2
3	ST. REINF. BAR	64800	LB	$ 1	$ 64,800	BDM APPENDIX 12.3-A2
4	CONC. CLASS 4000 (COLUMNS)	3600	CY	$ 250	$ 900,000	BDM APPENDIX 12.3-A2
5	CONC. CLASS 4000 (ABUT. & RET. WALLS)	160	CY	$ 450	$ 72,000	BDM APPENDIX 12.3-A2
6	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	1250	LF	$ 2,500	$ 3,125,000	BDM APPENDIX 12.3-A2
7	QA SHAFT TEST	15	EA	$ 1,000	$ 15,000	BDM APPENDIX 12.3-A2
8	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 157,000	BDM APPENDIX 12.3-A3
9	BRIDGE APPROACH SLAB	210	SY	$ 350	$ 73,500	BDM APPENDIX 12.3-A1
10	SCOUR PROTECTION	180000	LS	1	$ 180,000	costs provided by NHC (rounded up)
11	MOBILIZATION	1	LS	1	$ 1,227,863	
				15 % CONTINGENCY	$ 1,841,795	
				TOTAL=	$ 15,348,292	
OPTION 6: 3 - STEEL GIRDER SPANS (TOTAL LENGTH = 614')						
1	STEEL GIRDER	21960	SF	$ 400.00	$ 8,784,000	BDM APPENDIX 12.3-A1
2	STRUCTURE EXCAVATION CLASS A INCL. HAUL	444	CY	$ 12	$ 5,333	BDM APPENDIX 12.3-A2
3	ST. REINF. BAR	52800	LB	$ 1	$ 52,800	BDM APPENDIX 12.3-A2
4	CONC. CLASS 4000 (COLUMNS)	2400	CY	$ 250	$ 600,000	BDM APPENDIX 12.3-A2
5	CONC. CLASS 4000 (ABUT. & RET. WALLS)	160	CY	$ 450	$ 72,000	BDM APPENDIX 12.3-A3
6	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	1250	LF	$ 2,500	$ 3,125,000	BDM APPENDIX 12.3-A2
7	QA SHAFT TEST	12	EA	$ 1,000	$ 12,000	BDM APPENDIX 12.3-A2
8	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 156,850	BDM APPENDIX 12.3-A2
9	BRIDGE APPROACH SLAB	210	SY	$ 350	$ 73,500	BDM APPENDIX 12.3-A1
10	SCOUR PROTECTION	180000	LS	1	$ 180,000	costs provided by NHC (rounded up)
11	MOBILIZATION	1	LS	1	$ 1,306,148	
				15 % CONTINGENCY	$ 1,959,223	
				TOTAL=	$ 16,326,854	

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Project: Savage Creek
By: KPFF
Date: 4/25/2025

ENGINEER'S QUANTITIES ESTIMATE

ITEM NO.	ITEM NAME	QUANTITY	UNIT	UNIT COST	TOTAL COST	NOTES/ASSUMPTIONS:
OPTION 1: SINGLE PRESTRESSED CONCRETE SPAN (TOTAL LENGTH = 205')						
1	PRESTRESSED CONCRETE GIRDER	7380	SF	$ 350	$ 2,583,000	BDM APPENDIX 12.3-A1
2	STRUCTURE EXCAVATION CLASS A INCL. HAUL	1000	CY	$ 12	$ 12,000	BDM APPENDIX 12.3-A2
3	CONC. CLASS 4000 (ABUT. & RET. WALLS)	65	CY	$ 450	$ 29,167	BDM APPENDIX 12.3-A2
4	ST. REINF. BAR	11667	LB	$ 1	$ 11,667	BDM APPENDIX 12.3-A2
5	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	400	LF	$ 2,500	$ 1,000,000	ASPECT INPUT
6	QA SHAFT TEST	6	EA	$ 1,000	$ 6,000	BDM APPENDIX 12.3-A2
7	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 50,300	BDM APPENDIX 12.3-A2
8	BRIDGE APPROACH SLAB	220	SY	$ 250	$ 55,000	BDM APPENDIX 12.3-A2
9	SCOUR PROTECTION	35000	LS	1	$ 35,000	costs provided by NHC
10	MOBILIZATION	1	LS	1	$ 369,213	
				30 % CONTINGENCY	$ 1,245,404	
				TOTAL=	$ 5,396,751	
OPTION 2: SINGLE STEEL SPAN (TOTAL LENGTH = 205')						
1	STEEL GIRDER	7380	SF	$ 400	$ 2,952,000	BDM APPENDIX 12.3-A1
2	STRUCTURE EXCAVATION CLASS A INCL. HAUL	1000	CY	$ 12	$ 12,000	BDM APPENDIX 12.3-A2
3	CONC. CLASS 4000 (ABUT. & RET. WALLS)	65	CY	$ 450	$ 29,167	BDM APPENDIX 12.3-A2
4	ST. REINF. BAR	11667	LB	$ 1	$ 11,667	BDM APPENDIX 12.3-A2
5	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	400	LF	$ 2,500	$ 1,000,000	ASPECT INPUT
6	QA SHAFT TEST	6	EA	$ 1,000	$ 6,000	BDM APPENDIX 12.3-A2
7	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 50,883	BDM APPENDIX 12.3-A2
8	BRIDGE APPROACH SLAB	220	SY	$ 250	$ 55,000	BDM APPENDIX 12.3-A2
9	SCOUR PROTECTION	35000	LS	1	$ 35,000	costs provided by NHC
10	MOBILIZATION	1	LS	1	$ 411,672	
				30 % CONTINGENCY	$ 1,369,017	
				TOTAL=	$ 5,932,405	

OPTION 3: SINGLE PRESTESSED CONCRETE SPAN (TOTAL LENGTH = 175'						
1	SAVAGE CREEK SUPERSTRUCTURE	6300	SF	$ 350	$ 2,205,000	BDM APPENDIX 12.3-A1
2	STRUCTURE EXCAVATION CLASS A INCL. HAUL	167	CY	$ 12	$ 2,000	BDM APPENDIX 12.3-A2
3	CONC. CLASS 4000 (ABUT. & RET. WALLS)	65	CY	$ 450	$ 29,167	BDM APPENDIX 12.3-A2
4	ST. REINF. BAR	11667	LB	$ 1	$ 11,667	BDM APPENDIX 12.3-A2
5	SE WALL - PRECAST CONC. PANELS OR CONC. BLOCK	750	SF	$ 60	$ 45,000	ASPECT INPUT
6	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	400	LF	$ 2,500	$ 1,000,000	BDM APPENDIX 12.3-A2
7	QA SHAFT TEST	6	EA	$ 1,000	$ 6,000	BDM APPENDIX 12.3-A2
8	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 53,133	BDM APPENDIX 12.3-A1
9	BRIDGE APPROACH SLAB	220	SY	$ 250	$ 55,000	costs provided by NHC
10	SCOUR PROTECTION	35000	LS	1	$ 35,000	
11	MOBILIZATION	1	LS	1	$ 340,697	
				30 % CONTINGENCY	$ 1,134,799	
				TOTAL=	$ 4,917,462	
OPTION 4: SINGLE STEEL SPAN (TOTAL LENGTH = 175')						BDM APPENDIX 12.3-A1
1	SAVAGE CREEK SUPERSTRUCTURE	6300	SF	$ 400	$ 2,520,000	BDM APPENDIX 12.3-A2
2	STRUCTURE EXCAVATION CLASS A INCL. HAUL	167	CY	$ 12	$ 2,000	BDM APPENDIX 12.3-A2
3	CONC. CLASS 4000 (ABUT. & RET. WALLS)	65	CY	$ 450	$ 29,167	BDM APPENDIX 12.3-A2
4	ST. REINF. BAR	11667	LB	$ 1	$ 11,667	ASPECT INPUT
5	SE WALL - PRECAST CONC. PANELS OR CONC. BLOCK	750	SF	$ 60	$ 45,000	
6	SHAFTS (CONSTRUCTING - FT. DIAM SHAFT (4' TO 6' DIA.)	400	LF	$ 2,500	$ 1,000,000	BDM APPENDIX 12.3-A2
7	QA SHAFT TEST	6	EA	$ 1,000	$ 6,000	BDM APPENDIX 12.3-A2
8	REMOVING SHAFT OBSTRUCTION	-	EST	-	$ 50,300	BDM APPENDIX 12.3-A1
9	BRIDGE APPROACH SLAB	220	SY	$ 250	$ 55,000	costs provided by NHC
10	SCOUR PROTECTION	35000	LS	1	$ 35,000	
11	MOBILIZATION	1	LS	1	$ 375,413	
				30 % CONTINGENCY	$ 1,238,864	
				TOTAL=	$ 5,368,411	

NHC Inc.
301 W Holly Street, U-3
Bellingham, WA 98225
Tel: 206-241-6000
www.nhcwater.com

NHC Reference No. 2009051
April 17, 2025

KPFF Consulting Engineers
1601 5th Ave #1600
Seattle, WA 98101

Attention: Anne Fabrello-Streufert
Via email: Anne.Fabrello-Streufert@kpff.com

Re: **Mill Creek Phase I at South Skagit Highway**
Draft Preliminary Hydraulic Design Report

1 INTRODUCTION

Skagit County (County) wishes to re-route approximately 1.5 miles of South Skagit Highway, to cross Mill and Savage Creeks at more favorable locations, upstream from their respective alluvial fans which are experiencing aggradation. Sediment accumulation from Mill Creek has led to reduced hydraulic conveyance, increased maintenance costs, and has impaired fish passage and natural stream processes for both the Mill and Savage Creek crossings (NHC, 2004). NHC is assisting KPFF by providing hydrologic, hydraulic, and geomorphic analysis to support this design.

The following technical tasks were included in the scope of work that was developed to meet the project objectives.

- **Data Collection and Review** – Compile and review existing data and information that may aid in hydraulic and geomorphic analysis.
- **Field Reconnaissance** – Conduct a field inspection to examine the characteristics of the existing and proposed Savage and Mill Creek crossing, and surrounding floodplain with respect to hydraulic erosion, and scour processes.
- **Geomorphic Assessment** – Conduct a geomorphic analysis using LiDAR topography, provided survey information, aerial photos, and findings from field reconnaissance with the purpose of characterizing the future profile and stability of the stream channel in the vicinity of the proposed upland crossings.
- **Hydraulic Analysis (TS&L Phase)** – Model the existing conditions in at a conceptual level of detail to approximate the 100-year flood limits to select a bridge alignment and flood limits.
- **Hydraulic Analysis (Preliminary Design Phase)** – Model the proposed conditions to determine hydraulic parameters necessary for hydraulic design in the future phase of this project.
- **Channel Design** – Provide preliminary design drawings for the proposed bridge locations at Mill and Savage Creek, as well as for the channel design where the

existing Mill Creek bridge will be removed. Provide conceptual channel design for the portion of Savage Creek in the Skagit River floodplain.

1.1 Study Area

The project is located in Skagit County, Washington, about 5.5 miles south-southwest of Concrete, WA, as shown in Figure 1.1. Mill and Savage Creeks cross under South Skagit Highway near Mile Post 18. The existing Savage Creek crossing is located about 300 ft east of the existing Mill Creek bridge. Both creeks flow north and discharge into the Skagit River, which flows west into Skagit Bay. Figure 1.2 provides a more detailed map of the existing Mill and Savage Creek crossings under South Skagit Highway.

Figure 1.1 Vicinity map of the project site. Imagery obtained from Google Earth.

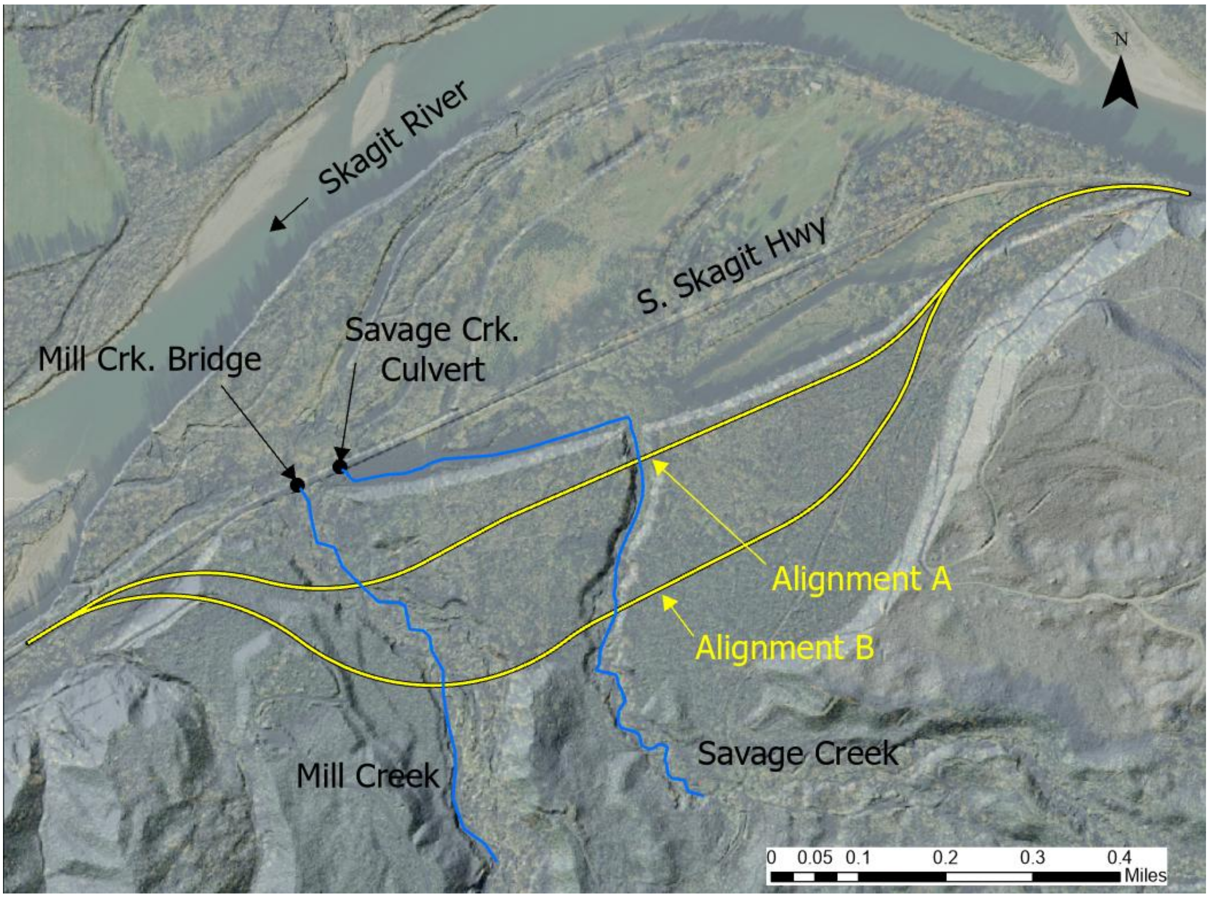

Figure 1.2 Overview of the project area and preliminary alignments under consideration.

2 EXISTING CONDITIONS STREAM PROCESSES

2.1 Contributing Basin Physiography

Figure 2.1 shows the limits of Mill and Savage Creek basins, which are adjacent to one another. Mill Creek's drainage area measuring about twice that of Savage Creek. Each watershed consists of primarily undeveloped foothills, and the land cover for each basin is comprised primarily of native forest. Relatively intense logging occurred across the northern portion of the basins in the late 1990s and early 2000s, and smaller areas have been recently harvested. Mill and Savage Creek have significant vertical relief across their basins, dropping about 4600 ft and 3900 ft, respectively. Table 2.1 summarizes some key basin characteristics calculated by the USGS StreamStats web-based program. On average, Mill Creek has a higher mean slope and receives more mean annual precipitation, possibly due to its higher elevation.

The headwaters of Mill Creek Basin are underlain by Shuksan Greenschist and phyllite, while the headwaters of Savage Creek are underlain solely by Shuksan Greenschist (Tabor et al., 2002). Both rock types are low-grade metamorphic rocks that readily break down through weathering, providing an abundant sediment supply. The upper part of the Mill Creek Valley contains a glacial till deposit, which also mantles the south wall of the Skagit River Valley—an area both creeks intersect as they approach the project site (Tabor et al., 2002, 2003). In the project area, the creeks have incised up to 200 feet through pliestocene recessional glacial outwash terraces (upstream) and terraces composed of modern alluvium (downstream) that parallel the Skagit River. The planned South Skagit Highway reroute traverses a large bench that lies about 60 ft above the modern Skagit River Floodplain; Tabor et al. (2003) map this as a terrace of Skagit River alluvium.

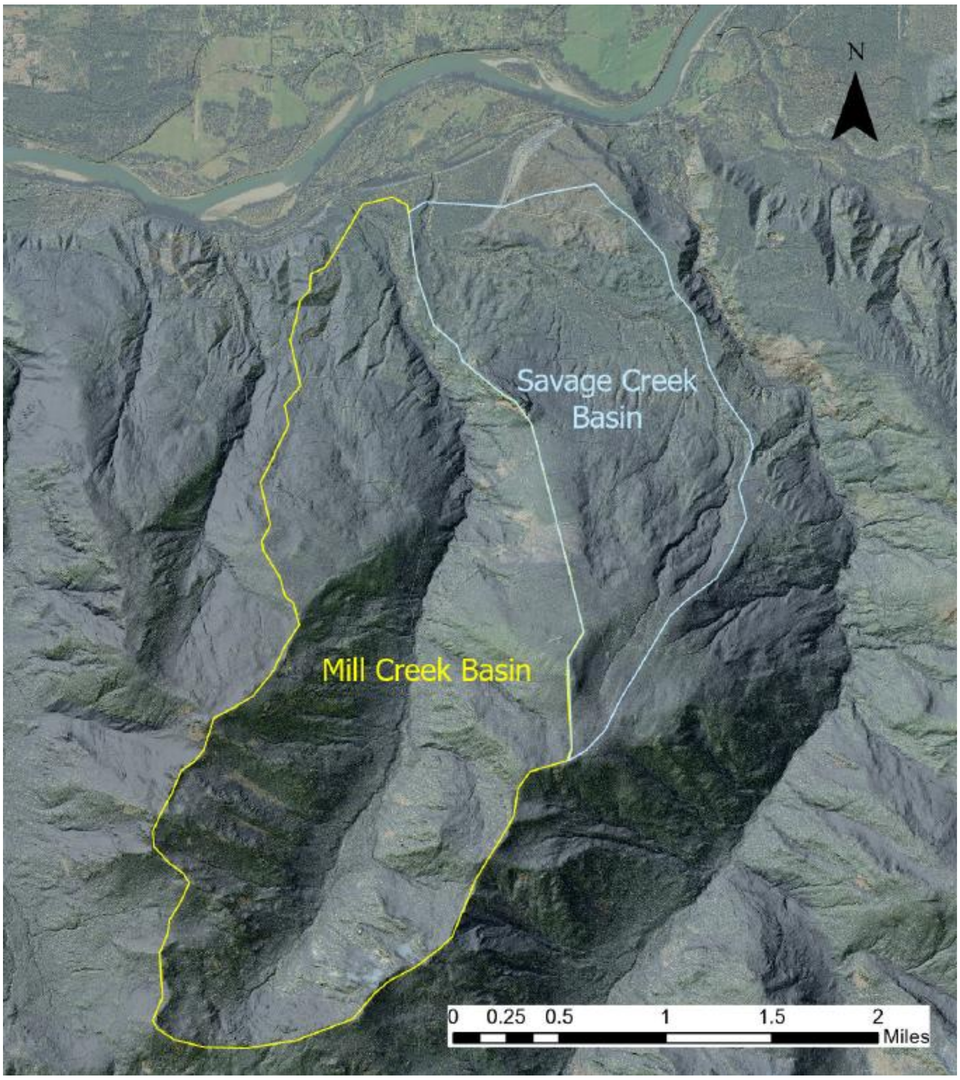

Figure 2.1 Plan view of Mill and Savage Creek watersheds.

Table 2.1 Mill Creek basin characteristics obtained from StreamStats.

Basin Characteristic	Mill Creek	Savage Creek
Drainage Area	4.6 mi^2	2.1 mi^2
Mean Elevation	2730 ft	1343 ft
Mean Slope	54%	34%
Mean Annual Precipitation	73.9 in.	62.8 in.
Canopy Cover	82%	70%

2.2 Hydrology

A detailed hydrologic analysis was not included in the scope for this phase of the project. Instead, the hydrologic estimates documented in TranTech's 2015 report (TranTech, 2015) were used for the hydraulic analysis in this phase of the project. The referenced flood estimates were estimated using the USGS StreamStats web-based and are summarized in Table 2.2.

Table 2.2 Estimated flood hydrology for the project rivers.

RECURRENCE INTERVAL (YEARS)	DISCHARGE (CFS)	
	MILL CREEK	SAVAGE CREEK
2	231	78
10	422	142
25	524	176
50	620	208
100	698	235

2.3 Channel Conditions

2.3.1 Mill Creek and Skagit River Floodplain

From well upstream of the project area to about 50 ft above the existing Mill Creek Bridge, Mill Creek flows through a floodplain that is deeply incised into the surrounding terraces. Below this, the creek has formed an alluvial fan, which is now bisected by the South Skagit Highway. Immediately upstream of the existing bridge, Mill Creek bifurcates, and about half of its discharge flows east to Savage Creek culvert, as shown in Figure 2.2 and Figure 2.3. Downstream of the highway, the main channel turns northeast and joins with Savage Creek before discharging into the Skagit River through a slough along a relict Skagit River side channel. Immediately downstream of the highway, two relict channel alignments head west and northwest into Skagit River, shown in Figure 2.2. Given the unstable nature of the alluvial fans, Mill Creek can be expected to avulse and re-occupy these prior alignments.

The valley upstream of the alluvial fan ranges from 200 to 450 ft wide. The channel generally anabranches and has migrated throughout the valley bottom at different times. Where the main channel abuts the valley wall, cutbanks readily erode into the valley wall toe, indicating the creek is actively expanding the valley bottom. The slides act as a significant source of sediment for downstream transport. During NHC's site visit, staff observed evidence of scour holes on overbank terraces, indicating the occurrence of a valley filling flood. More information about this flood is provided in Section 3.2.

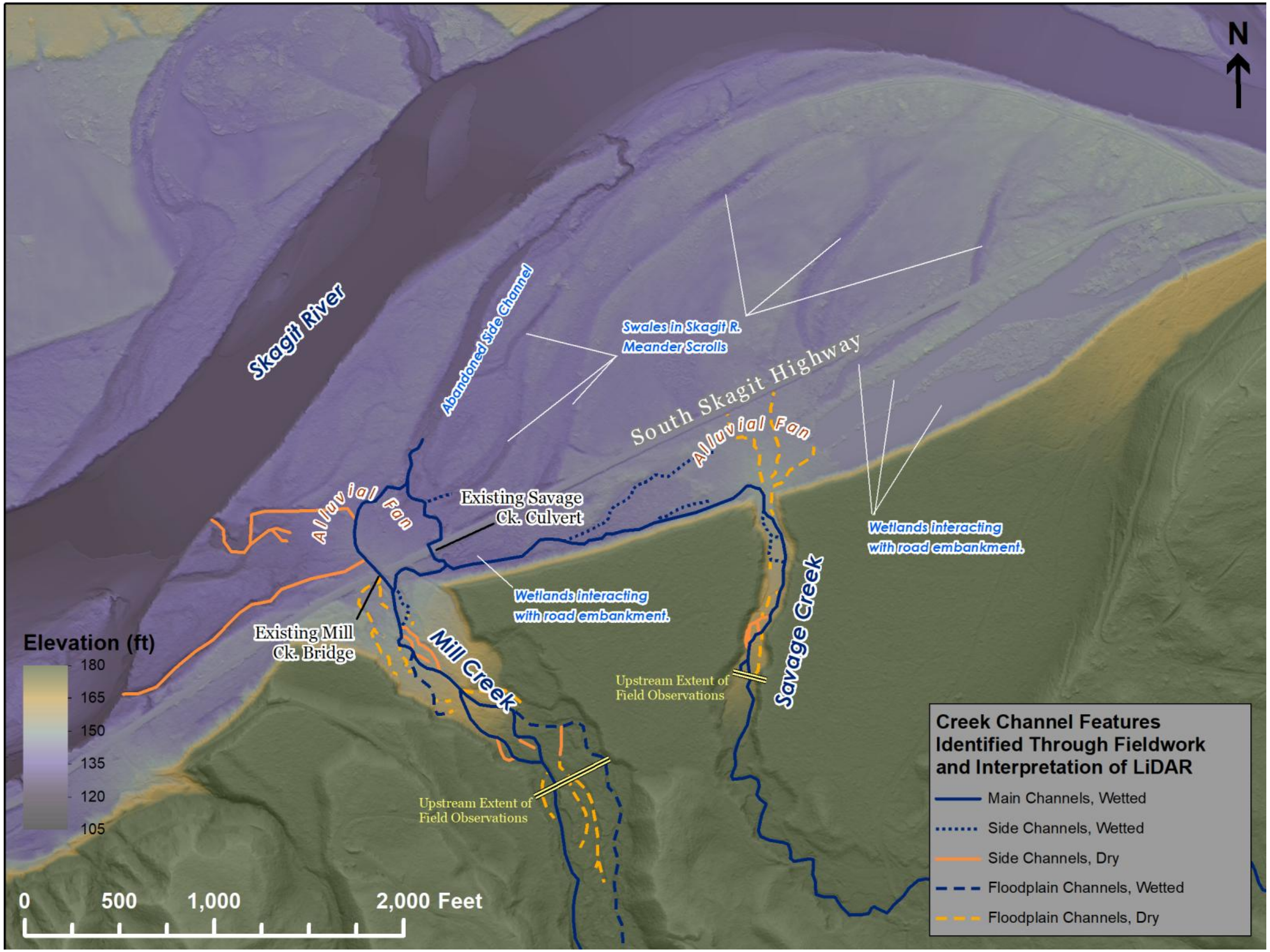

Figure 2.2 Overview map of Mill and Savage Creeks and Skagit River Floodplain between the creek fans and river.

Figure 2.3 Mill Creek's side channel flowing east towards Savage Creek culvert.

2.3.2 Savage Creek and Skagit River Floodplain

Roughly 2000 ft upstream of the Savage Creek crossing at South Skagit Highway, Savage Creek debouches from an approximately 300 to 400 ft wide valley that is also incised below terraces. At this point, it has built up an alluvial fan (Figure 2.2) that extends to the north. The South Skagit Highway cuts through this fan. In some places the fan was lowered to meet the highway grade, while in others fill was placed, thereby blocking potential Savage Creek flow paths and impounding several large ponds and wetlands bounded by the Savage Creek Alluvial fan, terrace escarpment, and South Skagit Highway. Presently, Savage Creek turns abruptly to the west at the fan apex and follows a westerly alignment to the current culvert crossing through the highway. Given this geomorphic and hydraulic setting, removing the South Skagit Highway embankment opens the possibility of Savage Creek occupying a large area of the Skagit River floodplain where it may flow between various swales across the floodplain.

In the valley upstream of the alluvial fan, the mainstem and side channels of Savage Creek generally anabranch across the entire valley bottom. In many areas, the channel is very wide (on the order of 40-60 ft), poorly defined, and surrounded by very low wet floodplain, while in some areas is slightly more channelized and occupies a 15-25 ft wide channel. Similar to

Mill Creek, the valley sidewalls readily erode where the channel abuts the valley wall toe, indicating the creek is actively expanding the valley bottom.

3 MILL CREEK - GEOMORPHIC HISTORY

Rapid accumulation of sediment in Mill Creek at and downstream of the South Skagit Highway crossing has almost completely filled the bridge opening over the past four decades. Chronological photo evidence of the deposition at Mill Creek is provided in Figure 3.1. This accumulation has resulted from interaction between channel changes in the Skagit River and high sediment supply from Mill Creek. Understanding this history is important to help inform the prediction of future channel change and understand possible future flood scenarios, as well as make determinations about the preferred crossing location.

Figure 3.1 Photos of Mill Creek Crossing between 1972 and 2024. Photos from NHC (2004).

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3.1 Mill Creek Interactions with Skagit River

The history of changes in the Skagit river channel morphology explains the rapid sediment accumulation around the existing Mill Creek Crossing over the past few decades. Aerial photos of the site in 1972 (Figure 3.2) show that a large (~150 ft wide) side channel of the Skagit River meandered to a position about 240 ft northwest of the Mill Creek crossing location and that Mill Creek had built a small delta-fan bar into this side channel. Before this time, periodic high flows in the Skagit River likely transported most of the sediment supplied by Mill Creek out of this side channel, keeping it open. Between 1972 and 1985, however, the slow accumulation of sediment at the mouth of Mill Creek reduced the capacity of flow through the side channel to carry away sediment supplied by Mill Creek, creating a positive feedback cycle where sediment accumulation reduced the amount of flow through the side channel, further driving additional sediment accumulation. By 1985, the Mill Creek delta-fan had prograded completely across the side channel and blocked throughflow from the Skagit River (Figure 3.2). After this, all the sediment supplied by Mill Creek was deposited locally and Mill Creek began building a larger alluvial fan through a sequence of avulsions downstream of the South Skagit Highway, driving aggradation of the bed at the crossing.

This sequence explains the history of aggradation at the Mill Creek crossing. Substantial aggradation began around 1985, when the side channel closed, and aggradation thereafter proceeded rapidly until the 1990s, after which periodic sediment removals were necessary to maintain flow through the bridge.

Comparison of recent (2017-2023) shows that sediment accumulation remains focused on the Mill Creek fan near and downstream of the crossing, with little channel profile change occurring from above about 600 ft upstream of the current crossing. The proposed Mill Creek bridge will be located upstream of this aggradation zone.

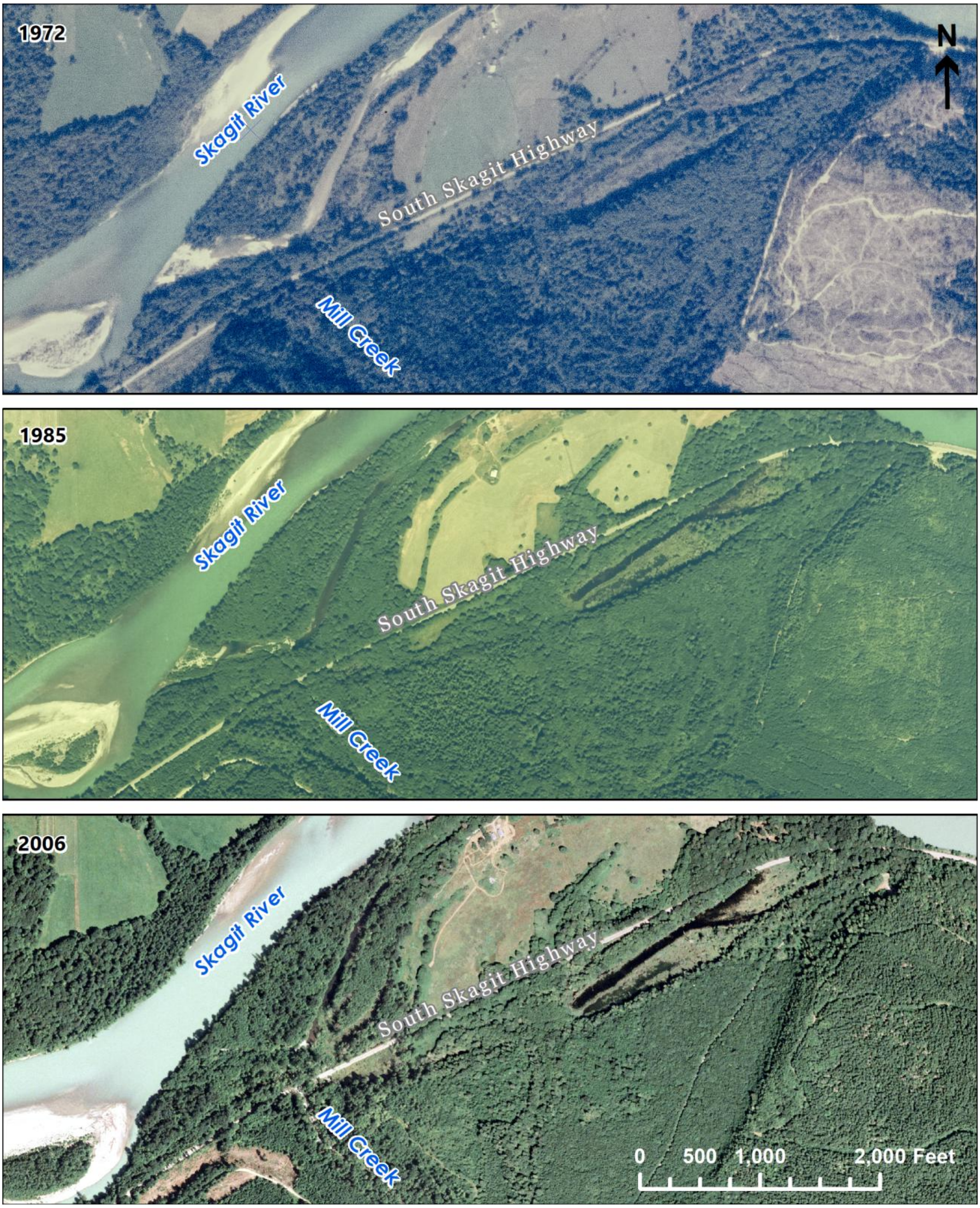

Figure 3.2 Aerial photos showing closure of the Skagit River side channel at Mill Creek confluence.

3.2 2002 Hydrogeomorphic Flood

A particularly important flood occurred in 2002, when a rain-on-snow flood generated numerous landslides throughout the Mill Creek basin, which introduced a large volume of sediment and large wood to the creek and generated a combined debris flow and bridge-dam failure outburst flood (Grizzel, 2002). In addition to supplying sediment to the South Skagit Highway crossing over the creek, wood entrained by the flood formed very large jams across the creek upstream of the crossing (Grizzel 2002). Because debris flows move faster than flood waves and entrain material from along their paths, the peak discharges in such events can be much higher than typical hydrometeorological floods (Jakob et al., 2015). Based on documentation by Grizzel and sedimentary evidence of the event, it appears the debris flow stalled upstream of the project area and transitioned to a debris flood. The combined effects of the wood jams and large flood peak raised water levels enough to scour channels through terraces well above the channel elevation (Grizzel, 2002). Preliminary estimates indicate that the peak discharge of the 2002 event was potentially an order of magnitude higher than the estimated 100-year recurrence interval flood generated solely from hydrometeorological processes, which is well within the range of typical ratios between Type 2 (debris flow to debris flood dilution) and Type 3 (outbreak flood generated) debris floods (Church and Jakob, 2020). Field observations from 2024 and interpretation of LiDAR show this terrace (the T1 terrace on the right bank between RM 0.45 and 0.8 in Figure 3.3) was located at an elevation six to eight feet above the channel. Published observations of the event do not include estimates of the debris flow volume or peak instantaneous discharge; however, using a hydraulic model and quantitative calculations, we estimate discharge could have been about 8,000 cfs ± 5,000 cfs. The description of the hydraulic modeling is provided in Section 5.1.1. The recurrence interval of this event is not known, but the possibility of such an event occurring in the future should be considered in the bridge design.

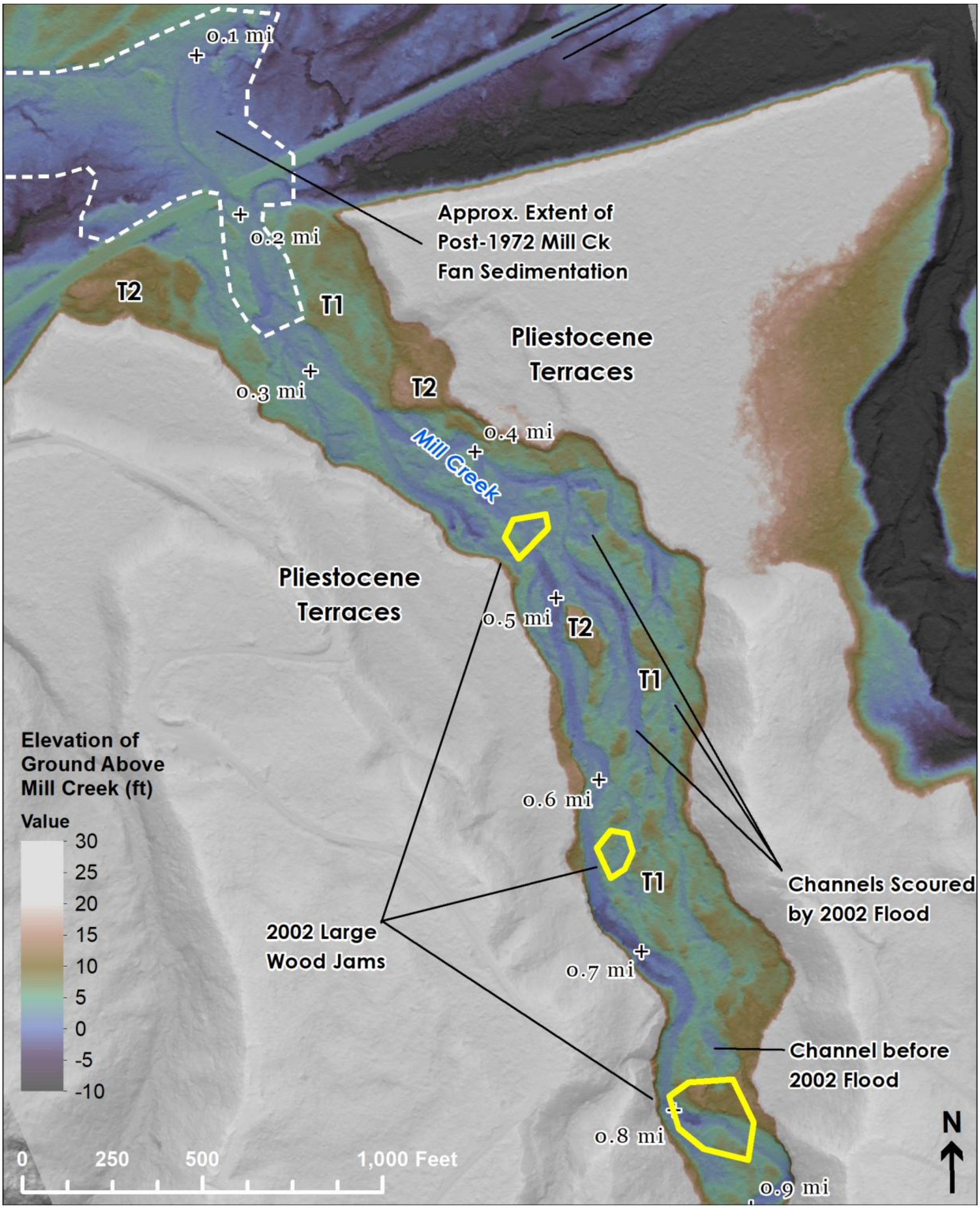

Figure 3.3 Relative elevation model of mill creek with key features from the 2002 hydrogeomorphic flood, identified by Grizzel (2002), and select other valley bottom geomorphic features annotated.

4 PREFERRED ALTERNATIVE

NHC walked each creek and collected data to assist with making a recommendation for preferred bridge crossing locations at Mill and Savage Creeks. The two highway alignments considered are shown as Alignments A and B in the Figure 1.2. While onsite, NHC staff collected the following field data to assist with selecting an alignment:

- Photo documentation of channel conditions
- Evidence of geomorphic change
- Bankfull measurements
- Pebble counts
- Floodplain conditions
- Hydraulic Modeling

This data, along with desktop analysis of LiDAR and aerial imagery was used to make a hydraulic recommendation for the preferred alignment. A comparison of the alignment crossing locations is provided in the following sections.

4.1 Prospective Crossing Locations – Mill Creek

4.1.1 Alignment A

About 650 ft upstream from the Mill Creek stream crossing at Alignment A, Mill Creek bifurcates into two main channels but merges into a single main channel immediately upstream of this crossing location, as shown in Figure 4.1. The valley-bottom naturally contracts at this location due to a substantial terrace protruding from the right bank. A smaller groundwater-fed floodplain channel is located on the left side of the valley, as shown in Figure 4.1Figure 4.2 and Figure 4.2. At this location, the 165 ft wide active channel corridor would need to be spanned to avoid fill within high-value habitat areas.

It is worth noting that the main channel is perched above the surrounding valley bottom, which appears to be due to a natural levee that likely formed during the 2002 debris flow/flood event. Upstream from the proposed bridge crossing, there are relic floodplain channels on river-left that could re-activate during a future avulsion. For the sake of bridge protection, it needs to be assumed that the entire channel could occupy the left side of the valley bottom in the future.

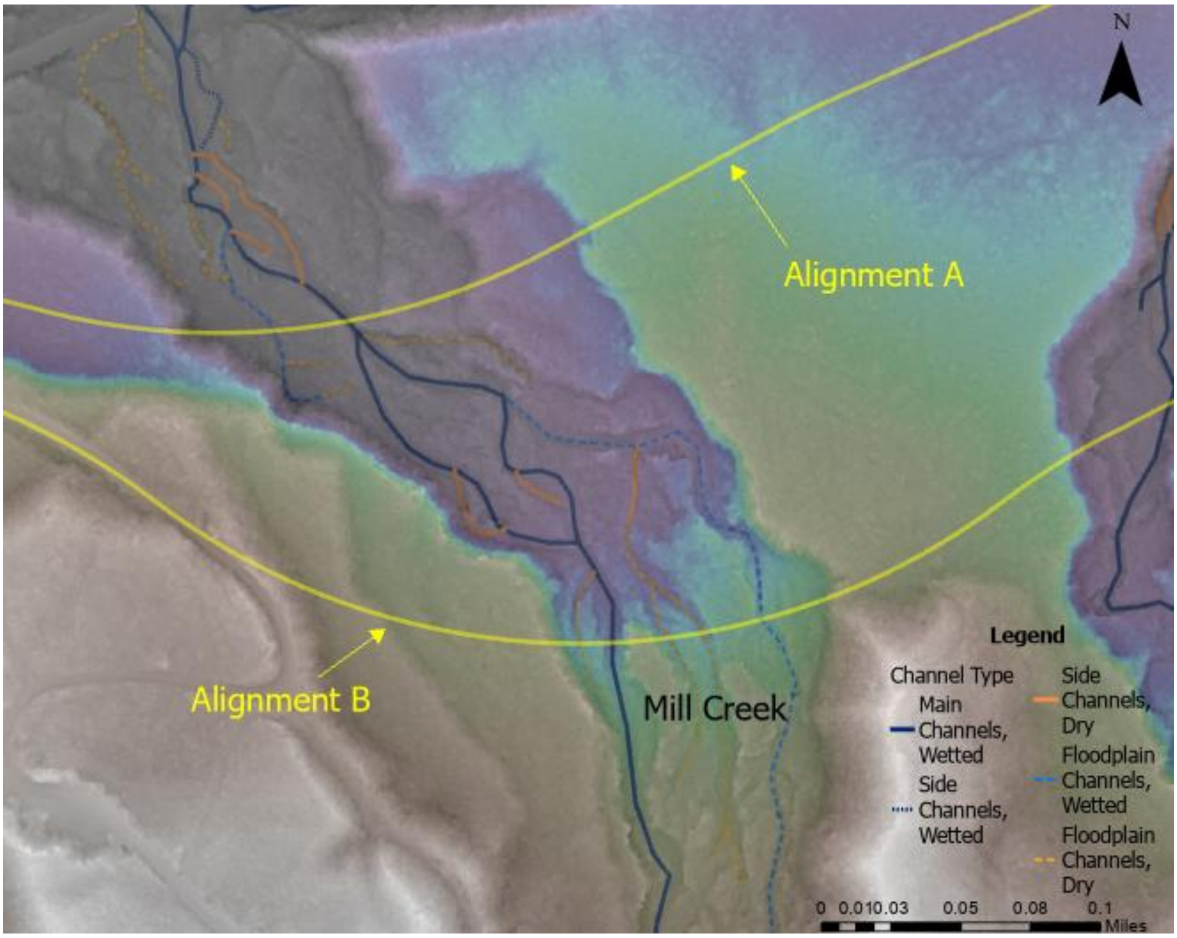

Figure 4.1 Plan view of the prospective Mill Creek crossing locations.

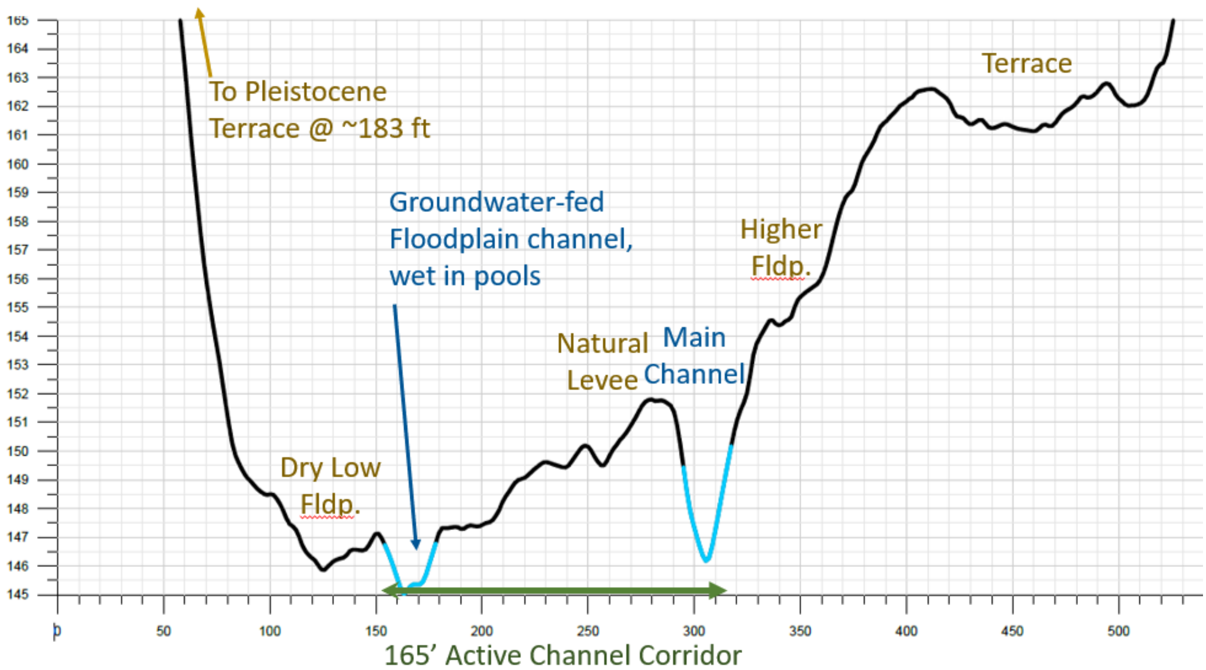

Figure 4.2 Mill Creek channel cross-section at Alignment A.

4.1.2 Alignment B

At this location, Mill Creek is less confined than at Alignment A. The channel cross-section includes a single main channel and two relic channels that the creek occupied prior to an apparent avulsion that re-directed flow to the current flow path. There is also a wetted channel in the river-right floodplain, that was observed conveying a substantial amount of flow during NHC's site visit. Figure 4.3 shows the channel section view along the centerline of Alignment B. The active channel corridor is about 100 ft wide, however the potential avulsion zone is an additional 115 ft wide. A single bridge structure would need to either span the active channel corridor and avulsion zone, roughly 300 ft, or two smaller spans could span the channel corridor and avulsion zone separately. With either option, a large culvert would be required to convey the river-right floodplain channel.

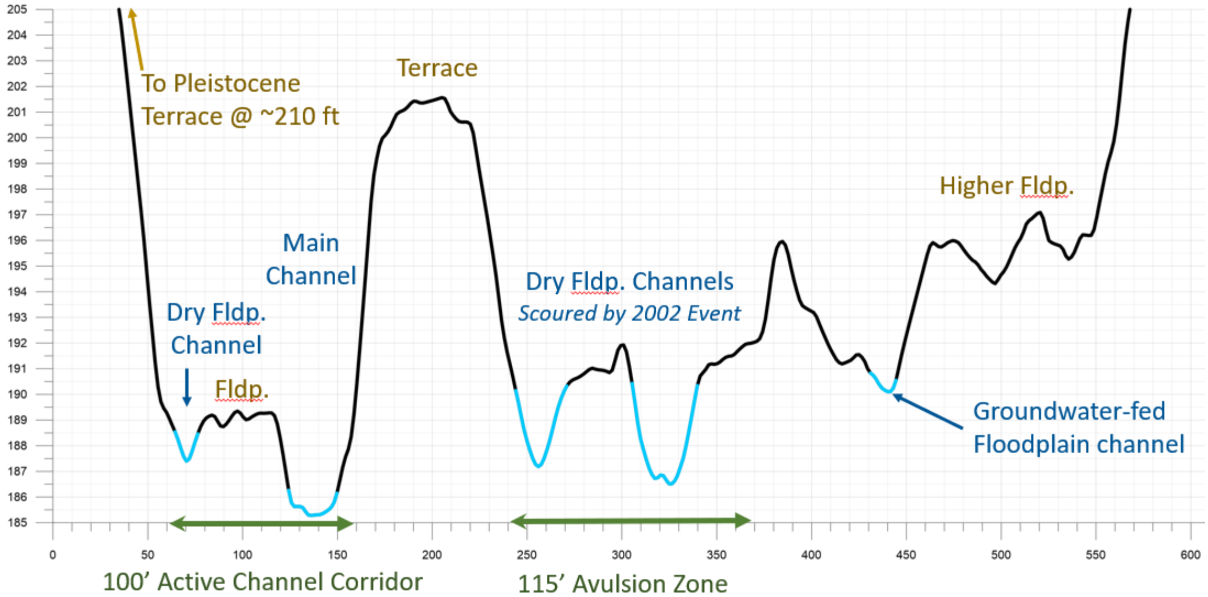

Figure 4.3 Mill Creek channel cross-section at Alignment B.

4.1.3 Preferred Crossing Location – Mill Creek

Alignment A was chosen as the preferred crossing location over Mill Creek. This crossing location was advantageous from a hydraulics perspective since the active channel corridor was substantially more confined than at Alignment B, thus requiring a shorter, less costly structure to span critical habitat areas. Additionally, Alignment A allowed the project to utilize a shorter road alignment. While Alignment B was feasible, it held no clear advantages over Alignment A.

4.2 Prospective Crossing Locations – Savage Creek

4.2.1 Preferred Alignment

When NHC visited the project site, there was still uncertainty about which crossing locations were under consideration. NHC walked Savage Creek up to a point about 900 ft upstream from the alluvial fan apex and observed the channel characteristics through this reach. Where Alignment A crossed Savage Creek, the valley bottom and top widths were approximately 100 ft and 160 ft, respectively. The valley is significantly wider along Alignment B, with the valley top and bottom widths measuring about 200 ft and 310 ft, respectively. As mentioned in Section 2.3.2, there is minimal topographic relief across the valley floor and the system is prone to avulsions, therefore it was assumed the channel could migrate across the entire valley bottom through the design life of the new structure. Therefore, it is preferable for the proposed bridge to span the entire valley bottom. Because of this consideration, Alignment A offered an advantage over Alignment B due to its narrower valley width; however, upon further consideration the project team selected a preferred crossing location roughly half-way in between Alignments A and B, shown in Figure 4.4. This alignment featured a similar valley width as Alignment A while allowing the proposed roadway to take advantage of an existing gravel-road to the west of Savage Creek. A valley cross-section of the preferred crossing is provided in Figure 4.5.

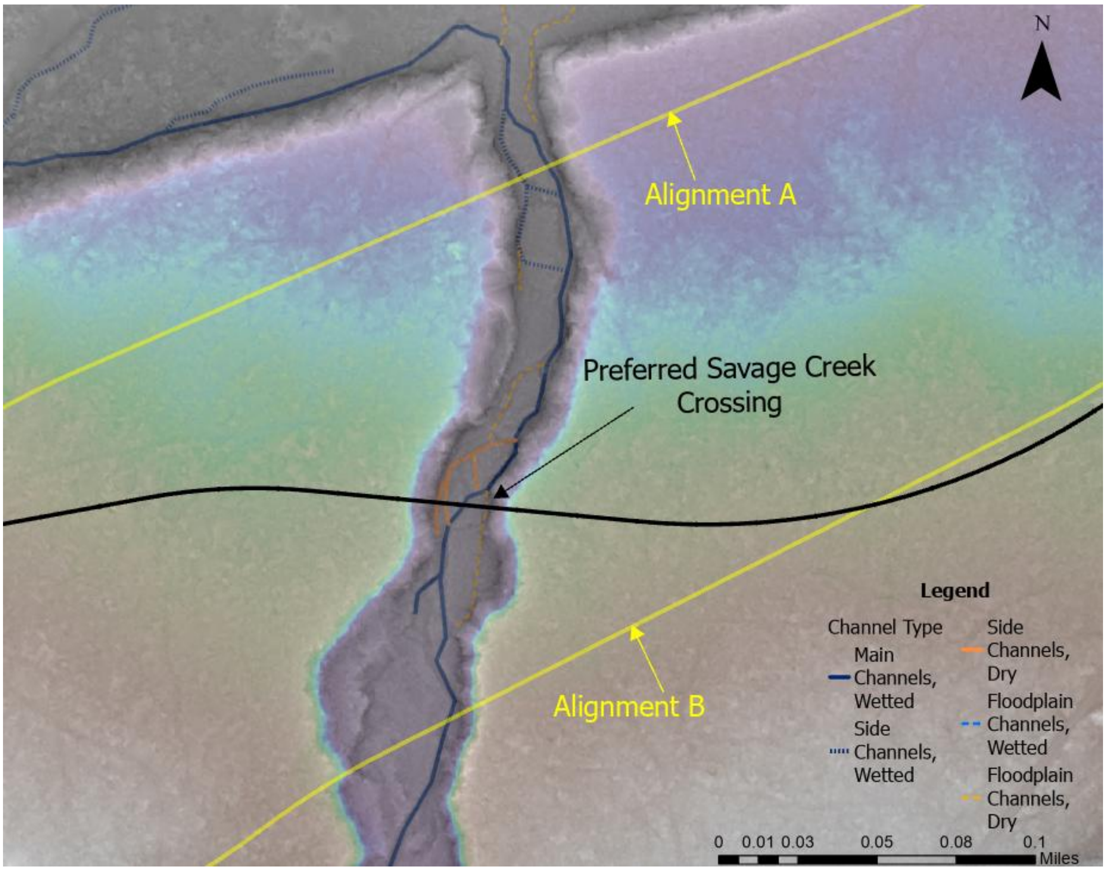

Figure 4.4 Shows the location of the preferred Savage Creek crossing in relation to prospective alignments A and B.

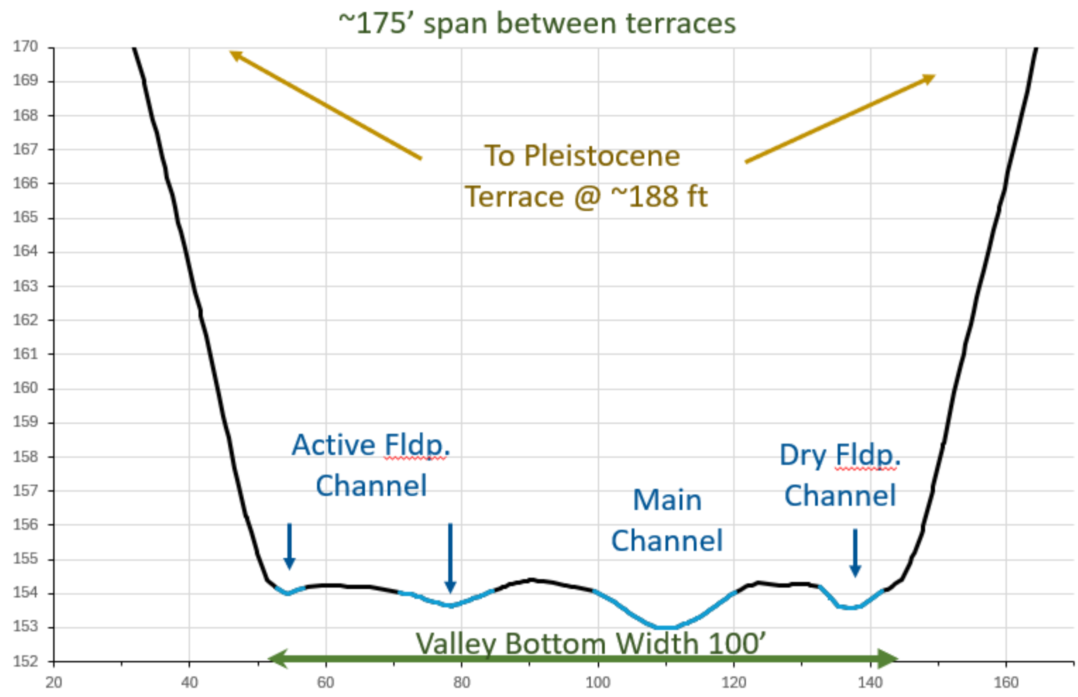

Figure 4.5 Cross-section of the preferred alignment across Savage Creek.

4.3 Proposed Bridge Geometries

At Mill Creek, six bridge alternatives were developed and assessed, including single- and multi-span options with both prestressed concrete and steel girders. After thorough evaluation by the County and design team, the preferred alternative emerged: a two-span steel girder bridge, measuring 424-ft long. This option was selected due to its ability to span the valley bottom, minimize in-channel piers and fill, and reduce the need for tall abutments on steep slopes. Steel girders were preferred for their ability to be delivered in segments and assembled on-site, improving constructability in constrained terrain.

At Savage Creek, four single-span alternatives were evaluated, varying by span length and girder type. The 205-foot single-span steel girder bridge was identified as the preferred alternative, offering a balance of reduced abutment height, improved hydraulic opening, and feasible construction logistics. Refer to Appendix A for drawings of the proposed structures.

5 HYDRAULIC MODELING

As part of the preliminary hydraulic design for this project, NHC developed two model geometries in HEC-RAS 2D, version 6.5. First, the existing conditions geometry was developed to approximate the 100-year floodplain width at Alignments A and B, to help guide the estimation of the required bridge length and substructure location. The existing conditions model was then updated to reflect the preliminary bridge designs along the preferred alignment, with the intent of using the hydraulic model outputs from an updated version of the model to assist with hydraulic design and scour estimation in the next phase of this project. Because the existing conditions were modelled only for preliminary bridge sizing, this report focuses on the proposed conditions model results. It should be noted that because the model geometry was developed from light detection and ranging (LiDAR) data, it doesn't include the topography of the channel below the water surface that was observed at the time the LiDAR was collected. Because of this, the floodplain inundation is likely conservative.

5.1 Geometry

Two LiDAR datasets were used to create the hydraulic model terrain. Pacific Surveying and Engineering (PSE) collected drone-based LiDAR throughout the project area during Fall of 2024, and this data was overlaid upon the Cascades North 2023 LiDAR data set, which was flown in 2022 and 2023 by NV5 Geospatial. The existing Mill and Savage Creek crossings under South Skagit Highway were modelled approximately based on field documentation and are not based on survey data.

Mannings roughness values were selected based on engineering judgement. Mill Creek's floodplains were forested with moderate undergrowth and the channel was comprised of a cobble bed, with intermittent large woody debris. At Savage Creek, the channel consisted of fine to coarse gravel, with forested floodplains. The channel was much narrower, with less defined banks so it was challenging to accurately identify the active channel from LiDAR. Therefore, a composite roughness was assigned to the valley-bottom, rather than attempting to differentiate between the active channel and floodplain. Table 5.1 summarizes the Mannings roughness coefficients applied to the model.

Table 5.1 Summary of Mannings Roughness Coefficients used in the HEC-RAS 2D hydraulic model.

Land Cover	Mannings Roughness Coefficient
Road	0.012
Mill Creek Channel	0.04
Mill Creek Floodplain	0.10
Savage Creek Composite Channel/Floodplain	0.07
Wetland	0.07

The proposed model was only created for the preferred alignment at Mill and Savage Creek. The same geometry file developed for the existing conditions simulation was used for the proposed model with updates listed below.

- The existing Mill Creek bridge was removed, and the Savage Creek culvert was replaced with a trapezoidal channel through the existing highway embankment. The South Skagit Highway was not removed, but it does not impact the hydraulics at the proposed alignment. Once proposed grading is developed in the next phase of this project, the hydraulic model should be updated.
- The piers for the proposed Mill Creek bridge were integrated into the model terrain, with an engineered logjam located immediately upstream of the left pier to protect against debris flow impacts. The right pier does not interact with modeled flows, so impact protection was not necessary.
- Savage Creek spans the entire valley, terrace-to-terrace, so model terrain modifications were not necessary.

Figure 5.1 and Figure 5.2 show plan views of the proposed Mill and Savage Creek bridge model geometries.

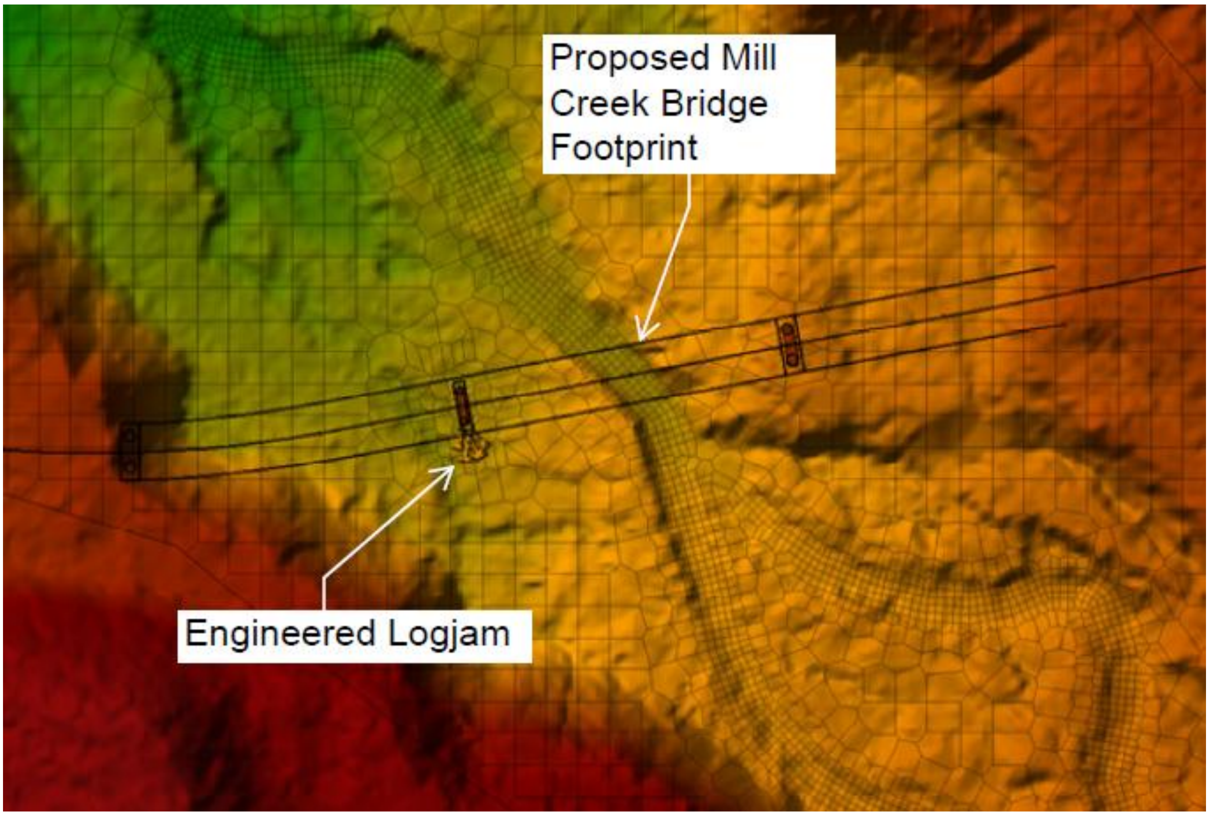

Figure 5.1 Plan view of the proposed bridge geometry, including an engineered logjam at the left pier.

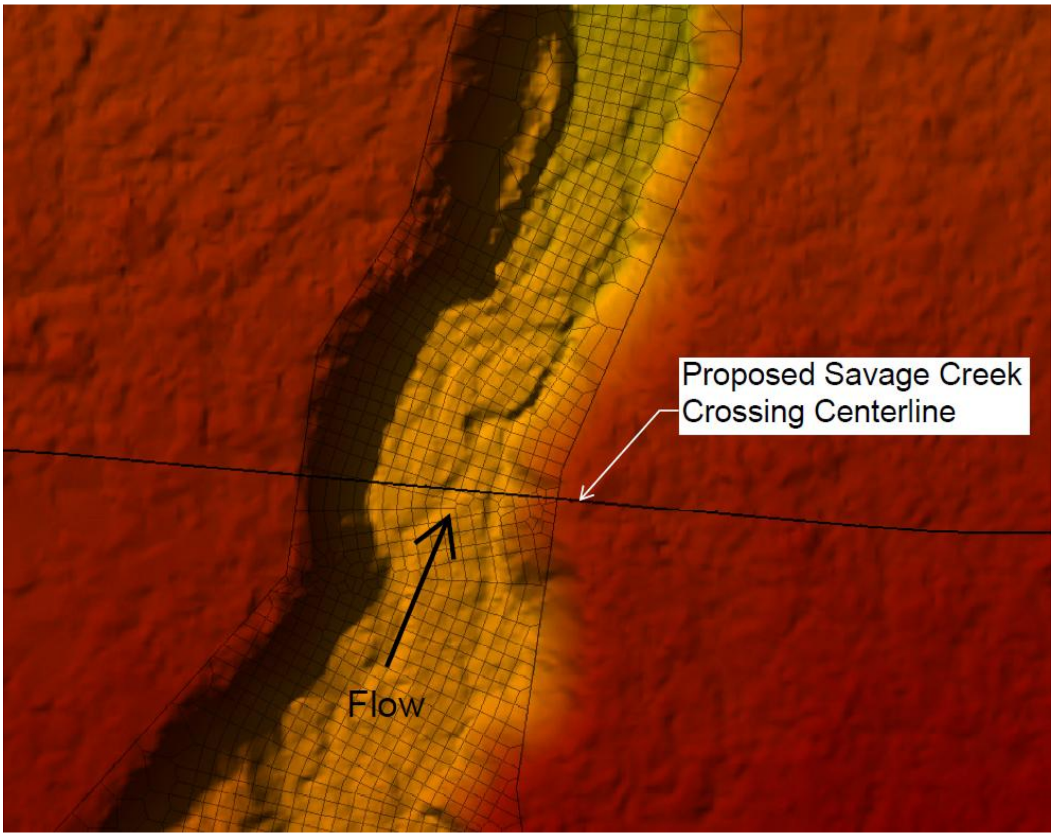

Figure 5.2 Plan view of the proposed Savage Creek Crossing location. The bridge will span the entire valley, so no terrain modifications were necessary.

5.1.1 Mill Creek Results

Figure 5.3 shows the 100-year inundation limits and channel velocities. The maximum velocities in the main channel can be as high as 10.5 ft/s. Figure 5.4 presents a section view through the proposed bridge centerline, including the 100-year water surface elevation. The wetted width of the main channel is about 45 ft, or 190 ft if accounting for the relatively stagnant inundation around the left-pier, due to overbank flow further downstream. In the section view, it should be noted that the main channel is perched above the valley-floor. This is thought to be the result of a previous debris flow. If future flood-flows avulse through the natural levee that has formed, it is likely the main channel will migrate to the left side of the valley. To account for this scenario, as well as deflect future debris flow impacts, the engineering logjam was modeled upstream of the left pier.

Through the bridge section, the model results suggest the main channel has adequate conveyance capacity to pass the 100-year discharge within its banks. However, this basin is subject to rain-on-snow events which have the potential to exceed the magnitude of local hydrometeorological floods by an order of magnitude, as was likely the case during the 2002 debris flow event. The observance of scour holes on overbank terraces suggests this event was caused by a valley filling flood. Using the existing conditions model, NHC attempted to develop an order-of-magnitude estimate of what discharge would cause the observed scour, which is described in the following paragraph.

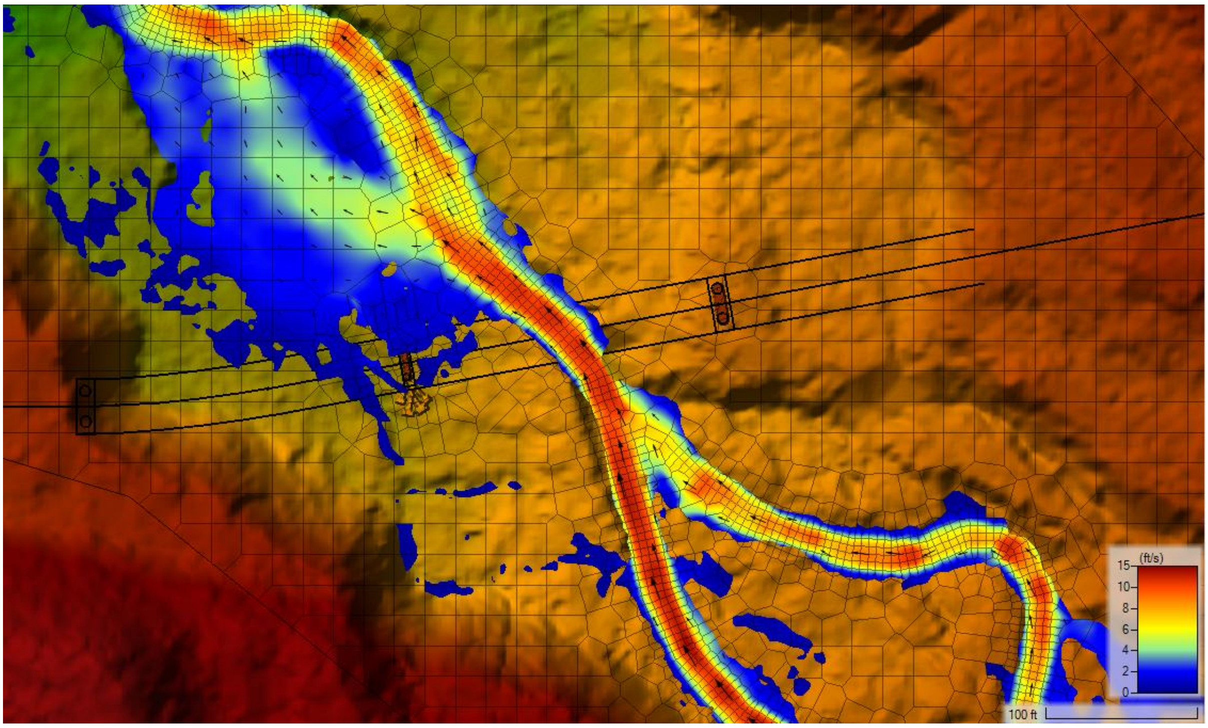

Figure 5.3 Graphical representation of the 100-year inundation limits and velocities at the proposed Mill Creek bridge.

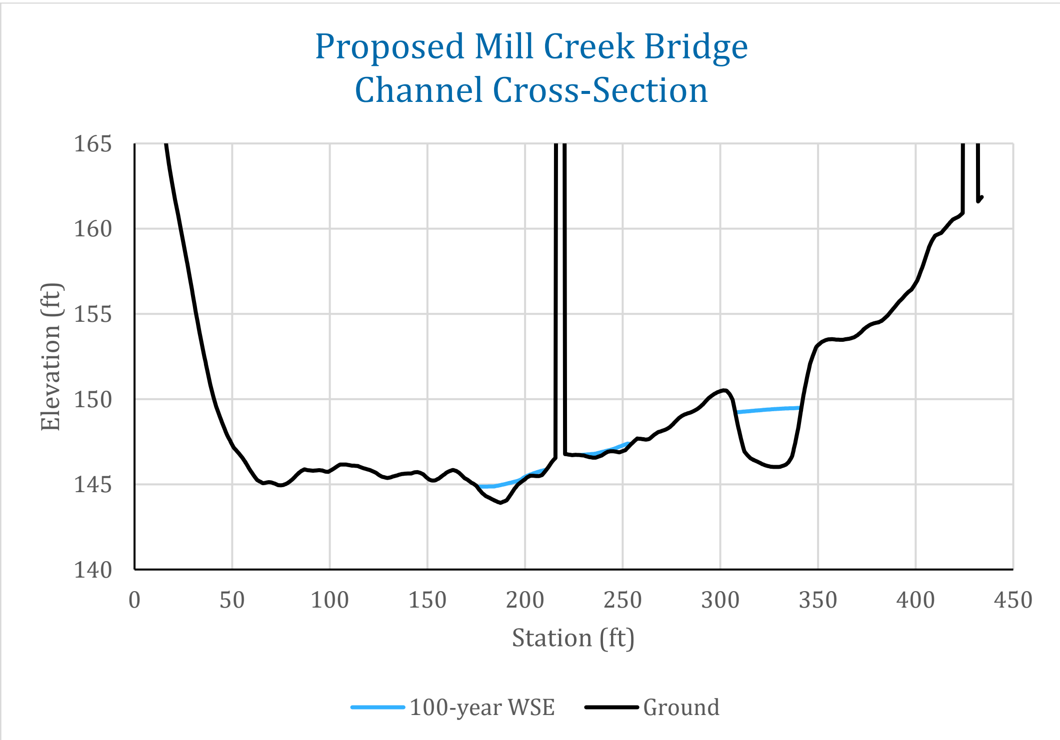

Figure 5.4 The 100-year water surface elevation plotted on the proposed bridge channel section.

To estimate the flood magnitude necessary to produce high enough flood levels to induce scour on Terrace 1 (T1), identified in Figure 5.5, a channel blockage was placed in the main channel to simulate a logjam and discharge was incrementally increased until at least 1 ft of depth was achieved at Terrace 1. This condition was met with a discharge of 6500 cfs. This does not account for any flow bulking that is common in debris flows: however, it does provide a rough order-of-magnitude flow estimate. While the frequency of large valley-filling floods in Mill Creek basin is unknown, NHC recommends that the bridge substructure be designed to withstand an equivalent flood event.

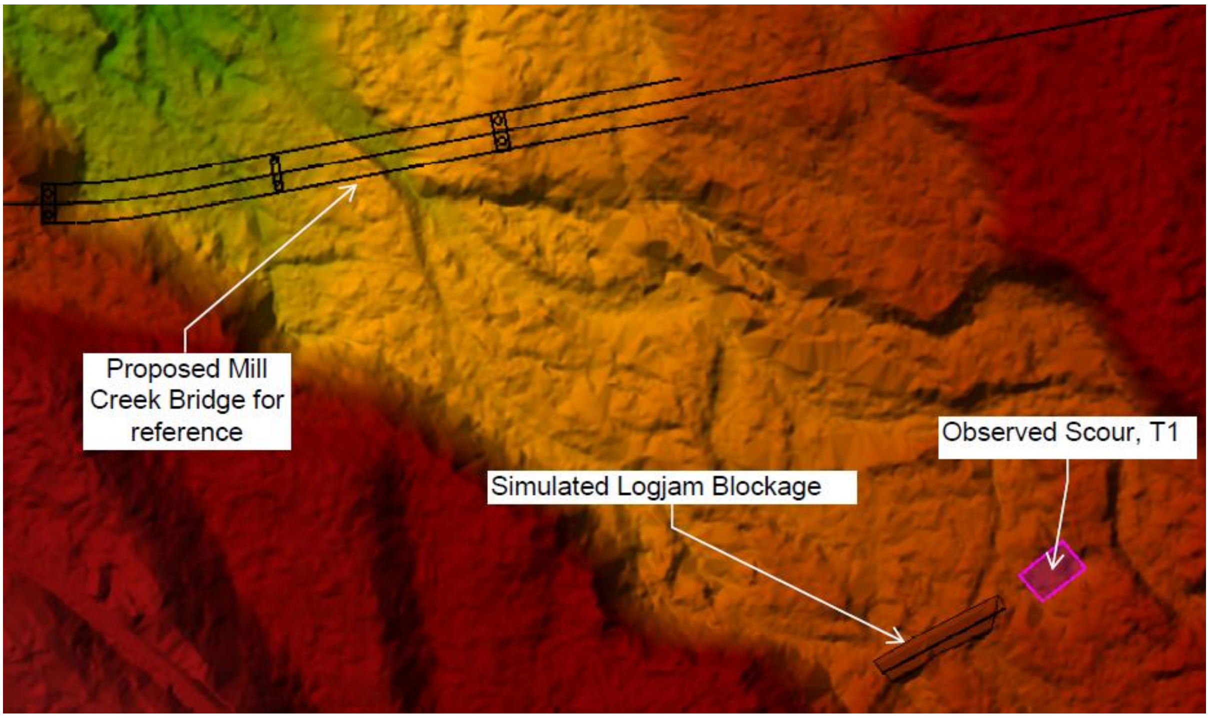

Figure 5.5 Shows the placement of the simulated logjam and the location of the observed scour location, Terrace 1 (T1).

5.1.2 Savage Creek Results

Figure 5.6 shows the 100-year inundation limits and channel velocities. The maximum velocity along the proposed bridge centerline is 4.1 ft/s. Figure 5.7 shows 100-year discharge plotted on the channel cross-section under the proposed bridge. The 100-year discharge at the proposed Savage Creek bridge, spans the entire valley-bottom, measuring about 92 ft wide.

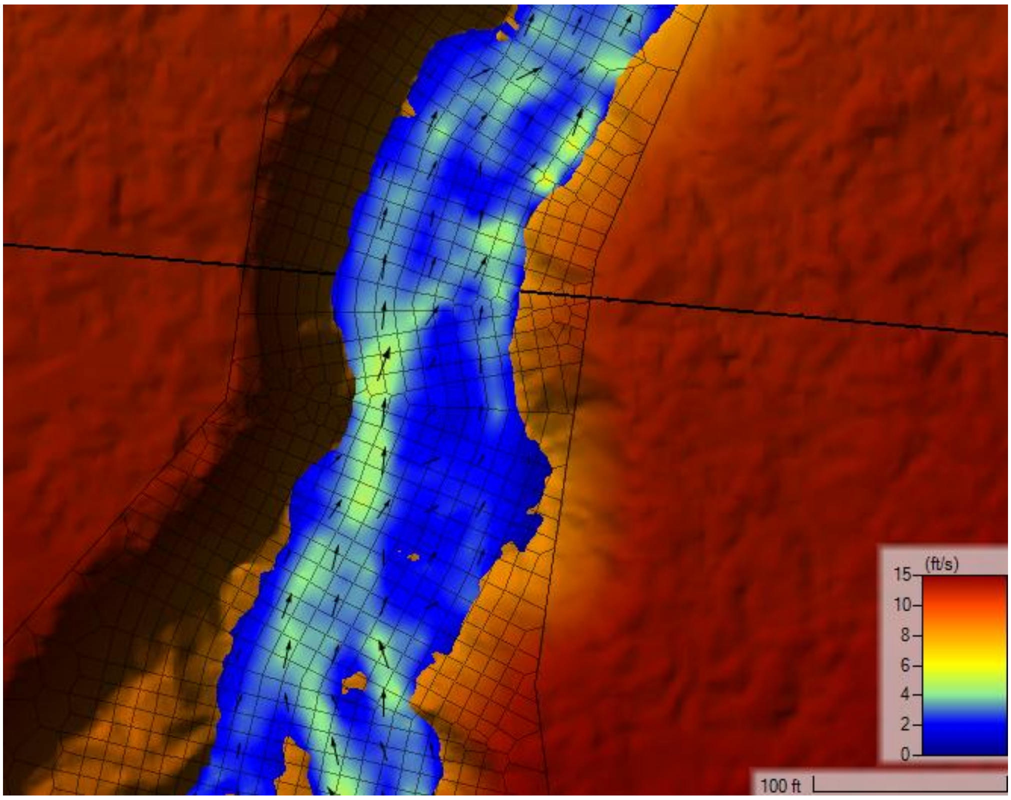

Figure 5.6 Shows the 100-year flood event inundation limits and velocities at the proposed Savage Creek bridge crossing.

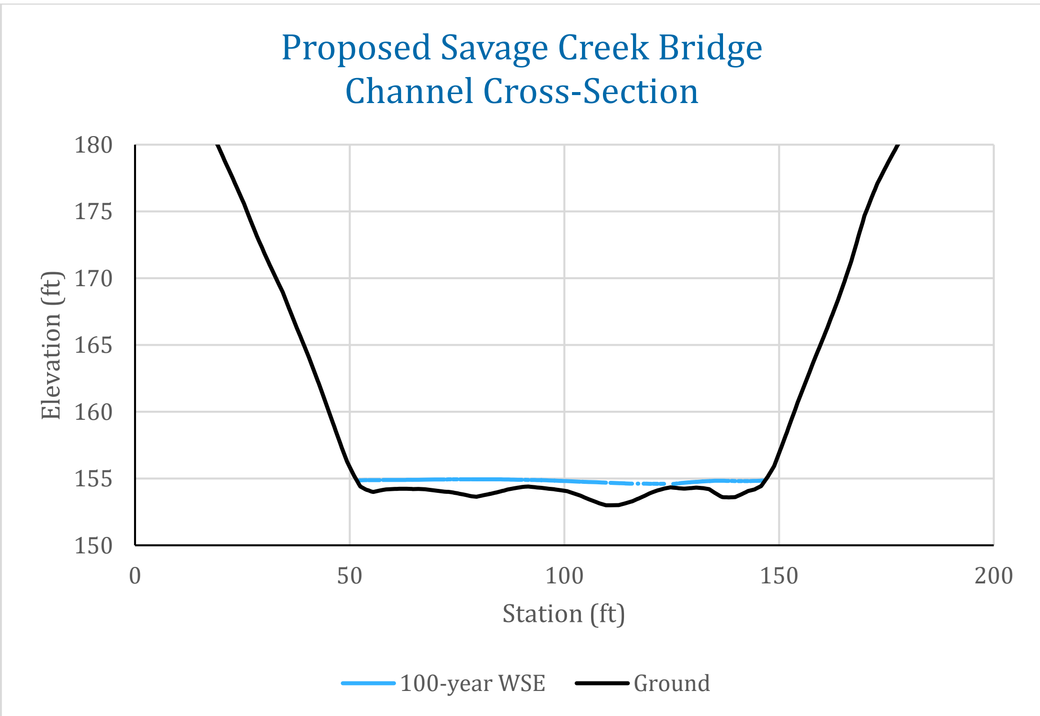

Figure 5.7 Savage Creek channel section and 100-year water surface elevation along the proposed bridge centerline.

6 CHANNEL DESIGN

About 1.5 miles of the existing highway will be removed to improve fish passage and habitat function within the project area. This will include the removal of the existing bridge and culvert where South Skagit Highway currently crosses Mill and Savage Creek. Channel grading will be necessary to re-establish natural stream-processes at these locations. Since the existing highway controls the alignment of the lower reaches of Savage Creek, its removal presents a unique opportunity to re-route Savage Creek to increase available fish habitat. The highway removal will need to be conducted thoughtfully to avoid adverse impacts to existing wetlands while increasing fish habitat within Savage Creek. This phase of the project included preliminary channel design at the existing Mill Creek bridge, as well as concept-level plans of re-routing Savage Creek and removing 1.5 miles of the highway. Details about these plans are provided in the following sections.

6.1 Existing South Skagit Highway Road Removal Concept

Within the project area, the existing South Skagit Highway alignment is in the Skagit River floodplain and acts as hydraulic control for multiple large wetlands, as well as influences the Savage Creek channel alignment within the Skagit River floodplain. It is the intent of this project to remove this section of highway and restore it back to a more natural landscape.

In combination with the proposed plans for Mill and Savage Creek channels, NHC has provided conceptual recommendations for removing the existing South Skagit Highway, which are provided in Appendix B. The overall intent is to remove the abandoned road embankment, blend the grading in with the adjacent existing ground elevations, and revegetate. In select areas, specific elevations will need to be maintained to sustain the existing wetlands and reconnect relict channels of Savage Creek, as part of the proposed Savage Creek alignment described in Section 6.3.

6.2 Mill Creek Channel Design at Existing Bridge Location

The existing single-span concrete girder bridge will be removed in its entirety, including its abutments. The adjacent approach road embankment will also be removed and the riverbanks through the bridge entrance will be laid back at 2H:1V slopes. Large wood will be placed in the channel to help establish the bank line once the abutments are removed. The large wood will also introduce hydraulic complexity by creating lower velocities zones, which are important resting areas for salmonid species.

As mentioned in Section 2.3, immediately upstream of the existing Mill Creek bridge, the road embankment redirects a side-channel abruptly to the east, towards Savage Creek. Once the road embankment is removed, inertia will cause this discharge to find a new path. NHC proposes to guide this new path by grading in a new side-channel bearing to the northeast that ties into Savage Creek downstream of the existing South Skagit Highway alignment. This meandering side-channel will be loaded with large wood. Refer to Appendix B for the preliminary design drawing of this concept.

6.3 Savage Creek Channel Design

Where Savage Creek debouches from its confined valley into the Skagit River floodplain, an alluvial fan has been built up (see Figure 2.2). At this location, several avulsions have occurred in the past and future avulsions may occupy any part of the fan surface. At present, the channel abruptly turns west from the fan apex and proceeds about 2000 ft towards the existing Savage Creek culvert crossing. It is possible that Savage Creek has been trained along its current alignment to avoid the existing highway embankment, which bisects two of Savage Creek's relict channels. By removing the highway embankment, this project provides an opportunity to reroute Savage Creeks alignment to provide about a mile of fish habitat. This would be done by routing Savage Creek through its relict channels and low-lying wetlands, as well as grading a new channel through high points until reconnecting with its current alignment downstream of the existing highway. A conceptual diagram of the proposed alignment is provided in Appendix B.

6.4 Recommended Analysis

To understand the impacts of implementing the proposed Savage Creek channel design and road removal concept, it will be important to understand how the proposed Savage Creek channel will interact with the adjacent wetlands and groundwater within the Skagit River floodplain. The following data will be required to develop grading plans for the abandoned road removal and design a mile-long alternate Savage Creek reach to increase fish habitat:

1. Review site hydrology to determine adequacy of designing based on StreamStats outputs or perform an assessment of the design's sensitivity to uncertainty in hydrology.
2. Characterize existing sensitive areas (wetlands) and habitat conditions that may be affected by re-aligning Savage Creek.
3. Conduct groundwater monitoring to understand groundwater interactions and its effect on wetland and channel hydraulics. This may include installing groundwater monitoring wells and deploying level loggers in open-water features. This data would be collected and analyzed over a 9-month period to characterize groundwater movement in the project area.
4. Collect topographic survey of the wetlands and Savage Creek relict channels adjacent to the existing roadway.
5. Using the collected topography, update the hydraulic model with the proposed channel geometry and obliterated road embankment to confirm channel hydraulics.

CLOSURE

We trust this report meets your needs. If you have any questions or requests, please feel free to contact the undersigned.

Sincerely,

NHC Inc.

Report prepared by:

Unsigned draft by

Dane Palmer, P.E., CFM
Hydraulic Engineer
Modeling and Documentation

Report reviewed by:

Unsigned draft by

Andrew Nelson, PG
Principal Geomorphologist
Geomorphic Assessment

Report reviewed by:

Unsigned draft by

Derek Stuart, PE
Principal
Overall QA/QC

NHC File Path: B:\2009051_Mill_Creek_at_South_Skagit_Highway_Phase_1\80_Documentation

REFERENCES

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DISCLAIMER

APPENDIX A

PROPOSED BRIDGE GEOMETRIES

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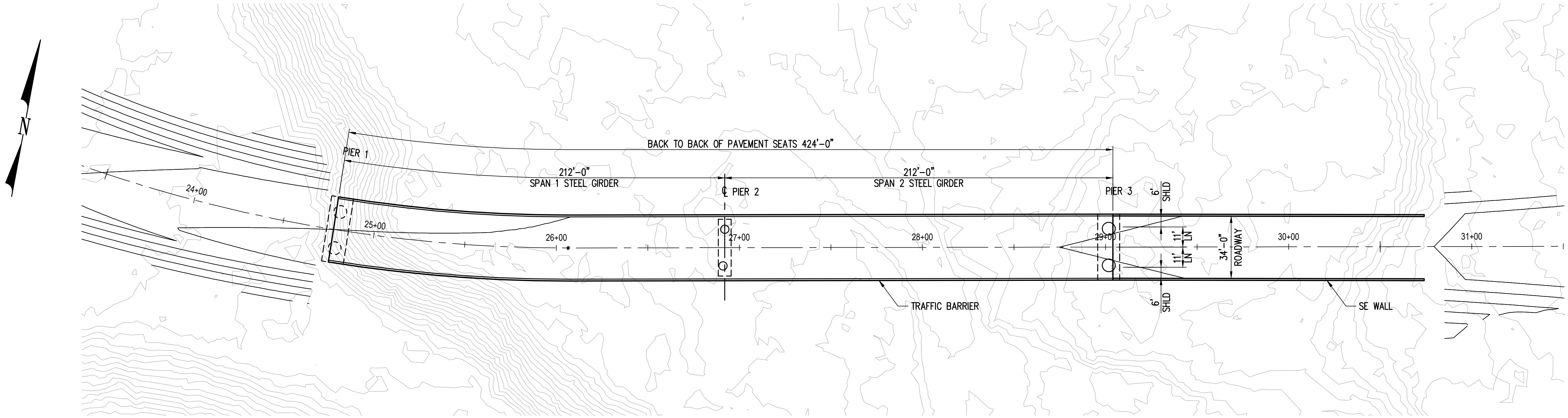

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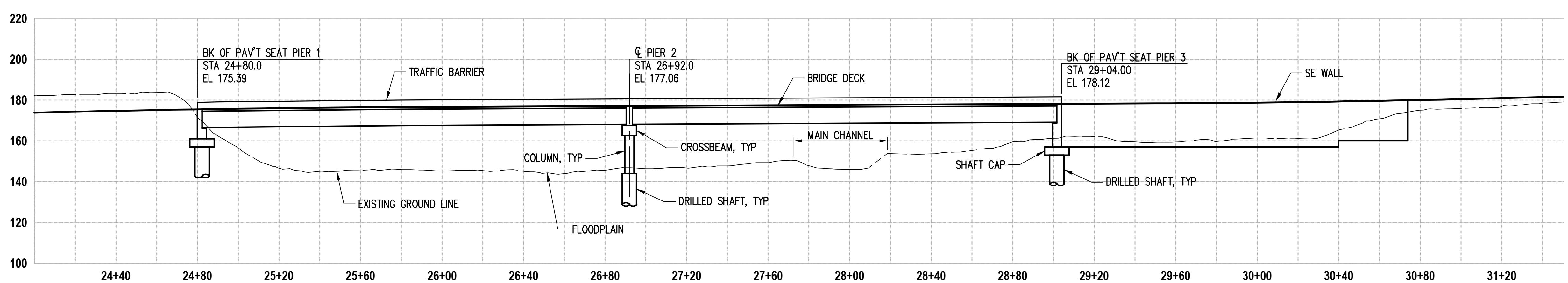

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NO.	DATE	BY	REVISION

MILL CREEK BRIDGE
--
MILL CREEK BRIDGE OPTION 4
TWO SPAN STEEL GIRDER BRIDGE
BRIDGE LAYOUT

DRAWN: HT	PROJECT NO.: 2400576
DESIGN: --	SCALE: AS SHOWN
CHECKED: --	DATE: --
DRAWING NO.	S01
SHEET NO.	- OF -

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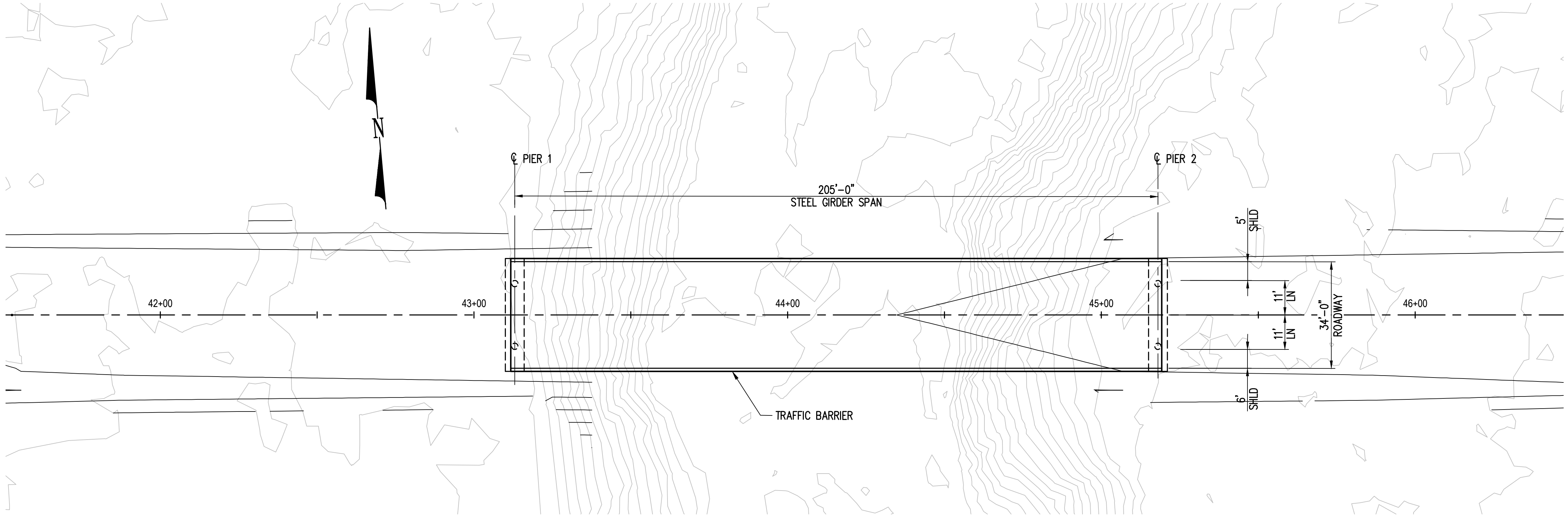

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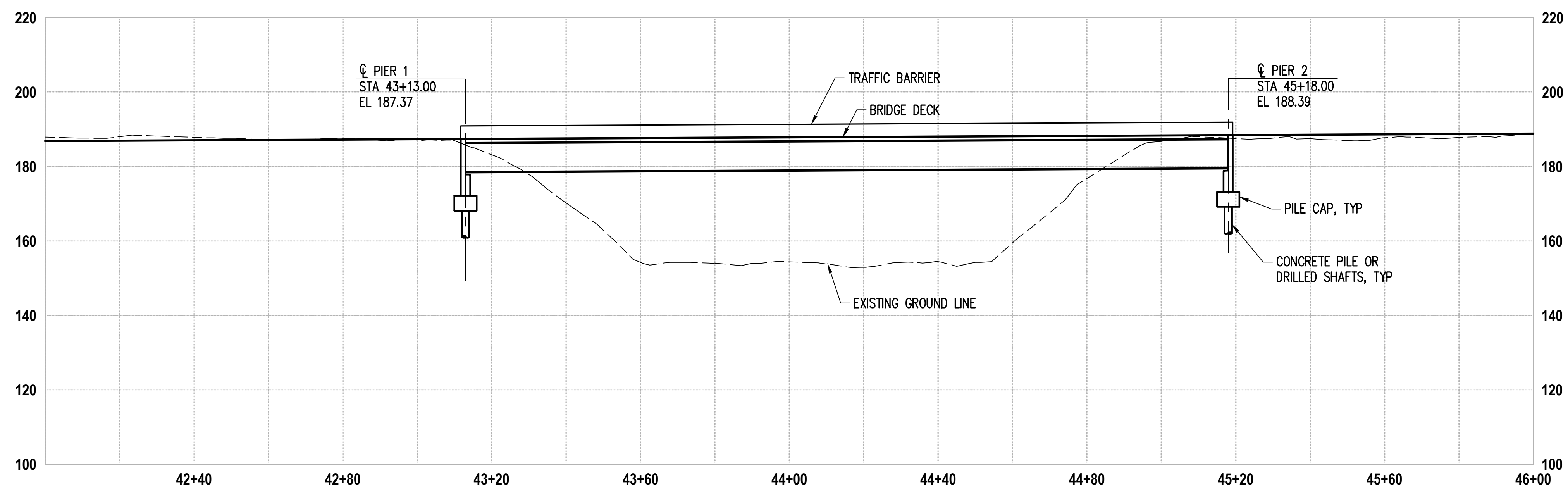

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NO.	DATE	BY	REVISION

SAVAGE CREEK BRIDGE

--

SAVAGE CREEK BRIDGE OPTION 5
SINGLE SPAN STEEL GIRDER BRIDGE
BRIDGE LAYOUT

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DESIGN: --	SCALE: AS SHOWN
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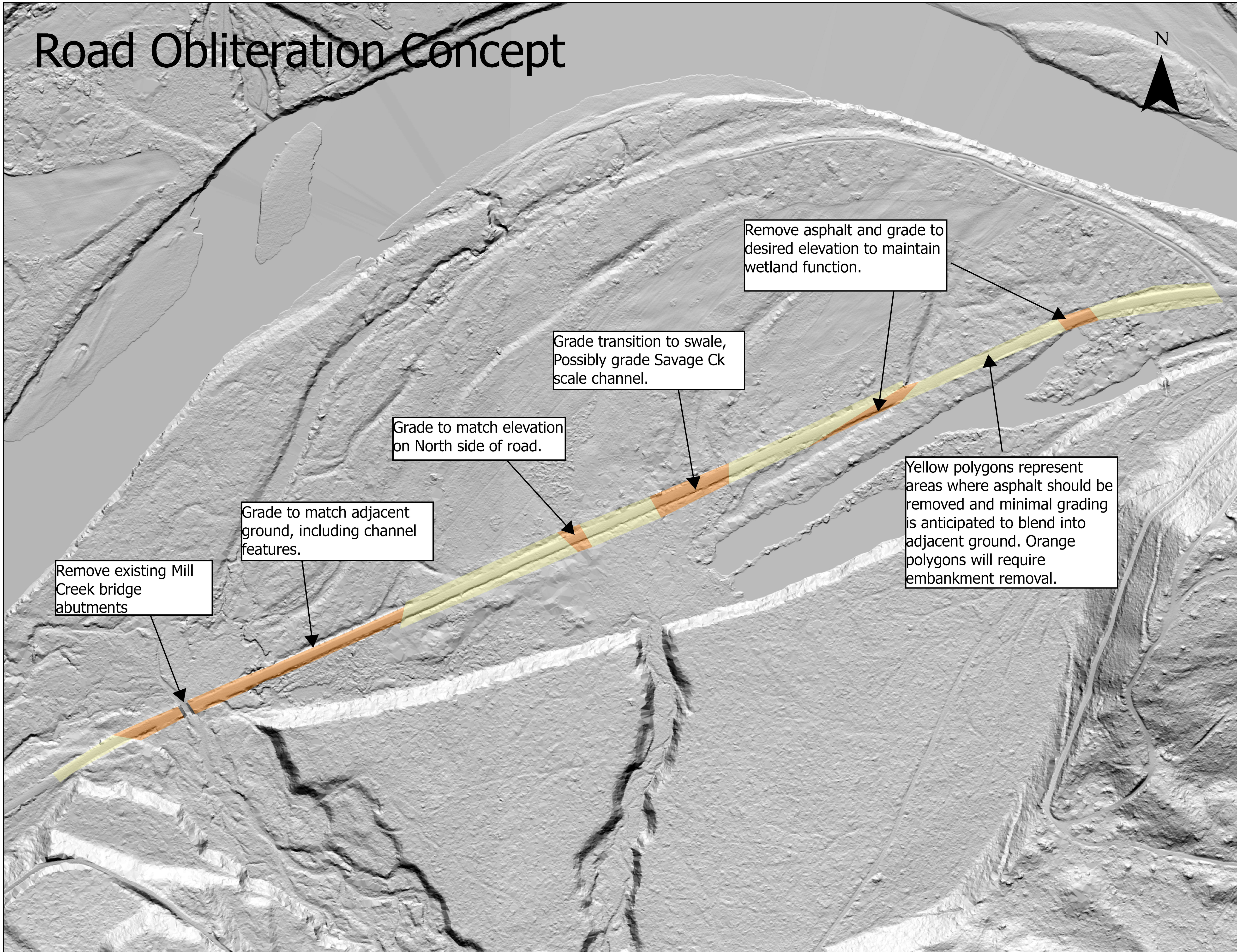
SHEET NO.	- OF -

APPENDIX B

CONCEPT DRAWINGS

Road Obliteration Concept



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nhc northwest hydraulic consultants

DATA SOURCES:

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Coordinate System: WGS 1984 WEB MERCATOR AUXILIARY SPHERE

Job: 2009051 | Date: 17-JAN-2025

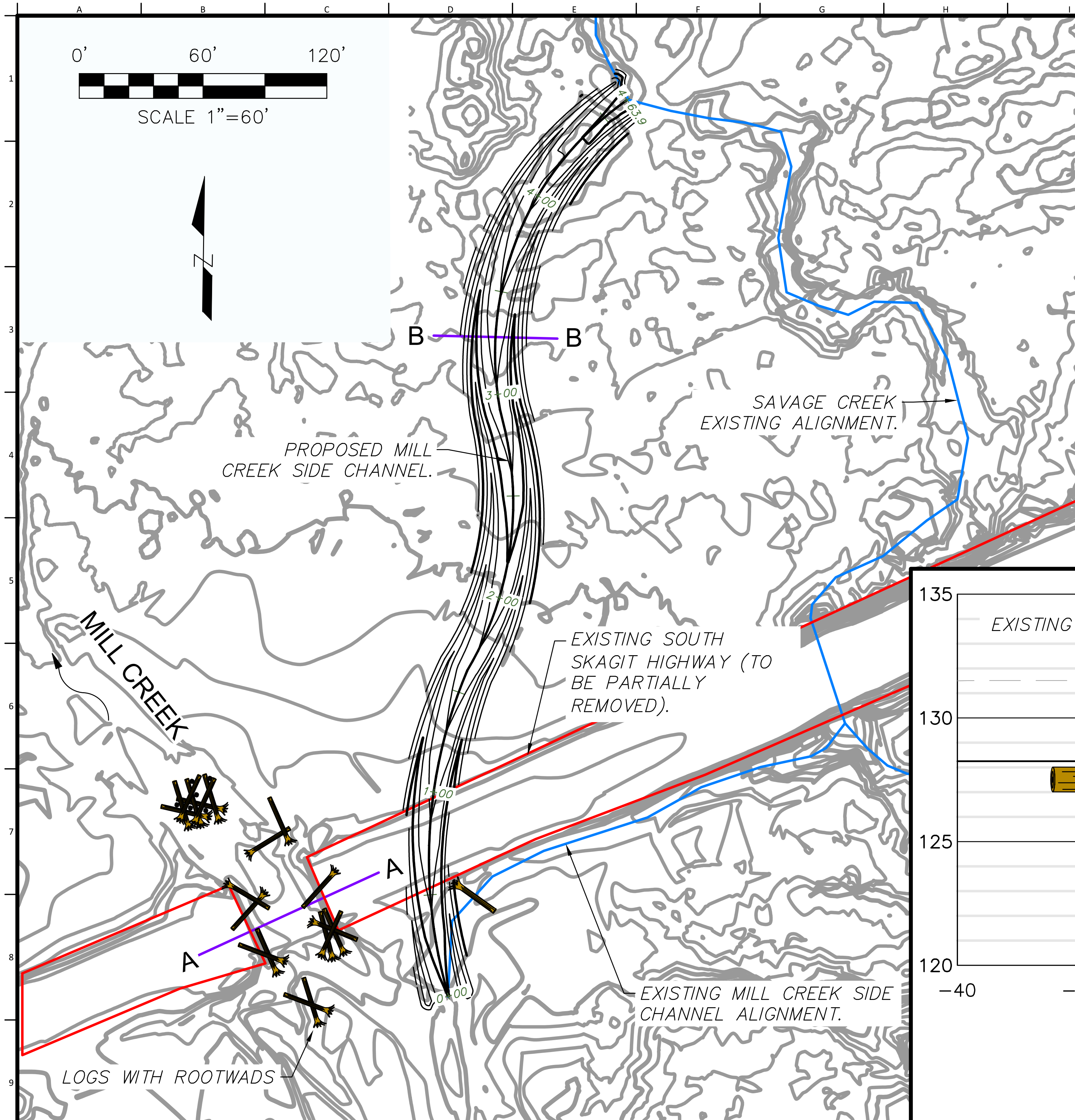
Mill Creek at South Skagit Highway Phase 1

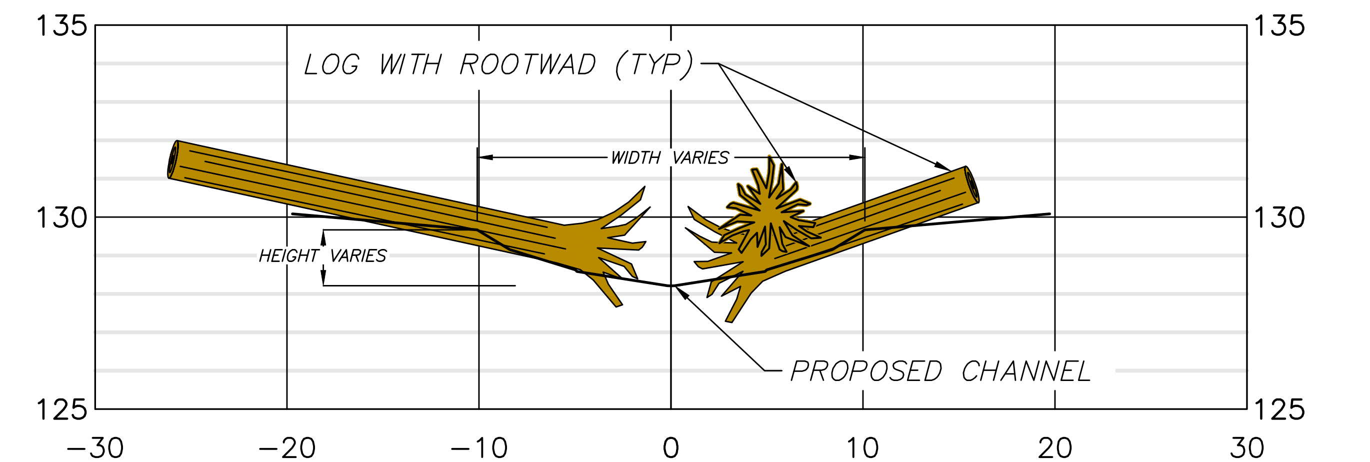
DRAFT

Road Obliteration Concept

FIGURE 4

ABC, Z:\2009051_Mill_Creek_at_South_Skagit_Highway_Phase_1\95_GIS\20250108_SavageCreekAlternatives.aprx





SECTION B-B: MILL CREEK SIDE CHANNEL TYP. SECTION

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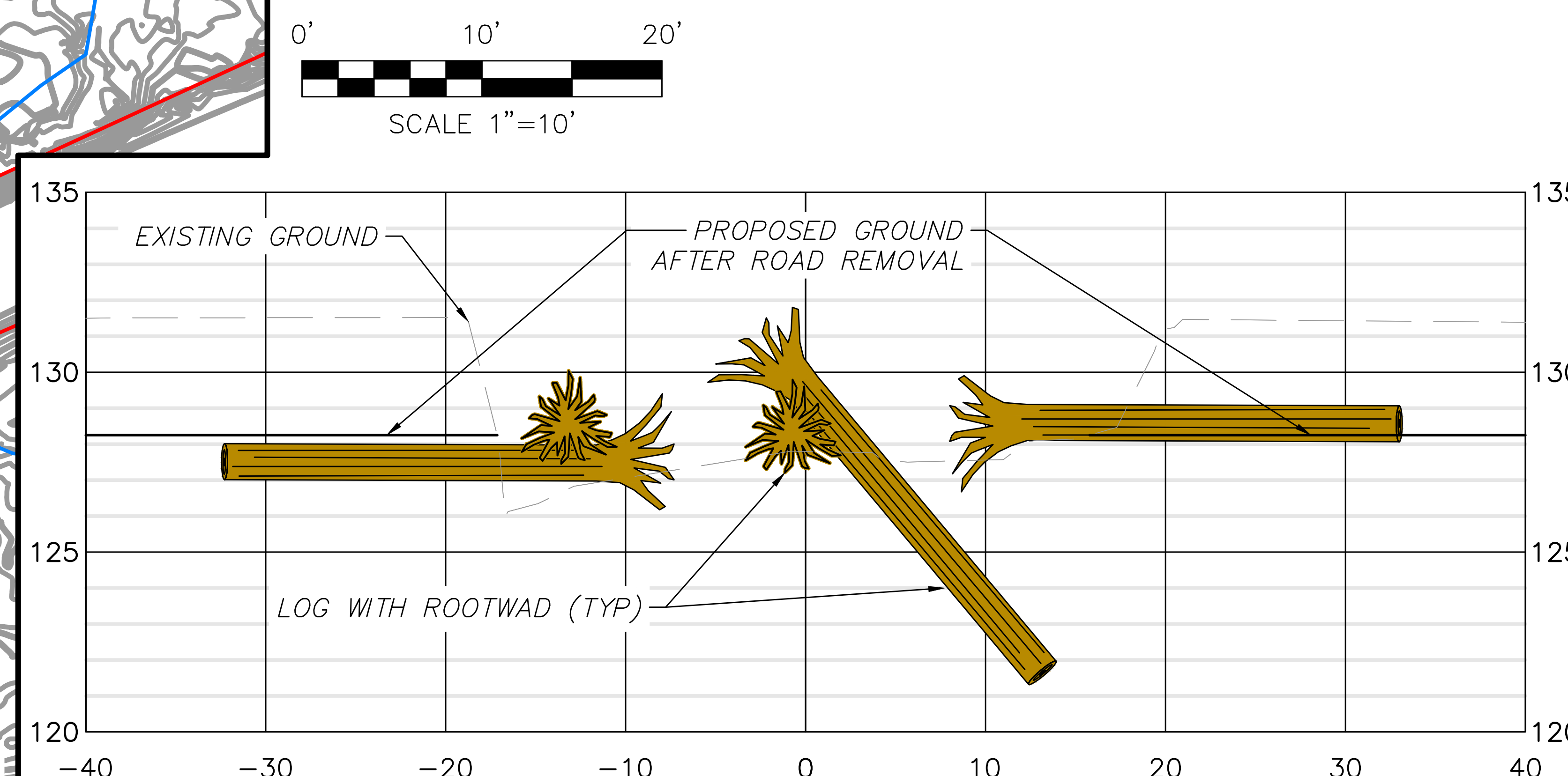

SECTION A-A: BRIDGE CROSSING TYP. SECTION

H: 1"=10' V: 1"=20'

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PRELIMINARY
NOT FOR CONSTRUCTION

Revisions		
No.	Date	Description

Drawing Information	
Date	24 February 2025 (08:49)
Status	PRELIMINARY
Designer	DSP
Drafter	ARW
Checked	DSP
File Name	Preliminary_Concepts_ARW
Plotted Scale	

MILL CREEK PHASE 1

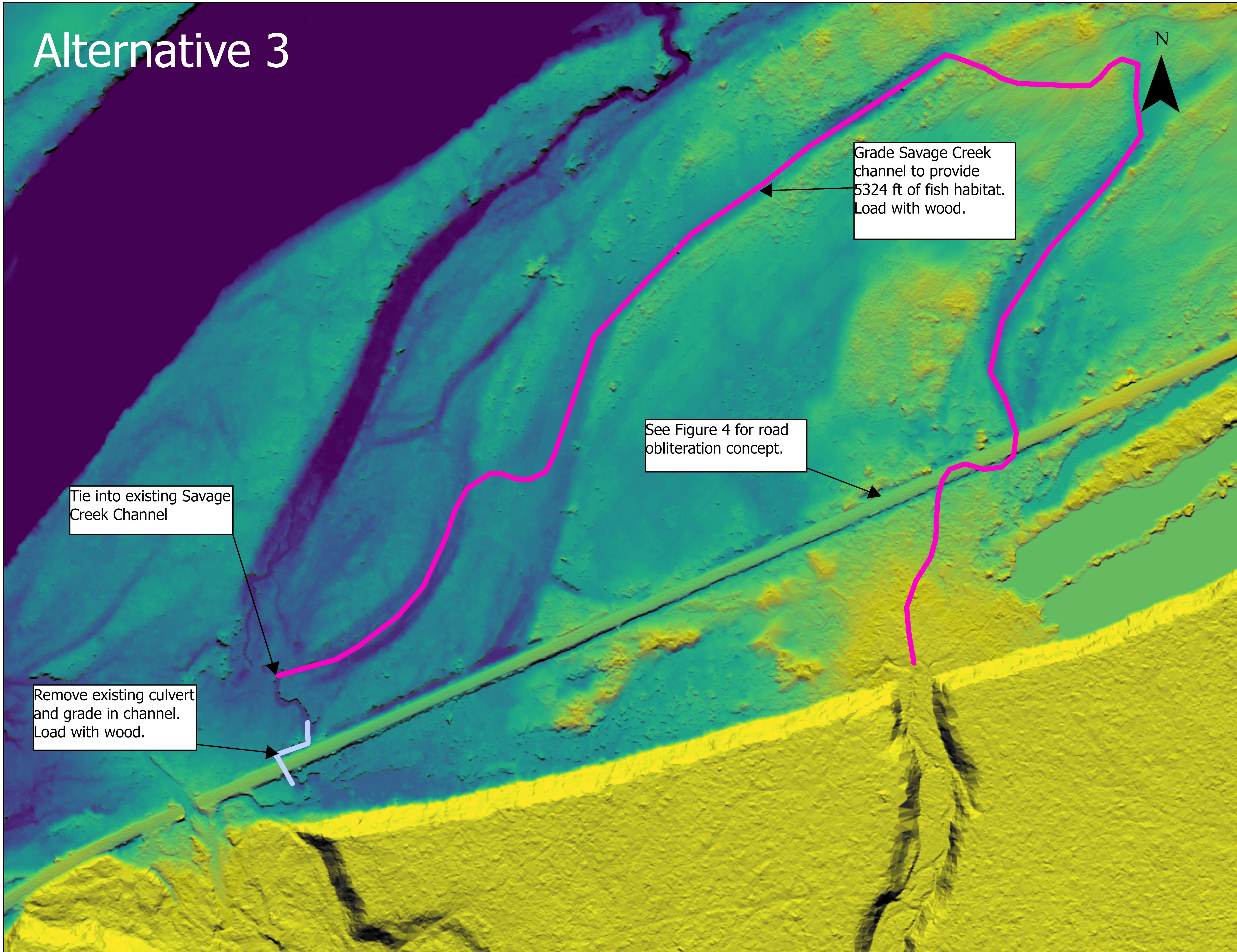
MILL CREEK PROPOSED LAYOUT

Job Number 2009051

Sheet Number

L1

Sheet 1 of 1



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northwest hydraulic consultants

LiDAR Elevations

Value

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DATA SOURCES:

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Feet

Coordinate System: WGS 1984 WEB MERCATOR AUXILIARY SPHERE

Job: 2009051	Date: 17-JAN-2025

Mill Creek at South Skagit Highway Phase 1

DRAFT

Savage Creek Grading, Alternative 3

FIGURE 3

ABC, Z:\2009051_Mill_Creek_at_South_Skagit_Highway_Phase_1\95_GIS\20250108_SavageCreekAlternatives.aprx

Aspect
A Geosyntec Company

DRAFT MEMORANDUM

Project No. AS240257

March 31, 2025

To: Anne Fabrello-Streufert, PE, SE, KPFF Consulting Engineers

From:

Henry N. Haselton, PE
Project Geotechnical Engineer
henry.n.haselton@aspectconsulting.com

Erik O. Andersen, PE
Senior Principal Geotechnical Engineer
erik.andersen@aspectconsulting.com

Re: **Mill Creek Phase 1 Geotechnical Engineering Memorandum**

Aspect Consulting (Aspect) is providing this geotechnical engineering memorandum to support the type, size, and location (TS&L) study of the Mill Creek Phase 1 project (Project) along the South Skagit Highway in Skagit County, Washington (Site). Our services were provided in support of engineering studies led by KPFF Consulting Engineers (KPFF) for the Skagit County Public Works Department (County) in accordance with our subconsultant agreement authorized on September 12, 2024.

Project Description

An approximately 1½ mile long stretch of the South Skagit Highway (roadway) extends across the lower Mill Creek and Savage Creek drainages near their confluences with the Skagit River. The elevated roadway grade with small culverts and a narrow bridge over Mill Creek has impacted flow from these creeks to historic wetlands on the Skagit River floodplain, resulting in degradation of the floodplain and aggradation of the creek beds and frequent flooding in the roadway. The objective of this Project is to restore wetland function along the Skagit River floodplain along this section of the South Skagit Highway, and reduce long-term flooding and associated maintenance requirements.

The Project aims to design and construct a new roadway alignment that extends across the upland alluvial terrace, above the 100-year flood elevation. The key features of the new roadway alignment as related to our geotechnical work include:

- A new multi-span steel girder bridge over Mill Creek that will consist of either two or three spans with approximate total lengths of 420 and 610 feet, respectively. The two-span alternative includes filling an approximately 170-foot-long portion of the Mill Creek ravine with up to 20 feet of fill.
- A new single-span steel girder bridge over Savage Creek with an approximate length of 175 feet.
- Associated bridge approach and abutment walls that may include structural earth walls (SEWs).
- Roadway cut/fill, most significantly on the slopes near the tie-in points to the existing roadway, including a permanent cut wall on the western side of the alignment between proposed roadway stations 18+00 to 19+50 with exposed heights on the order of 15 to 20 feet.
- Stormwater management including potential for infiltration of stormwater.
- Clearing, grading, and roadway subgrade preparation in the currently undeveloped areas of the roadway alignment.

Design of the Project will generally follow Washington State Department of Transportation (WSDOT) and American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor (LRFD) methodologies. We anticipate construction will be in accordance with the most current edition of the WSDOT Standard Specifications and Skagit County Road Standards.

Site Conditions

We reviewed available geologic maps, aerial and light detection and ranging (LiDAR) imagery, topographic maps, and other information provided by KPFF and the County. The following sections describe the surface conditions observed during the Site reconnaissance, topography, geologic setting and local seismic conditions, and the subsurface conditions encountered in our explorations completed for our previous study for the Project (Aspect, 2015).

We completed a Site reconnaissance with the design team, County, and other key stakeholders and landowners on February 27, 2025.

Surface Conditions

The majority of the proposed roadway alignment traverses across a relatively flat, alluvial terrace elevated above the existing roadway by about 20 to 35 feet. The alluvial terrace is primarily undeveloped second-growth forest with little understory vegetation. Along the eastern portion of the alignment, east of Savage Creek, the proposed alignment follows a gravel logging road (Photograph 1).

Photograph 1. *Proposed roadway alignment along the eastern portion is a gravel logging road.*

Notable locations along the proposed alignment include the two ends where the existing and proposed roadways meet (tie in points), and the crossings of Mill and Savage Creek. These areas are described briefly below with photographs from our Site reconnaissance on February 27, 2025.

Western Tie In

The proposed roadway will ascend an approximately 35-foot-tall slope that is currently inclined at about 1.3H:1V (horizontal to vertical) and heavily vegetated. We understand this will require a 150-foot-long cut wall with exposed heights on the order of 15 to 20 feet.

Photograph 2. *Slope above existing roadway at proposed Western Tie-In Location (view to the south).*

Mill Creek Crossing

At the proposed crossing of Mill Creek, the west side of the creek bank is about 35 feet tall and inclined at about 1.2 to 1.3H:1V. The eastern bank, that the two-span bridge alternative proposes to fill in, is more gradually inclined and undulating.

***Photograph 3**. Mill Creek, standing near the proposed location of the western bridge abutment (view to the northeast).*

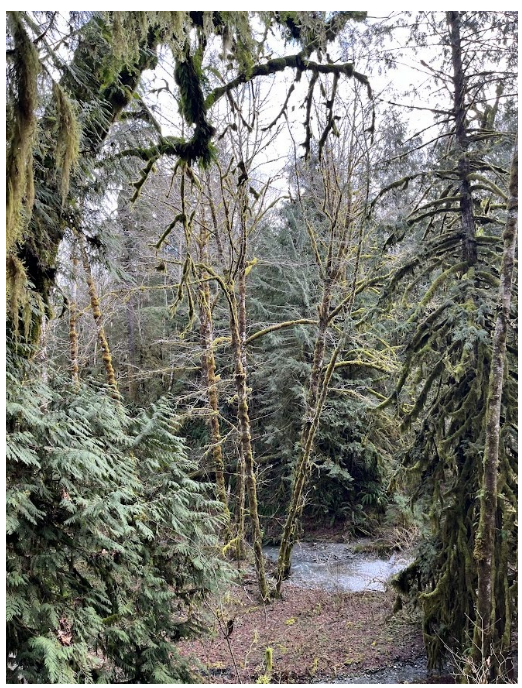
***Photograph 4**. Mill Creek ravine, eastern extent of fill area for two-span alternative or near proposed bridge abutment for three-span alternative (view to the west).*

Savage Creek Crossing

At the proposed crossing of Savage Creek, the creek banks are about 30 feet tall on both sides and relatively steep with inclinations ranging from about 1.2 to 1.5H:1V.

Photograph 5. *Savage Creek eastern bank near the proposed bridge location (view to the west).*

Photograph 6. *Savage Creek western bank near the proposed bridge location (view to the west).*



Photograph 7. *Savage Creek standing near the proposed location of the western bridge abutment (view to the east).*

Eastern Tie In

The proposed roadway follows an existing private/logging gravel road near the eastern tie in point, which is below two landslide features (see in-text Figure 1). We understand that the western of the two is from past logging operations using the area as a borrow pit (Photograph 8). These features are discussed further in the *Slope Stability* Section.

Photograph 8. *Aerial view of the old borrow pit landslide feature (view to the south, photograph provided by Skagit County).*

Site Geology

The geologic map of the area (Tabor et al., 2003) shows the proposed alignment is underlain by alluvium. This material was deposited by the Skagit River in a terrace about 75 feet above the current level of the Skagit River floodplain. South of the alignment is another terrace that is an additional 100 feet higher in elevation and mapped as glacial recessional outwash. Post glacial (Holocene) incision and meander of the Skagit River and its tributary drainages have eroded this glacial outwash terrace and created a series of successively lower terraces of recent alluvium that step down to the north into the modern river channel. Meander of the Skagit River also created a number of now abandoned incised flood channels, many of which are now the wetlands adjacent to the highway.

Based on our observations of deposits exposed at the site, regional geologic mapping, and subsurface conditions encountered in the borings from previous studies (Aspect, 2015), we anticipate that deposits at the Site will generally consist (from generally older to younger) of the following:

- **Recessional Glacial Outwash –** Chiefly medium dense sand and gravel with variable silt content. Expected to have low compressibility, moderate shear strength, and high permeability. This unit contains cobbles and boulders. This unit is not expected to be encountered at the surface along the alignment but is relevant due to its presence above the road alignment and possibly at depth for bridge foundations and cut retaining walls.

- **Alluvium** – Alluvium occurs in two settings at the Site – in the older terraces deposited by the Skagit River (that now lie well above modern river level), and within the modern drainage channels of Mill and Savage Creeks where these creeks have eroded through these older Skagit River terraces. Within these two settings, alluvium is divided into two principal types: channel deposits and overbank floodplain deposits. Overbank floodplain sediments were deposited in low-energy backwater environments and consist of soft/loose silt and fine sand. Channel alluvium was deposited in high-energy environments in the Skagit River and modern channels of Mill and Savage Creeks. Channel bed alluvium consists of loose grading to medium dense to dense sand and gravel with cobbles and boulders.

  The channel deposits are anticipated to have low compressibility and possess moderate to high shear strength. The overbank floodplain deposits are anticipated to be moderately compressible, possess low to moderate shear strength, and may contain interbeds of weak silt and clay and potentially highly compressible organic rich soils. Buried logs and wood debris may be present in both channel and overbank deposits.
- **Wetland Deposits** – Wetlands in the vicinity of the existing highway may contain deposits with high fines and organics content. These soils are expected to be compressible, and to possess low to very low shear strength, and low permeability.
- **Topsoil –** Topsoil is present in most forested areas of the site. Topsoil thickness is estimated to be on the order of up to several feet deep. Topsoil is compressible and weak.
- **Landslide Deposits** – Although not indicated on the regional geologic map, a deep-seated landslide was observed near the eastern end of the site alignment (Photograph 9, below). The landslide deposits are expected to consist of unsorted sand and gravel deposits with variable silt content that has slid from the steep slope of the glacial outwash terrace. Landslide deposits are anticipated to be loose and possess low shear strength.

Subsurface Conditions

As part of a past study for the Project (Aspect, 2015), we completed three borings at the approximate locations shown on Figure 2. The locations of the borings were selected based upon previously considered roadway alignments (different than the current proposed alignment) and where access was feasible. Borings B-2 and B-3 were each drilled to 21.5 feet below ground surface (bgs) using hollow stem auger. Boring B-1 (next to Mill Creek) was drilled using hollow stem auger for the first 25 feet and then it was completed to 51.5 feet bgs using rotary wash methods. Disturbed samples were obtained from all three borings at 5-foot intervals in each of the borings using non-standard penetration test (NSPT) methods.

The three borings encountered topsoil, and alluvium which can be subdivided into two units: coarse-grained channel deposits, and fine-grained floodplain overbank deposits. Boring B-1, located on the east side of Mill Creek, encountered alluvium extending to the bottom of the boring at a depth of 51.5 feet bgs. Alluvium in B-1 was interpreted as a channel bed deposit. It included sandy gravel (GW and GP), slightly silty gravelly sand (SM-SW), slightly silty sandy gravel (GM-GP), and silty sandy gravel (GM). Broken coarse gravel in the sampler indicate that cobbles were present in this deposit. Groundwater was encountered in B-1 at about 10 feet bgs, which corresponds to approximately the level of surface water in nearby Mill Creek. Soil densities ranged from very loose in the upper approximately 5 feet, grading medium dense to the bottom of the borehole, with interbeds of dense to very dense strata.

Boring B-2, located on an alluvial terrace near the western end of the alignment, encountered alluvial channel bed deposits from the ground surface to the bottom of the borehole at 21.5 feet bgs. Soils in this borehole consisted of medium dense, slightly silty sand gravel (GM-GW). A several-inch-thick bed of clayey silt was encountered at the 6-foot depth. Groundwater was not encountered.

Boring B-3, located on an alluvial terrace near the eastern end of the alignment, encountered recent alluvium consisting of interbedded channel bed deposits and floodplain overbank deposits. The upper approximately eight feet was interpreted to be channel bed alluvium and consisted of medium dense, slightly moist, slightly silty gravelly sand (SM-SW). Broken coarse gravel suggests that cobbles were present in this deposit. From about 8 to 18 feet bgs, a bed of floodplain overbank deposits was encountered. This was composed of soft grading to medium stiff, moist, slightly sandy silt (ML). Below 18 feet, channel deposits resumed with a layer of medium dense, moist sand (SP). Groundwater was not encountered in this boring.

Boulders and cobbles were not directly observed in the channel bed samples, but our observations of site conditions and understanding of the site setting suggest that they may be present in these deposits. Logs and wood and organic deposits may also be present, particularly in the floodplain deposits.

Geologic Hazards

The Skagit County Potential Landslide and Erosion Areas hazard mapping (County, 2024) maps the existing crossing of Mill Creek and the South Skagit Highway as an alluvial fan and also maps the slopes on the far ends of the proposed alignment as being 15 to 40 percent with areas noted as having an erosion hazard. A preliminary assessment of the relevant geologic hazards to the Site/Project is below.

Seismic Hazards

The Site is located within an area of active seismicity that is subject to earthquakes on shallow crustal faults and deeper subduction zone earthquakes. The Site is in the vicinity of several active faults as summarized below:

- About 14 miles south-southwest of the Site is the Darrington-Devils Mountain fault zone, which consists of shallow crustal tectonic structures that are considered active (evidence for movement within the Holocene [since about 15,000 years ago]; Johnson et al., 2016a). The recurrence interval of earthquakes on this fault zone is believed to be on the order of 6,000 years or more. There are also several other shallow crustal faults in the region capable of producing earthquakes and strong ground shaking.

- About 40 miles southwest of the Site is the southern Whidbey Island fault zone (SWIFZ). This broad, northwest-trending fault zone represents the boundary between two major crustal blocks: the basaltic Crescent Formation to the southwest, and pre-Tertiary bedrock of various compositions to the northwest. Evidence for rupture along the Southern Whidbey Island Fault Zone includes several meters of offset, and the fault is considered active (evidence for movement within the Holocene [since about 15,000 years ago]; Johnson et al., 2016b). This fault is considered capable of producing an earthquake with a magnitude of 7.0 or greater. The recurrence interval is hypothesized to be on the order of 1,000 to 3,000 years. The most recent large earthquake on the SWIFZ occurred about 3,200 to 2,800 years ago. There are also several other shallow crustal faults in the region capable of producing earthquakes and strong ground shaking.

- The Site also lies within the zone of strong ground shaking from earthquakes associated with the Cascadia Subduction Zone (CSZ). Subduction-zone earthquakes occur due to rupture between the subducting oceanic plate and the overlying continental plate. The CSZ can produce earthquakes up to magnitude 9.3, and the recurrence interval is thought to be on the order of about 500 years. A recent study estimates the most recent subduction zone earthquake occurred on January 26, 1700 (Atwater et al., 2015).

Deep intraslab earthquakes that occur from tensional rupture of the sinking oceanic plate are also associated with the CSZ. An example of this type of seismicity is the 2001 Nisqually earthquake. Deep intraslab earthquakes typically are magnitude 7.5 or less and occur approximately every 10 to 30 years.

The new bridges and retaining walls will need consider seismic loading and its associated effects. We will provide the appropriate seismic design parameters as the Project design progresses and additional subsurface data is collected. Our preliminary assessment of relevant seismic hazards is discussed below.

Liquefaction

The Washington Department of Natural Resources (DNR) maps the proposed alignment and creek crossing locations area as having moderate to high liquefaction susceptibility (DNR, 2007). Based upon our limited subsurface data previously collected near Mill Creek (B-1), the liquefaction hazard may be less severe than indicated from DNR mapping. This will need to be confirmed with additional explorations near the proposed bridge foundation locations at both creek crossings.

Fault Rupture

Due to the suspected long recurrence interval and distance of active faults to the Site (see section above), the risk of surficial ground rupture is considered be low and does not need to be considered for design.

Slope Stability

Three types of landslides are common on steep slopes in the region: topples, deep-seated rotational slides, and shallow flows (Varnes, 1978). Landslides may be triggered by natural causes, such as precipitation, freeze-thaw cycles, adjacent river/creek channel migration, or a seismic event, or be man-made (e.g., broken water pipes, construction activity, changes to topography, etc.).

On the east end of the proposed alignment there are two notable landslide features within the alluvium/recessional outwash bluffs that are elevated above the existing roadway and proposed alignment (see in-text Figure 1). From conversations with the County and landowners, we understand that the western of the two features was previously used by logging operations as a borrow pit and thus is not the result of natural slope instability (Photograph 8). We anticipate this over-steepened old borrow pit will continue to experience small topple type failures and erosion that will deposit material at the base of the slope. In our opinion, this slope will not adversely affect or be affected by the proposed roadway alignment as it is sufficiently far (about 100 feet) from the toe of the slope.

The larger, eastern feature is a natural deep-seated landslide (Photograph 9, below). We are not aware of when this occurred, but based upon the size of the landslide mass, vegetation within the slide debris, and condition of the roadway below, we hypothesize that it is older and dormant. The lower approximate three-quarters of this slope is covered with colluvium standing at its natural angle of repose, and the upper approximately one-quarter of the slope is near-vertical.

The proposed roadway alignment will be located at a similar distance as the existing roadway from the toe of the slope and thus will have a similar risk. During periods of heavy precipitation, it is possible that debris may come loose from this steep slope and impact the roadway. In our opinion, the risk of this is relatively low given (a) the lower portion of the slope is covered with vegetation, and (b) the proposed offset of the new roadway from the toe of the slope of about 15 to 20 feet. This could be addressed if/when it occurs as a maintenance item or if it continues to occur, some ecology blocks could be placed at the base of the slope similar to other areas along the South Skagit Highway. During extreme precipitation events or during a seismic event, it is possible that this deep-seated landslide could re-activate and affect the roadway; however, in our opinion it would be impractical to design for this.

To ensure the Project does not destabilize these slopes, we recommend the eastern tie-in be designed such that there are not cuts into the base of this slope.

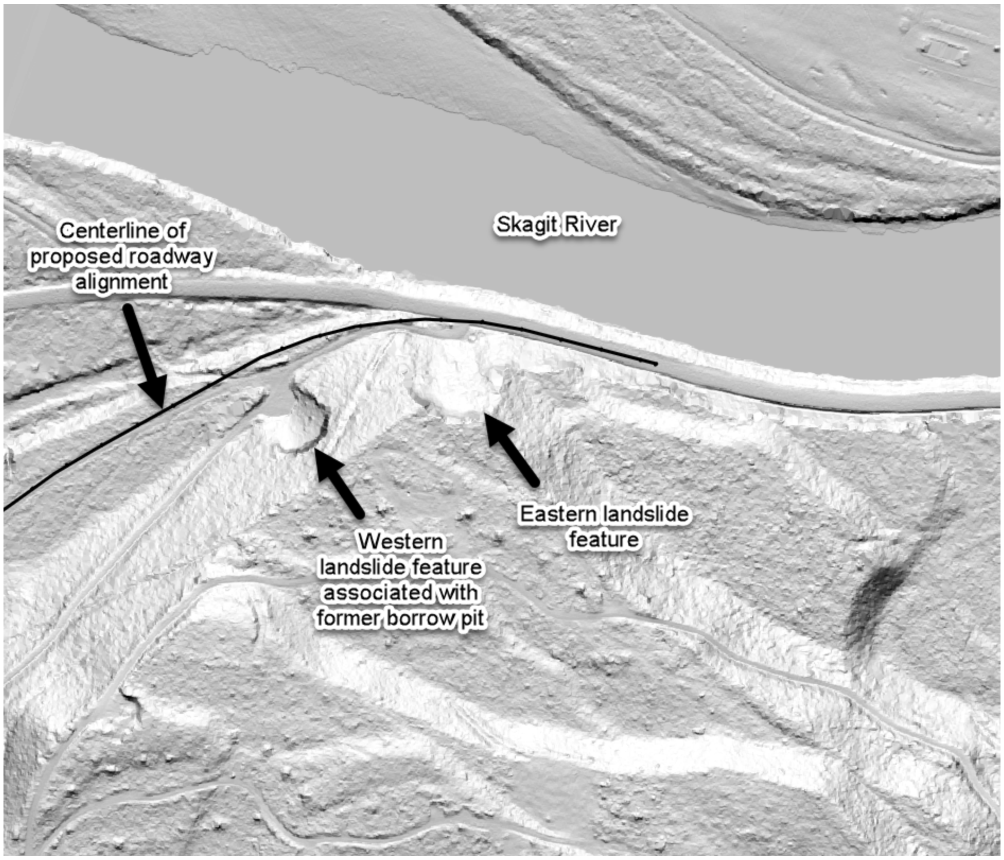


Figure 1*. LiDAR imagery of landslide features on the eastern side of the Site (north up).*

Photograph 9. *Landslide feature above existing and proposed roadway (view to the southwest).*

Erosion Hazard

In our opinion, the subsurface soils have a moderate erosion potential due to the fines content (soil particles passing the No. 200 sieve, like silt and clay) when exposed during construction. The erosion risk increases on sloped areas. During construction, the erosion hazard should be managed through standard temporary erosion and sedimentation control (TESC) and best management practices (BMPs).

Preliminary Engineering Conclusions

The soils conditions at the Site are generally favorable for new road and bridge construction along the proposed alignment. General and preliminary geotechnical engineering conclusions for bridge foundations, approaches, walls, stormwater infiltration, and site earthwork, are presented in the following paragraphs.

- **Bridge Foundations** – The saturated sandy gravel alluvium encountered in B-1 has medium dense zones above 25 feet bgs that are susceptible to liquefaction during an extreme (design-level) earthquake. New bridge foundations will need to penetrate liquefiable soils and extend a sufficient distance into the underlying more competent and non-liquefiable alluvium. For the single-span bridge over Savage Creek, we conclude that heavy-walled open- or closed-ended steel pipe piles are a potentially suitable deep foundation type. For planning purposes, 24-inch diameter, ½-inch wall thickness, steel pipe piles, may be considered feasible. For the multi-span bridge over Mill Creek, 4 to 6-foot diameter, cast-in-place concrete drilled shafts, are likely suitable. Depending upon construction staging and mobilization, it may be beneficial to use the same foundation type at both bridges, in which case we recommend drilled shafts be assumed. Driven pile and drilled shaft foundation embedment depths on the order of 60 feet should be considered for preliminary purposes. More detailed geotechnical explorations are required to further explore and evaluate bridge-pier-specific subsurface conditions, liquefaction hazard, depth to suitable bearing soils, and to perform design-level geotechnical and structural engineering evaluations for the new bridges.
- **Bridge Approaches** – Depending on the crossing (Mill or Savage Creek) and location, approach embankments of varying thickness are anticipated. Where cantilevered bridge approaches and abutments are too tall to be designed as cantilevered walls, mechanically stabilized earth (MSE)/structural earth wall (SEW) approach embankments/walls can be used. MSE/SEWs should be protected against scour either via appropriately sized rip-rap, concrete facing extending below the scour elevation, or other methods determined by the design team. For permanent slopes below bridge abutments and walls, we recommend planning for a maximum slope inclination of 2H:1V. Permanent slopes inclined as steep as 1.5H:1V may be feasible where they are not directly supporting structures and protected from erosion and scour. For the Mill Creek two-span bridge alternative, up to about 20 feet of fill will be required. This fill may be sloped with side slopes as steep as 2H:1V or alternatively, SEWs could be used to limit the footprint of the approach fill.
- **Cut Retaining Walls –** A permanent cut wall is proposed on the western roadway alignment that will be about 150 feet long with exposed heights on the order of 15 to 20 feet. For permanent walls up to 20 feet tall, anchored/tied-back drilled soldier piles and lagging are recommended. Soil nail walls can be evaluated as a cheaper option with

targeted subsurface explorations. Cantilevered drilled soldier piles and lagging may be feasible for permanent cut walls with exposed heights on the order of 10 to 15 feet. Lower cut walls can be designed and constructed using cast-in-place concrete cantilever, gravity blocks, and MSE (if temporary excavations are allowed).

- **Fill Retaining Walls -** Fill retaining walls can be designed and constructed using MSE systems. A variety of wall fascia options are suitable including sculpted shotcrete, pre-cast concrete panels/blocks, and rock-filled wire gabions. Aesthetic or other non-geotechnical considerations may drive the required wall fascia. Additional subsurface data at targeted wall locations is required to determine feasible wall types and design parameters.
- **Stormwater Infiltration Feasibility –** The proposed alignment is underlain by alluvium and elevated above the Skagit River floodplain. Thus, we expect the soils will be feasible for infiltration of stormwater and there will be sufficient separation from the base of infiltration facilities to seasonal high groundwater and/or bedrock or impermeable layers. One boring (B-3) did encounter low-energy floodplain overbank soil consisting of soft to medium stiff sandy silt which will have a lower infiltration rate in comparison to more granular (sand and gravel) alluvium. More detailed explorations and testing is required to evaluate feasible infiltration rates and BMPs.
- **General Earthwork Considerations –** Construction of the new bridge approaches and tie-in points to the existing roadway will involve significant earthwork. In general, much of the existing alluvium along the Project alignment appears suitable for re-use as structural fill. Permanent cut and fill slopes should be planned at 2H:1V. One boring (B-3) encountered low-energy floodplain overbank soil consisting of soft to medium stiff sandy silt. These fine-grained soils are moisture sensitive and will be difficult to place and compact if they are exposed to rainfall and become wet of optimum. To that point, site earthwork should generally occur during the relatively dry season, from late spring through early fall.

References

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Limitations

Work for this project was performed for KPFF Consulting Engineers (Client), and this report was prepared consistent with recognized standards of professionals in the same locality and involving similar conditions, at the time the work was performed. No other warranty, expressed or implied, is made by Aspect Consulting (Aspect).

Recommendations presented herein are based on our interpretation of site conditions, geotechnical engineering calculations, and judgment in accordance with our mutually agreed-upon scope of work. Our recommendations are unique and specific to the project, site, and Client. Application of this report for any purpose other than the project should be done only after consultation with Aspect.

Variations may exist between the soil and groundwater conditions reported and those actually underlying the site. The nature and extent of such soil variations may change over time and may not be evident before construction begins. If any soil conditions are encountered at the site that are different from those described in this report, Aspect should be notified immediately to review the applicability of our recommendations.

Risks are inherent with any site involving slopes and no recommendations, geologic analysis, or engineering design can assure slope stability. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the client.

It is the Client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, and agents, are made aware of this report in its entirety. At the time of this report, design plans and construction methods have not been finalized, and the recommendations presented herein are based on preliminary project information. If project developments result in changes from the preliminary project information, Aspect should be contacted to determine if our recommendations contained in this report should be revised and/or expanded upon.

The scope of work does not include services related to construction safety precautions. Site safety is typically the responsibility of the contractor, and our recommendations are not intended to direct the contractor's site safety methods, techniques, sequences, or procedures. The scope of our work also does not include the assessment of environmental characteristics, particularly those involving potentially hazardous substances in soil or groundwater.

All reports prepared by Aspect for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect. Aspect's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

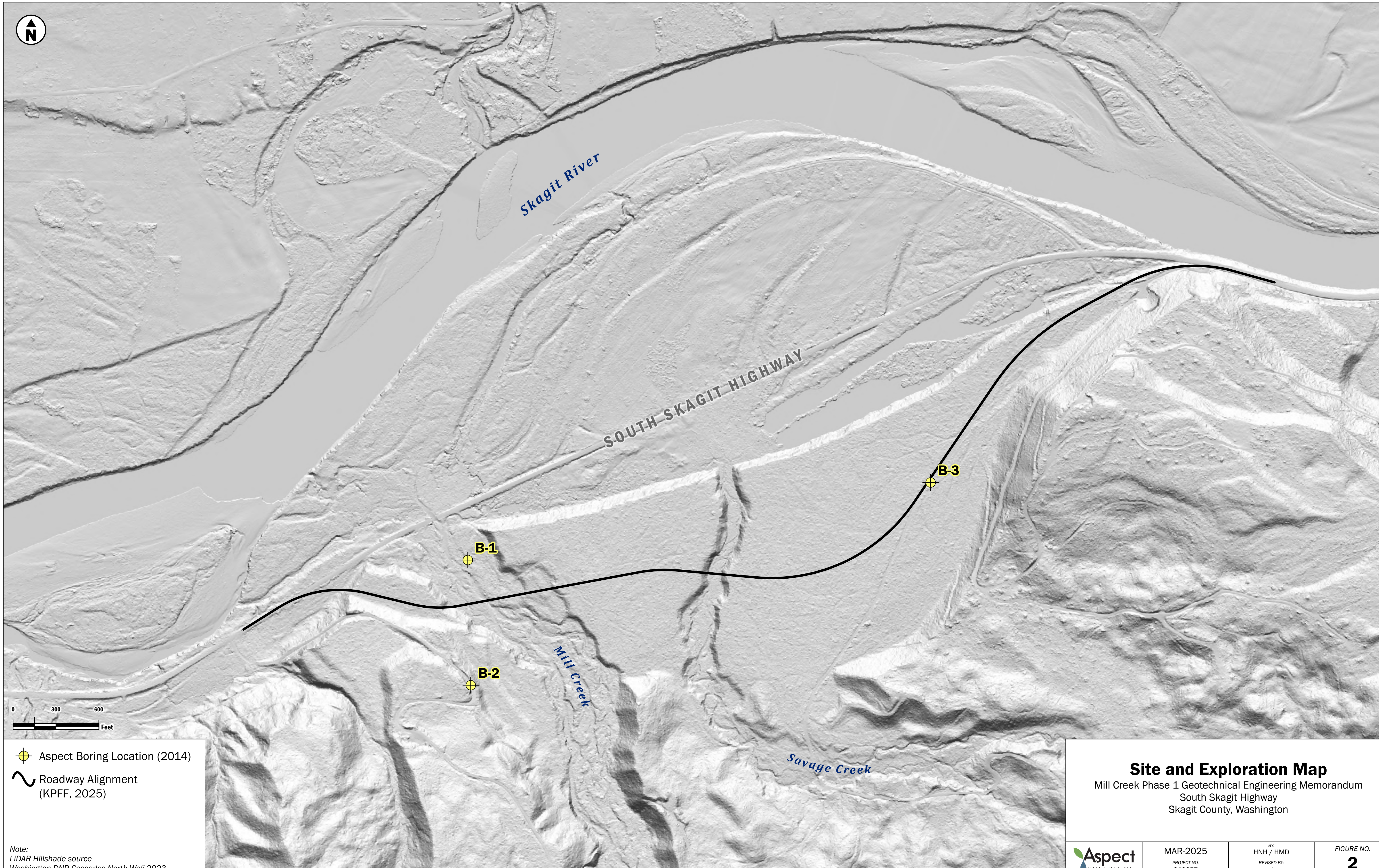
Please refer to Appendix B titled "Report Limitations and Guidelines for Use" for additional information governing the use of this report.

We appreciate the opportunity to perform these services. If you have any questions please call Henry N. Haselton, PE, Project Geotechnical Engineer, at 360.483.0664, or Erik O. Andersen, PE, Senior Principal Geotechnical Engineer, at 360.746.8964.

Attachments: Figure 2 – Site and Exploration Map
Appendix A – Previous Subsurface Exploration Logs
Appendix B – Report Limitations and Guidelines for Use

V:\240257 MILL CREEK AT SOUTH SKAGIT HIGHWAY\Geotechnical Memorandum\Mill Creek Phase 1 Draft Geotechnical Engineering Memorandum_20250331.docx

FIGURE



Site and Exploration Map

Mill Creek Phase 1 Geotechnical Engineering Memorandum
South Skagit Highway
Skagit County, Washington

Aspect CONSULTING	MAR-2025	BY: HNH / HMD	FIGURE NO.
	PROJECT NO. 240257	REVISED BY: - - - / - - -	2

APPENDIX A

Previous Subsurface Exploration Logs

Coarse-Grained Soils - More than 50% [1] Retained on No. 200 Sieve	Gravels - More than 50% [1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines [5]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥15% Fines [5]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50% [1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines [5]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥15% Fines [5]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50% [1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT [2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT [2] blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

FC = Fines Content
G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Consolidation
DD = Dry Density
K = Permeability
Str = Shear Strength
Env = Environmental
PiD = Photoionization Detector

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

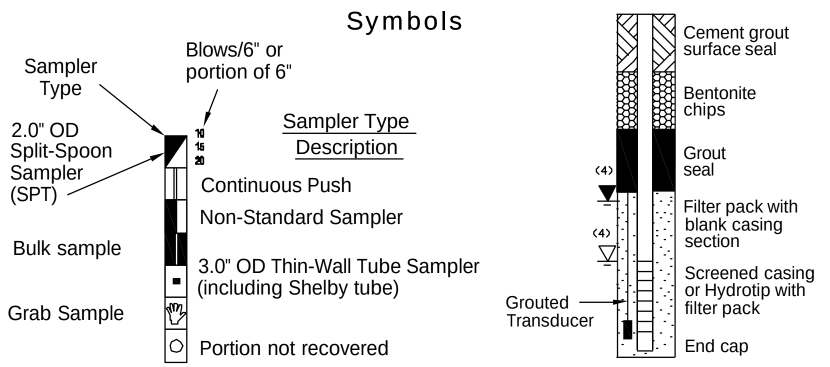
(3) Estimated Percentage

Percentage by Weight	Modifier
<5	Trace
5 to 15	Slightly (sandy, silty, clayey, gravelly)
15 to 30	Sandy, silty, clayey, gravelly)
30 to 49	Very (sandy, silty, clayey, gravelly)

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols



(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of groundwater
▽ ATD = At time of drilling
▼ Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 15% as estimated in General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

BGS = below ground surface

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

Aspect CONSULTING

Exploration Log Key

South Skagit Highway Realignment

DATE: OCT-2014
DESIGNED BY: Aspect
DRAWN BY: Aspect
REVISED BY: MML

PROJECT NO. 140034

FIGURE NO. 2

Q:_ACAD Standards\Standard Details\Exploration Log Key A1.dwg

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
140034	B-1	1 of 2

Project Name: South Skagit Highway Realignment

Ground Surface Elev: 145 ft (from Google Earth)

Location: Mile Post 18, S Skagit Hwy, WA

Driller/Equipment: Gregory Drilling / CME 850 X Track Mounted Rig

Depth to Water (ft BGS): 10

Drilling Method/Hammer: HSA/Mud Rotary / 300 lbs / 30" drop

Start/Finish Date: 9/25/2014 - 9/26/2014

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	Blows/ 6"	Description	Depth (ft)
0–1	Abandoned with bentonite chips				Very loose, moist, dark brown, silty sandy TOPSOIL; numerous root and fiber organics	1
1–4.5					**ALLUVIUM** Very loose, moist, grey brown, sandy GRAVEL (GW); fine to coarse angular sand, fine to coarse subrounded gravel, trace silt. Becomes light yellow brown at 2.5' bgs	2, 3, 4
5		S1		3 / 6 / 9	Becomes grey brown at 4.5' bgs. Becomes loose to medium dense with broken gravel in sampler	5, 6, 7, 8
8.5					Dense, wet, brown, silty sandy GRAVEL (GM); fine to coarse sand, fine to coarse subrounded gravel, with broken coarse gravel in shoe	9
10	▼ 9/26/2014	S2		13 / 14 / 20		10, 11, 12, 13
13.5					Medium dense, very wet, grey brown SAND (SW); fine to coarse angular sand, trace silt	14, 15
15.5		S3		6 / 12 / 16	Medium dense, wet, sandy GRAVEL (GP); trace silt, fine to coarse angular sand, fine subrounded gravel	16, 17, 18, 19
20		S4		2 / 10 / 13		20, 21, 22, 23, 24
25		S5		5 / 9 / 12	Switch from HSA to mud rotary drilling at 25' bgs. Medium dense, wet, gray brown, slightly silty, very gravelly SAND (SW-SM); fine to coarse angular sand, fine subrounded gravel	25, 26, 27, 28, 29

Blows/foot ▲ Water Content % ●: S1 ≈ 15, S2 ≈ 34, S3 ≈ 28, S4 ≈ 23, S5 ≈ 21 (plotted, scale 0–50)

Sampler Type:
- ○ No Recovery
- ▌ 3.25" OD D&M Split-Spoon Ring Sampler
- ▯ California, modified split spoon sampler

Drilling Method:
- HSA: Hollow Stem Auger
- MR: Mud Rotary

Logged by: MML

Approved by: EOA

Figure No. A - 2

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
140034	B-1	2 of 2

Project Name: South Skagit Highway Realignment

Ground Surface Elev: 145 ft (from Google Earth)

Location: Mile Post 18, S Skagit Hwy, WA

Driller/Equipment: Gregory Drilling / CME 850 X Track Mounted Rig

Depth to Water (ft BGS): 10

Drilling Method/Hammer: HSA/Mud Rotary / 300 lbs / 30" drop

Start/Finish Date: 9/25/2014 - 9/26/2014

Depth / Elevation (feet)	Sample Type/ID	Tests	Blows/ 6"	Blows/foot ▲ Water Content % ●	Description	Depth (ft)
30–31.5	S6		3, 11, 12		Medium dense, wet, gray brown, slightly silty, very gravelly SAND (SW-SM); fine to coarse angular sand, fine subrounded gravel Poor sample recovery, fines washed out of sample	31
35–36.5	S7		5, 15, 15		Fine to coarse subrounded gravel	35
40–41.5	S8		4, 15, 16			40
43.5					Medium dense, wet, gray brown, slightly silty, sandy GRAVEL (GP-GM); fine to coarse angular sand, fine subrounded gravel	44
45–46.5	S9		7, 13, 17			45
50–51.5	S10		7, 26, 27	50+	Grades very dense	50
51.5					Boring terminated at 51.5 ft bgs, groundwater encountered at 10' bgs (static) on 9/26/2014 with steel casing to 25' bgs	52

Sampler Type:
- No Recovery
- 3.25" OD D&M Split-Spoon Ring Sampler
- California, modified split spoon sampler

Drilling Method:
- HSA: Hollow Stem Auger
- MR: Mud Rotary

Logged by: MML

Approved by: EOA

Figure No. A - 2

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
140034	B-2	1 of 1

Project Name: South Skagit Highway Realignment

Ground Surface Elev: 260 ft (from Google Earth)

Location: Mile Post 18, S Skagit Hwy, WA

Driller/Equipment: Gregory Drilling / CME 850 X Track Mounted Rig

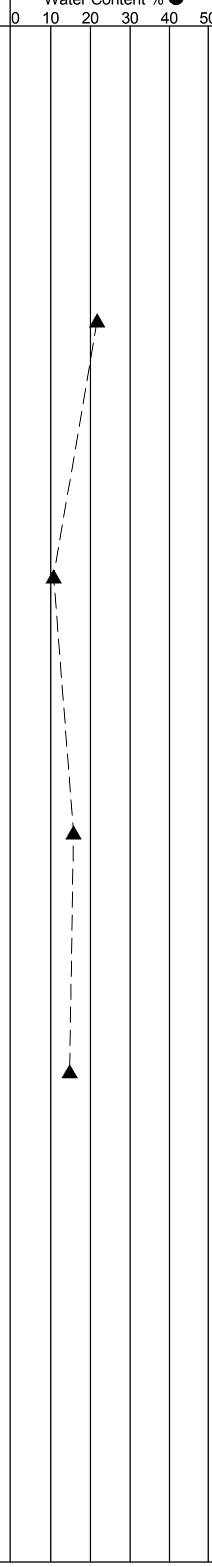
Depth to Water (ft BGS): Not Encountered

Drilling Method/Hammer: HSA / 300 lbs / 30" drop

Start/Finish Date: 9/25/2014

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	Blows/ 6"	Material Type	Description	Depth (ft)
0–1.5					GW-GM	**ALLUVIUM** Medium dense, moist, brown, slightly silty, very sandy GRAVEL (GW-GM); fine to coarse angular sand, fine to coarse subrounded gravel, trace organic material	1
5		S1		3 7 15		Sand becomes predominantly coarse	5
6						3" pocket of slightly clayey silt (ML); no organics observed	6
10	Abandoned with bentonite chips	S2		3 6 5		Broken coarse gravel in shoe	10
15		S3		5 8 8		Grades to gray, broken coarse gravel in sampler shoe	15
20		S4		6 6 9			20
21.5						Boring terminated at 21.5 ft bgs, groundwater not encountered	22

Blows/foot ▲ Water Content % ●



Sampler Type:

- ○ No Recovery
- ▌ 3.25" OD D&M Split-Spoon Ring Sampler

Drilling Method:

HSA: Hollow Stem Auger

MR: Mud Rotary

Logged by: MML

Approved by: EOA

Figure No. A - 3

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
140034	B-3	1 of 1

Project Name: South Skagit Highway Realignment
Ground Surface Elev: 180 ft (from Google Earth)
Location: Mile Post 18, S Skagit Hwy, WA
Driller/Equipment: Gregory Drilling / CME 850 X Track Mounted Rig
Depth to Water (ft BGS): Not Encountered
Drilling Method/Hammer: HSA / 300 lbs / 30" drop
Start/Finish Date: 9/26/2014

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	Blows/6"	Blows/foot ▲ / Water Content % ● (0 10 20 30 40 50)	Material Type	Description
0–1	Filled with 0.75" crushed gravel at surface						Road surface, compacted sand and gravel fill
1–8	Abandoned with bentonite chips						**ALLUVIUM** Medium dense, slightly moist, gray, slightly silty, gravelly SAND (SW-SM); fine to coarse angular sand, fine subrounded gravel
5–6.5		S1		8 13 9	▲		Broken coarse gravel in sampler
8–18							**OVERBANK DEPOSITS** Soft, moist, gray brown, slightly sandy SILT (ML); low plasticity, non dilatant silt, fine to medium sand in frequent laminae, trace clay, rare organics, micaceous with bioturbated fabric
10–11.5		S2		1 2 1	▲		
15–16.5		S3		2 2 3	▲		Grades to medium stiff
18–21.5							**ALLUVIUM** Medium dense, moist, brown, SAND (SP); fine to medium angular sand, trace silt, trace fine subrounded gravel
20–21.5		S4		5 6 8	▲		
21.5							Boring terminated at 21.5 ft bgs, groundwater not encountered

Sampler Type:
- ○ No Recovery
- California, modified split spoon sampler

Drilling Method:
- HSA: Hollow Stem Auger
- MR: Mud Rotary

Logged by: MML
Approved by: EOA
Figure No. A - 4

APPENDIX B

Report Limitations and Guidelines for Use

REPORT LIMITATIONS AND GUIDELINES FOR USE

Geoscience is Not Exact

The geoscience practices (geotechnical engineering, geology, and environmental science) are far less exact than other engineering and natural science disciplines. It is important to recognize this limitation in evaluating the content of the report. If you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or property, you should contact Aspect Consulting (Aspect).

This Report and Project-Specific Factors

Aspect's services are designed to meet the specific needs of our clients. Aspect has performed the services in general accordance with our agreement (the Agreement) with the Client (defined under the Limitations section of this project's work product). This report has been prepared for the exclusive use of the Client. This report should not be applied for any purpose or project except the purpose described in the Agreement.

Aspect considered many unique, project-specific factors when establishing the Scope of Work for this project and report. You should not rely on this report if it was:

- Not prepared for you;
- Not prepared for the specific purpose identified in the Agreement;
- Not prepared for the specific subject property assessed; or
- Completed before important changes occurred concerning the subject property, project, or governmental regulatory actions.

If changes are made to the project or subject property after the date of this report, Aspect should be retained to assess the impact of the changes with respect to the conclusions contained in the report.

Reliance Conditions for Third Parties

This report was prepared for the exclusive use of the Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against liability claims by third parties with whom there would otherwise be no contractual limitations. Within the limitations of scope, schedule, and budget, our services have been executed in accordance with our Agreement with the Client and recognized geoscience practices in the same locality and involving similar conditions at the time this report was prepared.

Property Conditions Change Over Time

This report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by events such as a change in property use or occupancy, or by natural events, such as floods, earthquakes, slope instability, or groundwater fluctuations. If any of the described events may have occurred following the issuance of the report, you should contact Aspect so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical, Geologic, and Environmental Reports Are Not Interchangeable

The equipment, techniques, and personnel used to perform a geotechnical or geologic study differ significantly from those used to perform an environmental study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually address any environmental findings, conclusions, or recommendations (e.g., about the likelihood of encountering underground storage tanks or regulated contaminants). Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding the subject property.

We appreciate the opportunity to perform these services. If you have any questions please contact the Aspect Project Manager for this project.

MILL/SAVAGE CREEK AT SOUTH SKAGIT HIGHWAY - PERMIT SUMMARY TABLE

PERMIT/REVIEW	LEAD AGENCY	TRIGGER	EXEMPTION	SUBMITTAL REQUIREMENTS & ESTIMATED REVIEW TIMEFRAME
LOCAL				
Critical Areas Review	Skagit County	Skagit County Code (SCC) 14.24.060 Authorizations required. With the exception of activities identified as allowed without standard review under SCC 14.24.070, any land use activity that can impair the functions and values of critical areas or their buffers, including suspect or known geologically hazardous areas, through a development activity or by disturbance of the soil or water, and/or by removal of, or damage to, existing vegetation, shall require critical areas review and written authorization pursuant to this Chapter.	SCC 14.24.540 (5) Allowed Uses in HCAs or Buffers. The following activities may be permitted within fish and wildlife HCAs, provided the activities comply with SCC 14.24.080, 14.24.520, and Chapter 14.34 SCC, where applicable. (a) Roads, Bridges and Utilities. Road, bridge and utility construction may be permitted across an HCA and/or its buffer under the following conditions: (i) It is demonstrated to the Administrative Official that there are no alternative routes that can be reasonably used to achieve the proposed development; and (ii) The activity will have minimum adverse impact to the fish and wildlife HCA; and (iii) The activity will not significantly degrade surface or groundwater; and (iv) The intrusion into the fish and wildlife HCA and its buffers is fully mitigated. SCC 14.24.240 (6) Allowed Uses in Wetlands or Wetland Buffers. The following activities may be permitted within wetlands or their buffers but shall comply with SCC 14.24.080 and 14.24.220: (a) Roads, Bridges and Utilities. Road, bridge and utility construction may be permitted across Category I wetlands and/or their buffers only with a variance in accordance with SCC 14.24.140, and across Category II, III or IV wetlands and/or their buffers under the following conditions: (i) It is demonstrated to the Administrative Official that there are no alternative routes that can be reasonably used to achieve the proposed development; and (ii) The activity will have minimum adverse impact to the wetland area; and (iii) The activity will not significantly degrade surface or groundwater; and (iv) The intrusion into the wetland area and its buffers is fully mitigated.	▪ Fees ▪ Request for Critical Areas Review: application form ▪ Site Visit (by County staff) ▪ Site Assessment & Critical Area Report ▪ Site Plans ▪ SEPA checklist ▪ Mitigation Plan/Wetland Bank Application Note: complete submittal requirements are not known until preliminary design plans are available and a pre-application has been completed. 120 days for local review (SEPA/CA/Shorelines)

GeoEngineers

PERMIT/REVIEW	LEAD AGENCY	TRIGGER	EXEMPTION	SUBMITTAL REQUIREMENTS & ESTIMATED REVIEW TIMEFRAME
Floodplain Development Review	Skagit County	SCC 14.34.100. A floodplain project permit, processed per Chapter 14.06 SCC, shall be obtained prior to construction or development on any property within a special flood hazard area as established in SCC 14.34.050. The permit is required for all structures and development activities as defined in Chapter 14.04 SCC. Definitions per Chapter 14.04: **Development:** construction or exterior alteration of structures, dredging, drilling, dumping, filling, earth movement, clearing or removal of vegetation (except activities meeting the definition of forest practices), storage of materials or equipment in a designated floodway, or other site disturbance, other than internal logging roads, which either requires a permit, approval or authorization from the County or is proposed by a public agency. **Development activity:** for the purposes of Chapter 14.30 SCC, Public Facilities Impact Fees, a type of construction, placement, conversion or expansion of a residential building or structure, or the siting of a mobile home, or a change in use of a residential building or structure or mobile home, or a change in use of land that creates or has the potential in the present or future to create an additional dwelling unit. **Structure:** that which is built or constructed, an edifice or building of any kind, or any piece of work artificially built up or composed of parts joined together in some definite manner excluding fences under 6 feet in height.	SCC 14.34.100 (2) lists activities are exempt from the requirement to obtain a floodplain project permit from Skagit County. None of the activities listed are relevant for the project.	As defined under SCC 14.34.110 Applications (see floodplain application for full submittals list). ▪ Fees ▪ Vicinity map ▪ Description of the project ▪ Two copies of the site plans drawn to scale that demonstrate the location and dimensions of the property, existing or proposed structures, fill and/or excavations, storage of material, drainage facilities, suspected critical areas per Chapter 14.24 SCC, and private or public utilities including sewage. The site plan shall also include the following information: ▪ The elevations and boundaries of the 10-, 50-, and 100-year floods, where information is available. ▪ The boundaries of both the SFHA as defined in SCC 14.34.050, and the protected review area as defined in SCC 14.34.055, where applicable ▪ Areas of compensatory storage per SCC 14.34.150(4), where applicable. ▪ Floodproofing verification when required per SCC 14.34.140 ▪ Description of the extent to which any watercourse will be altered or relocated as result of the proposed development. ▪ Where a permit is required for the repair, reconstruction or addition to any repetitive loss structure, as defined in Chapter 14.04 SCC (Definitions), such structure shall be required to meet the provisions of SCC 14.34.140, 14.34.160(1) and (3), and 14.34.170. Value for the structure shall be demonstrated by the current tax assessed value or by private appraisal at the expense of the applicant. Construction costs shall be demonstrated by a properly prepared construction bid from a currently licensed contractor or the valuation used by the Director for determining building permit fees. ▪ Habitat impact assessment checklist or, if within the protected review area, a fish and wildlife habitat conservation area site assessment prepared consistent with SCC 14.24.520 and 14.34.220(1). ▪ Notice on title pursuant to SCC 14.34.150(5). ▪ The Director may require additional information when deemed necessary to determine the degree of flood protection required. Time for review varies by type of review with review periods ranging from 65 to 170 days.

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Shoreline Substantial Development	Skagit County	Skagit County Shoreline Master Program (SMP); Skagit SMP 2.04 Applicability to Development and 2.05 Applicability to Substantial Development	The Skagit SMP defers to WAC 173-27-040 which lists development exemptions from the substantial development permit. No applicable exemptions.	▪ Lot certification ▪ Critical areas review ▪ Preapplication meeting or waiver ▪ Fact sheet ▪ Ownership certificate ▪ Assessor's map ▪ Site plan ▪ Vicinity map ▪ Narrative statement ▪ Joint Aquatic Resources Permit Application (JARPA) ▪ SEPA Checklist ▪ Pre-addressed/stamped envelopes for both owners of the record and the physical addresses within 300 feet of the property boundary. ▪ Fees Review period for approval varies by project complexity.
State Environmental Policy Act (SEPA) Determination	Skagit County	Required for any proposal which involves an action	WAC 197-11-800 lists Categorical exemptions for SEPA. No applicable exemptions.	▪ SEPA Environmental Checklist ▪ Submitted with Shoreline and Critical Areas Permit/Review 90 to 120 days for local review with a Determination of Nonsignificance (DNS). Review process and submittal requirements increase if the determination is Mitigated Determination of Nonsignificance (MDNS) or Determination of Significance (DS).
STATE				
Section 401 Water Quality Certification (401 WQC)	Washington Department of Ecology	Applying for a federal permit or license to conduct any activity that might result in a discharge of dredge or fill material into waters of the United States.	Review and approval may occur through the United States Army Corps of Engineers (USACE) Nationwide Permit (NWP) Process if thresholds for individual review are not triggered. Thresholds vary depending on the NWP issued for the project.	30 days prior to requesting a water quality certification, submit a *Pre-Filing Request Form*. At least 30 days after submitting a pre-filing meeting request, submit a *Request for Clean Water Act Section 401 Water Quality Certification* along with the following information: ▪ Copy of the Federal Permit application (in this case a copy of the Clean Water Act Section 404 permit application package sent to the USACE – see submittal requirements for "Clean Water Act Section 404 – USACE Review" below) ▪ Other requirements may include a Water Quality Protection Plan or other reports/analyses. 6 months review time and up to 12 months with an extension granted by the USACE.

Hydrologic Project Approval (HPA)	Washington State Department of Fish and Wildlife	All construction work waterward, under or over the ordinary high water mark (OHWM) of streams, lakes or marine shorelines or work that could change or affect the natural flow of water.	Streamlined process for restoration projects –not applicable.	▪ Online application: Aquatic Protection Permitting System (APPS) with attachments:
				  ▪ JARPA Drawings
				  ▪ Critical Areas Report
				  ▪ Hydraulic Design Report
				  ▪ Restoration/Mitigation Plan
				  ▪ SEPA determination letter
				45-day review after receiving a complete application.

MILL/SAVAGE CREEK AT SOUTH SKAGIT HIGHWAY - PERMIT SUMMARY TABLE

PERMIT/REVIEW	LEAD AGENCY	TRIGGER	EXEMPTION	SUBMITTAL REQUIREMENTS & ESTIMATED REVIEW TIMEFRAME
FEDERAL				
Clean Water Act (CWA) Section 404 – USACE Review	United States Army Corps of Engineers	Any activity that might result in a discharge of dredge or fill material into Waters of the United States (e.g., below the OHWM of streams and within wetlands).	Projects where the impacts are not greater than a "de minimis" effect. This determination is made by the USACE. NWP authorize specific activities under a streamlined review process. If NWP thresholds are exceeded an Individual Permit will be required.	▪ JARPA form and drawings ▪ Critical Areas Report ▪ Restoration/Mitigation Plan ▪ Biological Evaluation/ Assessment (Endangered Species Act (ESA) consultation) ▪ Cultural Resource Assessment (Section 106 of the National Historic Preservation Act [NHPA] Consultation). ▪ The applicant cannot begin the activity until receiving written notification from the USACE that there is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or section 106 of the National Historic Preservation Act (see 33 CFR 330.4(g)) has been completed. ESA and Section 106 consultations must be completed before the USACE can issue a permit and those consultation can take from 1 to 2 years depending on project impacts.
Section 106 National Historic Preservation Act (NHPA) Compliance	State of Washington Department of Archaeology and Historic Preservation (DAHP)	Federal permit, license or federally funded activity. Possible impacts to cultural resources that may be uncovered during excavation. However, if USACE permits or other federal reviews are not triggered and if the project is not federally funded, this review will not be required.	For federally funded projects there are some exemptions for maintenance within existing road prism – not relevant to the project.	▪ Cultural Resource Assessment (will be required because the project is occurring in an area with a high probability of encountering historic resources; near a river, in floodplain and in streams) ▪ Federal funding agency or the USACE (if not federally funded) will be the lead agency. Review period could take 6 months or longer depending on DAHP and Tribal feedback.
Section 7 Endangered Species Act (ESA) Compliance	US Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) Fisheries/ National Marine Fisheries Service (NMFS)	Applying for a federal permit or license to conduct any activity that might result in an effect to an ESA listed species. ESA-listed species of fish use of streams within the project area (e.g., Puget Sound Chinook salmon, steelhead, or bull trout) or other listed species known to be in the project area. If USACE permits are not triggered then this permit may not be required	Exemptions are rare and not relevant to this project. There are programmatic consultation processes for certain actions and under certain funding programs. The NMFS USACE restoration programmatic has an action category "Road Crossing Replacement, Relocation, or Removal" that may apply to some or potentially all aspects of the project, but the USACE and NMFS would need to concur.	▪ Biological Evaluation/ Assessment (Endangered Species Act consultation) ▪ Federal funding agency or the USACE (if not federally funded) will be the lead agency. ▪ ESA consultation must be completed before the federal funding agency and/or USACE can sign off on NEPA and before the USACE can issue a permit. ESA consultation is likely to take more than 1 year because of proposed work in streams and wetlands with listed fish species, and adjacent habitat for spotted owl and marbled murrelet.
National Environmental Policy Act (NEPA)	Federal Funding Entity or the USACE if no federal funding.	Federal permit, license or federally funded activity.	Categorical exemptions depend on the specific activity and the funding entity.	▪ USACE conducts their own internal NEPA review. ▪ Some federal funding entities require that the applicant complete a NEPA checklist or NEPA compliance report. ▪ NEPA checklist or NEPA compliance report and other supporting documentation and analyses to demonstrate NEPA compliance. The information listed under the USACE 404 and 401 WQC above will be required and potentially additional information related to hazardous materials, environmental and social justice and potential impacts to parks and recreation. ▪ NEPA review timeline is dependent on ESA and Section 106 consultation review times and on timing of right-of-way acquisition and certifications.