Nason Creek RM 3.3 to 4.6 Supplemental Alternatives Analysis

Yakama Nation Fisheries

August 24, 2022

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PREPARED FOR

Yakama Nation Fisheries
401 Fort Road
Toppenish, WA

PREPARED BY
Inter-Fluve
501 Portway Ave., Suite 101
Hood River, OR 97031

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1. Introduction

The Washington State Department of Transportation (WSDOT) manages State Route (SR) 207 from Highway 2 at Coles Corner to the intersection with Chiwawa Loop road in Chelan County, Washington. It is an important access road to Lake Wenatchee State Park, multiple communities near Lake Wenatchee and Plain, WA, and provides a detour route off of Highway 2 if the highway is closed through Tumwater Canyon. In 1941, SR 207 road alignment was straightened and moved into the Nason Creek floodplain and meander corridor, effectively cutting off nearly 70 acres of alluvial floodplain and constraining Nason Creek to roughly half of its historic channel migration corridor width downstream of Cole's Corner. While the straightened road improved travel efficiency, it also placed the road in a portion of the valley bottom that Nason Creek typically occupies and would likely migrate into in the future.

In 1995, flooding in Nason Creek washed out a segment of SR 207 as the creek channel migrated within its meander corridor (Figure 1). Since then, the creek has started eroding into two other nearby segments of the SR 207 road prism, requiring WSDOT to repeatedly protect and repair the road embankment at these three locations. These sites are now listed as high priority WSDOT Chronic Environmental Deficiency (CED) sites which require more intensive aquatic habitat mitigation and site stabilization under the CED designation to reduce immediate and long-term risk to the road prism. The location of the three CED sites can be viewed in the site map (Figure 2Figure 3).

Figure 1 - 1995 flood erosion of SR207 near RM 4.5 (WSDOT photo)

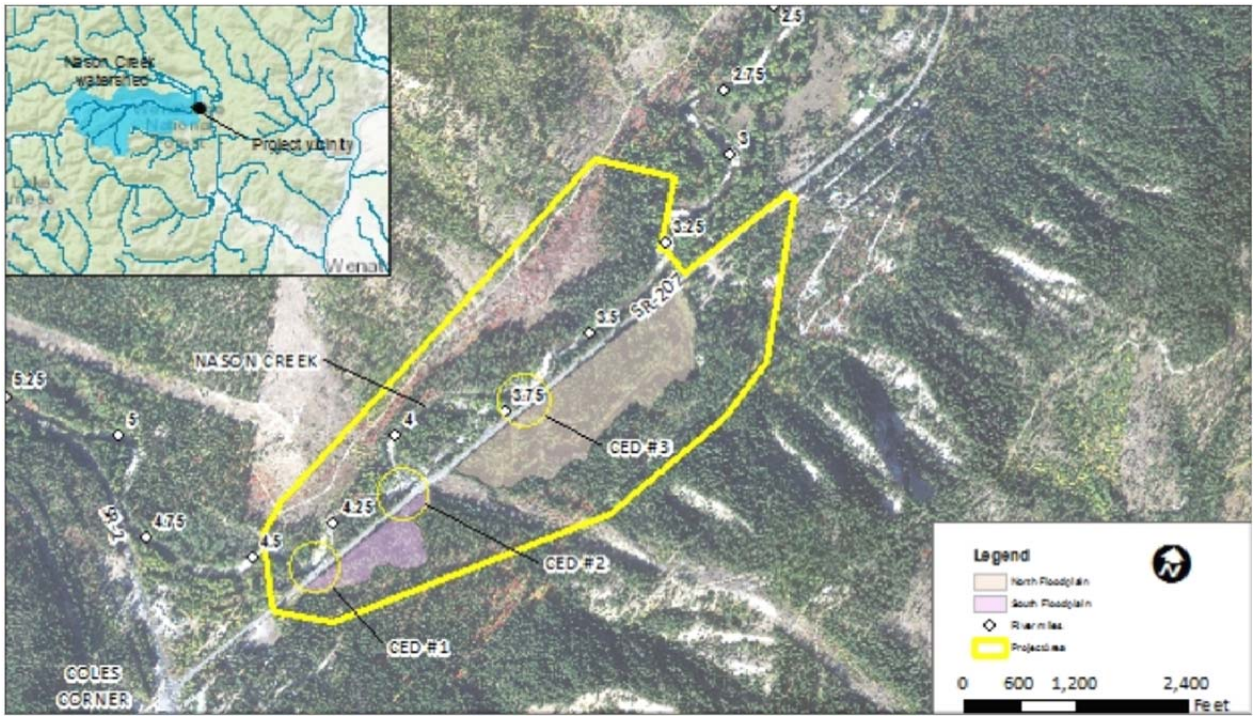

Figure 2 - Site Map

Nason Creek is a critical habitat tributary for ESA-listed spring Chinook salmon (*Oncorhynchus tshawytscha*, endangered) and steelhead (*O. mykiss*, threatened). Due to its biological importance, two separate investigations have been undertaken in the past decade by entities engaged in regional salmon recovery planning in an attempt to restore aquatic habitat and stabilize the SR 207 CED sites. The first investigation was led by Chelan County in 2010, which resulted in a 2012 feasibility study that identified multiple potential restoration alternatives including moving the road out of the meander migration corridor, placing new bridges, causeways, or culverts in the current road alignment, and placing in stream large woody material (LWM) for habitat to deflect flows from the roadway. Most of these alternatives were not implemented due to concerns about project costs, environmental impacts, motorist safety, private property impacts, and other considerations.

In 2017, a second investigation was initiated by the Yakama Nation in a partnership effort with WSDOT to address the SR 207 CED sites in a manner that improved habitat for ESA-listed fish. The Yakama Nation work initially investigated alternatives proposing to stabilize the road in place with engineered large wood structures and targeted floodplain grading that would deflect scouring flows away from the SR 207 road prism and enhance fish habitat. During this investigation another alternative to remove a segment of SR 207 out of the meander migration corridor was identified and has been under investigation since 2019.

Recent discussions with Chelan County and Yakama Nations Fisheries concluded that the degree of overlap in both efforts and unique alternatives in each investigation made a combined alternatives analysis useful in selecting future actions. This Supplemental Alternatives Analysis Report combines

the Yakama Nation and Chelan County alternatives and assesses each alternative using the same evaluation criteria. The report uses similar documentation methods found in the Chelan County 2012 feasibility study and paraphrases that work throughout. The Chelan County work provided key and important background information that the later Yakama Nation work built upon.

Several reports or segments of past reports are included in this document. They include: the 2012 Chelan County Feasibility Study completed by ICF International in Appendix B; the Yakama Nation Project Area 1 habitat enhancement concepts report completed by Inter-Fluve (March, 2021) in Appendix C; the Yakama Nation Project Area 2 habitat enhancement concepts report completed by Inter-Fluve (December, 2021) in Appendix D; and the Yakama Nation Project Area 3, road relocation study by Perteet (August, 2021) in Appendix E. Where appropriate, estimated project costs have been updated, and new information about site characteristics have been added.

The remaining components of this document provide background and existing conditions, description of project alternatives, a description of attribute and scoring methods used to evaluate alternatives, and scoring results for each alternative. The objective of scoring each alternative is to facilitate discussion with interested stakeholders to select future actions.

As noted in the Chelan County Feasibility Study, in 2007 two 12-ft diameter culverts were installed through the existing roadway embankment near RM 3.3 and 3.8. This was completed to provide fish access to an historic oxbow channel east of the highway while providing partial connection to Nason Creek. The existing channel and floodplain area east of the existing highway is approximately 40.7 acres.

2. Background and Existing Site Conditions

The project limits for both the Yakama Nation and Chelan County studies are similar (Figure 2). Existing conditions, physical processes, and fisheries background information within the project reach are provided below.

2.1 Geology, Geotechnical and Geomorphology

2.1.1 Geology

Visible bedrock within the project reach is composed of the Nahahum member of the Chumstick Formation (Tabor, et al 1987). The rock is a weak and friable stone that when exposed in Nason Creek, has been eroded into fluted or grooved bedforms by alluvial transport abrasion. At a large scale, the watershed is composed of older Cretaceous age metamorphic rocks of the Chiwaukum Schist that has been intruded by the granitic rocks of the Mount Stuart batholith. These rocks were buried by both volcanic deposits and sediment of Tertiary age before being uplifted and then eroded into the downthrown block of the Chiwaukum Graben. The project lies within the downthrown block of the Chiwaukum Graben and the exposed Chumstick Formation are deposits of that geologic process and history. After the Chumstick was deposited, the watershed was most recently eroded by glacial advances and retreats that left glacial till deposits of the rocks composing the watershed on the valley floor, in outwash terraces, and on watershed surfaces overrun by glaciers. Post glacial till, terraces and valley bottom alluvial material have been continually re-worked by post glacial river, debris torrent, and landslide processes throughout the watershed. Nason Creek meander migration into SR 207 is one example of post glacial alluvial processes occurring in the watershed.

2.1.2 Geotechnical

A geological engineering analysis and report of the area was conducted by Ken Neal in November 2011. Part of that report has information that directly affects segments of potential road alignments described later in this report and associated risk related to slope movement. Specifically, Zone 1A from the report is of interest and is copied directly from report below. Natapoc Ridge referred to in the following report segment below represents the ridge forming the top of the Nason Creek valley east of SR 207.

> *Zone Ia consists of steep, planer to complex slopes within the channels and headwall areas that bisect the upper portions of Natapoc Ridge. The headwalls are included from 80 to locally over 150 percent. Vegetation, where present, is similar to that in Zone I. In headwall areas where slope movement has been prevalent, the sparse vegetation present consists of local brush.*
>
> *A variety of surficial processes are affecting the headwall areas and adjacent slopes. The sandstone forming the Natapoc Ridge is subject to chemical weathering and freeze-thaw action. The resulting sandy soil is eroded and forms the slope wash covering the planar slopes, or collects within the headwall areas near the ridge crest. During major flood and rain-on-snow events, the accumulated soil, along with other debris, flows down the channel and out onto the fans below (Areas B, C, D, E, G, H, L and M on* Figure 3*)*

Slope movement, which generally occurs in the form of debris flows and slides, has occurred repeatedly in the headwall areas along Natapoc Ridge. Recent slope movement is visible in Area B on the 1949 air photo, and recurring movement is visible on 1968 photos. Massive slope movement is visible over much of Area E in 1949 and 1966 air photos, and recurrent movements on various segments of Area E are visible in photos taken in 1968, 1973, 1981, 1988, 1992, 1998, 2006, and 2009. Recurring slope movements are visible in portions of Area G on 1966, 1968, 1973, and 1988 air photos. Movements in Area H are visible on 1966 and 1988 air photos. Recurring slope movement is visible in Area L, located along and adjacent to the BPA power lines, in 1966, 1968, 1973, 1992, 1994, 1998, 2006, and 2009 air photos. Slope movement in Area M occurred prior to 1966, no evidence of subsequent movement is visible in more recent photos.

Based on conditions observed on historical aerial photographs and existing site conditions adjacent to the old highway, with the exception of Area E, debris from snow avalanches and other unstable slopes along Natapoc Ridge will not be delivered to or downslope from the proposed location of Alternative 6 (upslope purple alignment).

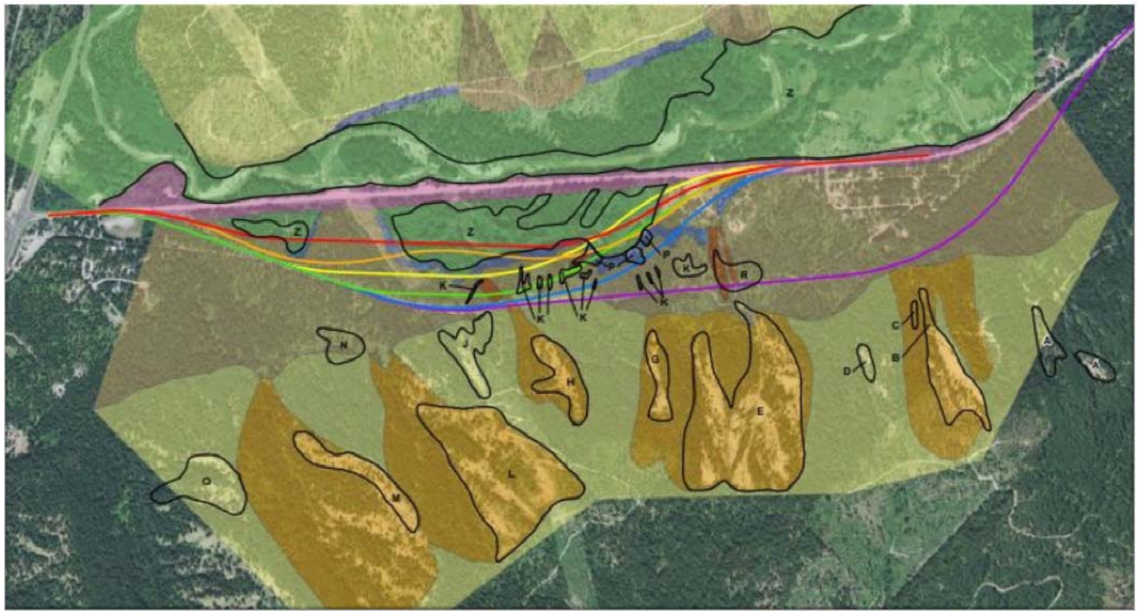

Figure 3 – Chelan County Road Realignment Alternatives and Geotechnical Regions

More detailed descriptions of each zone described above can be viewed in the original (Neal, 2011) report.

An SR 207 roadway prism test boring was completed by (Nelson 2010) at milepost 0.37 and 0.59 (the two 12-ft culvert locations). The test found that the road prism is composed of fine to course silty sand with gravel fill material 12-feet below the road surface. In areas where Nason Creek has eroded into or put the road at risk of erosion, riprap has been placed along the road to armor easily eroded prism materials. No further geotechnical drilling is known to have occurred in other segments of the project reach. Any approved road re-alignment will require exploratory drilling.

2.1.3 Geomorphology

Project area conditions can be compared through time in several figures that are shown on the following pages. Figure 4 shows a 1900 plat map and historical aerial imagery from 1957; Figure 5 shows 1963 and 1974 aerial imagery; and Figure 6 shows 1990 and 2017 aerial imagery. No photo is known to exist before 1957. However, based on 1941 road relocation drawings it appears the Nason Creek alignment is similar to the 1957 photos. Since 1957, the air photo history clearly shows Nason Creek has migrated eastward closer to the highway. In both the 1941 plans and 1957 photo, an 80 to 150-foot vegetated floodplain existed between the right bank of Nason Creek and the edge of Highway 207 from approximately RM 4.4 to 4.1. Approximating distances of migration between each air photo provides an average migration rate from 1957 to 1991 along RM 4.1 to 4.4 of approximately 2-4 feet per year (depending on location). By 1991 the 80-150 feet of floodplain buffer that existed in 1957 between Nason Creek and the road prism was eroded and removed by the creek. A side channel along the west side of highway between RM 3.7 to 4.1 was active to varying degrees in all photos but became significantly larger following the 1990 photo.

The 1941 Highway 207 embankment blocked flows into the eastern Nason Creek floodplain following its construction. Doing so reduced off channel and side channel habitats while increasing flood energy in Nason Creek and the remaining floodplain west of the highway. No pre-development survey is available to determine whether and to what degree incision may have occurred. However, it is believed that the loss of flood relief from side channels and floodplain east of the 1942 road construction may have led to some level of incision (UCRTT 2017). Segments of creek channel that have eroded down to Chumstick formation also indicate an increase in hydraulic energy due in part to the loss of floodplain relief and side channels following the 1941 road re-alignment through the valley bottom.

Nason Creek delivers a dynamic supply of substrate and wood to the project reach. Areas of wood accumulation exhibit defined scour pools and sediment deposit tail spills creating diverse habitats. The numbers and locations of redds mapped (Figure 7) indicate that a diversity of LWM and gravel deposition enables spawning to occur in those areas.

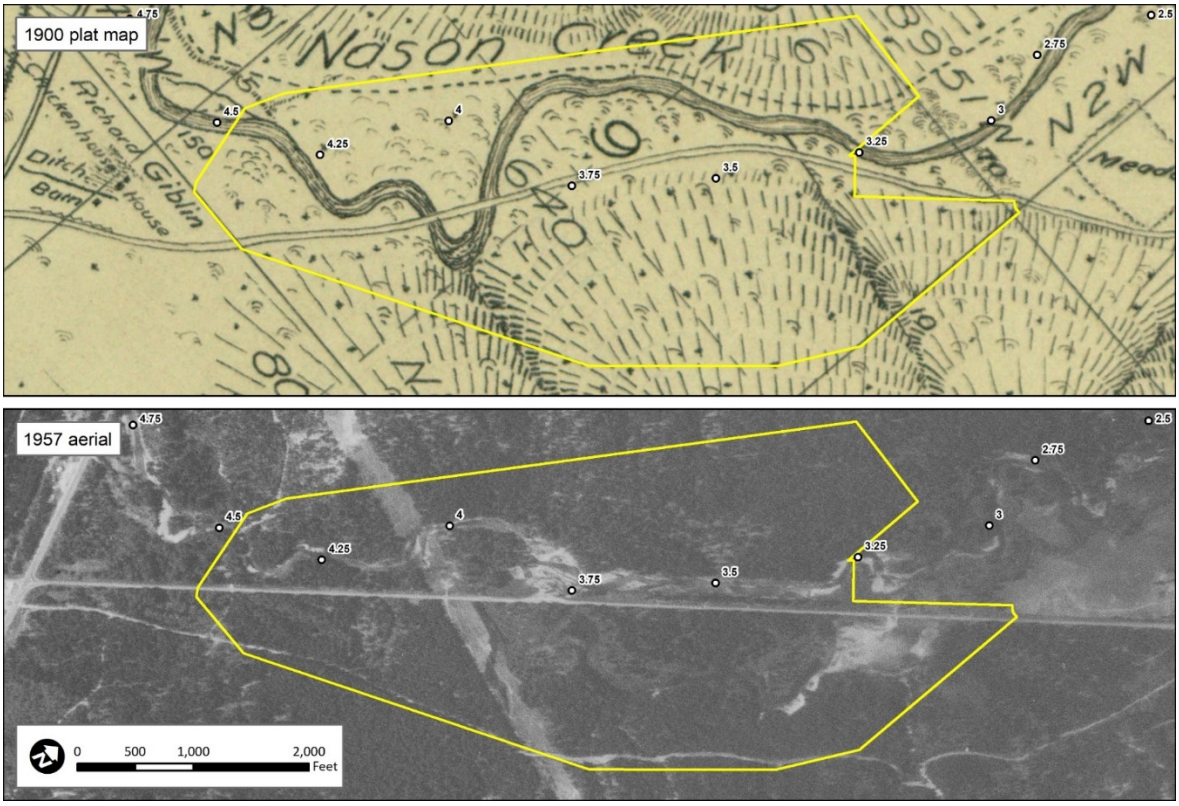

Figure 4 - 1900 Plat Map and 1957 Aerial Photograph

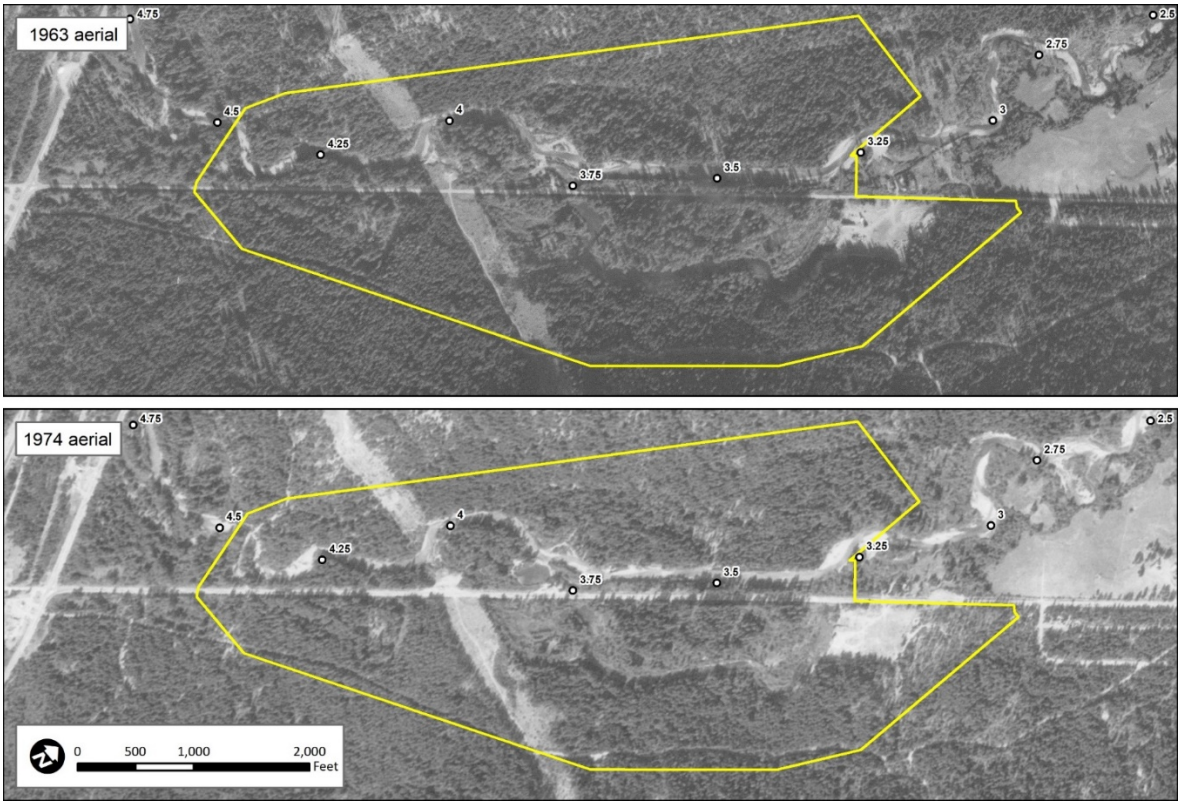

Figure 5 - 1963 and 1974 Aerial Photographs

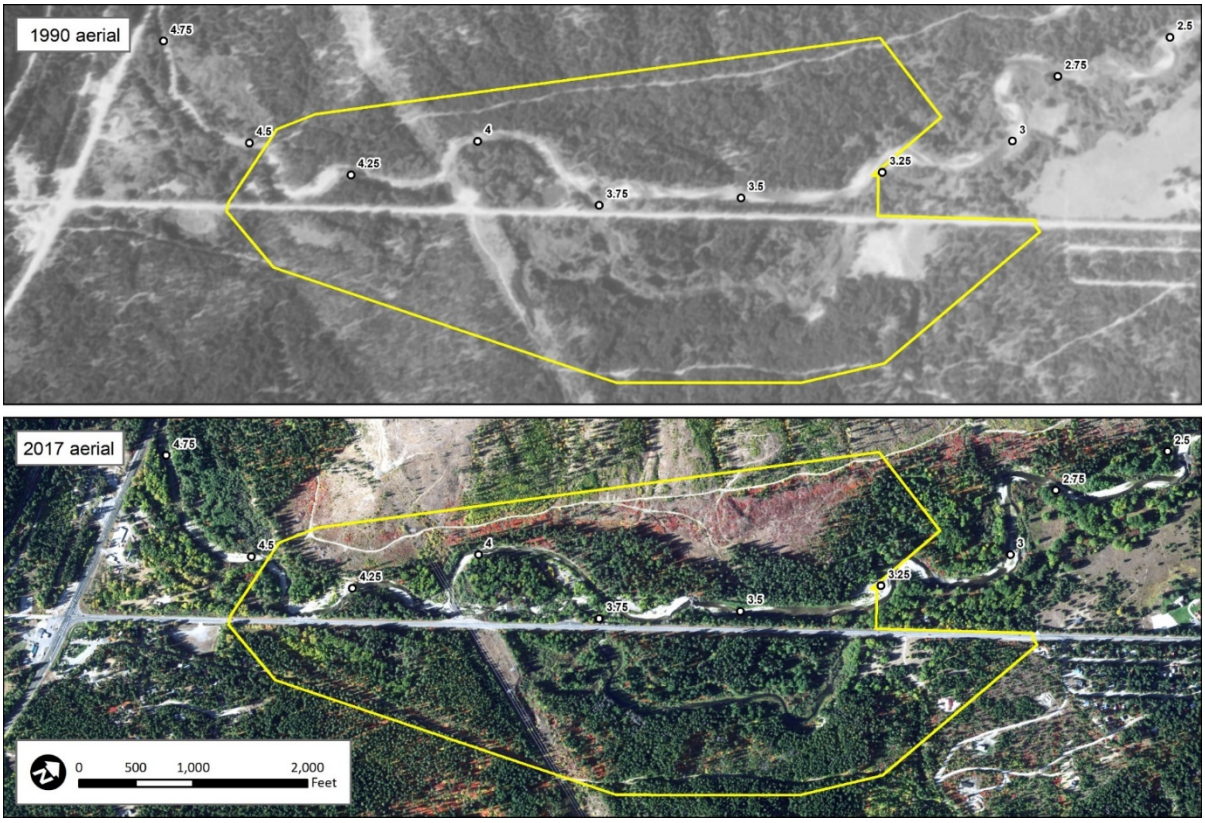

Figure 6 - 1990 and 2017 Aerial Photographs

Before the 1941 highway re-alignment, Nason Creek had flood access to valley bottom floodplain and off-channel wetlands, alcoves, and side channels. Habitats in these areas were likely accessible by juvenile and likely adult salmonids for rearing and spawning. In contrast, the existing highway embankment and culvert system prevents lateral channel migration east of the highway. Approximately 47 acres of active side channel, wetlands and floodplain are located east of the highway between RM 3.3 to 3.9 and will be referred to as the North Floodplain. Road footprint area adjacent to the North Floodplain is an additional 5.2 acres in size. Approximately 12.4 acres of floodplain, wetland and side channels exist between RM 4.15 to 4.4 which will be referred to as the South Floodplain. Road footprint area adjacent to the South Floodplain is an additional 2.6 acres in size. BPA transmission lines are located along a ridge extending from the east valley wall towards the existing road forming the boundary between the North and South floodplain areas.

2.2 Hydrology

Nason Creek drains high-elevation areas of the Chiwaukum Mountains and has a snowmelt-dominated hydrologic regime. Although peak flows typically occur due to snowmelt in the late spring or early summer, some of the largest floods have occurred from rain-on-snow events in late fall. Large historical flood events occurred in May 1948, November 1990, November 1995, and November 2006. As noted in Chelan County's Feasibility Study (2012), the November 1995 event

washed out portions of Highway 207. As of 2011, three repairs in 10 years at this location led to nomination for the WSDOT Chronic Environmental Deficient program.

2.2.1 Peak Flow Hydrology

Washington Department of Ecology has operated gage 45J070 near the mouth of Nason Creek since 2002, but no long-term stream gage record is available on Nason Creek to reliably estimate peak flows for the project reach. No major tributaries enter Nason Creek between the project and confluence. Detailed hydrologic analyses were completed by the US Bureau of Reclamation in their Nason Creek Tributary Assessment (Reclamation, 2008) that considered the Icicle Creek gage USGS Gage #12458000. Reclamation's peak flow estimates at RM 4 of Nason Creek (Appendix D, Table 5) are presented in Table 1.

Table 1. Peak flow estimates for Nason Creek near RM 4.0

Recurrence Interval (years)	Estimated flow at RM 4 (cfs)
2	**2600**
10	**4900**
25	**6500**
50	**7900**
100	**9400**

2.3 Hydraulic Modelling

Hydraulic modelling was completed for the Chelan County and Yakama Nation studies and results were used to verify the viability of each alternative. Chelan County completed SRH-2D hydraulic analysis in their study to confirm the viability of each proposed alternative. The Yakama Nation study used HEC-RAS in 2-dimensional mode for hydraulic modeling. Model outputs can be viewed in their respective reports found in Appendices A and B.

2.4 Fisheries

Current fish known to utilize the project area include ESA-listed spring Chinook (*Oncorhynchus tshawytscha*, endangered), steelhead (*O. mykiss*, threatened), Bull Trout (*Salvelinus confluentus*, threatened), species-of-concern Pacific Lamprey (*Lampetra tridentate*) and westslope cutthroat trout (*O. clarkii*), and non-listed summer Chinook, Coho Salmon (*O. kisutch*), mountain whitefish (*Prosopium williamsoni*), and non-native brook trout (*Salvelinus fontinalis*). Past redd counts show high Chinook Salmon and steelhead redd densities within the project area (Figure 7). The project reach is a low gradient reach with high quality spawning gravels located throughout.

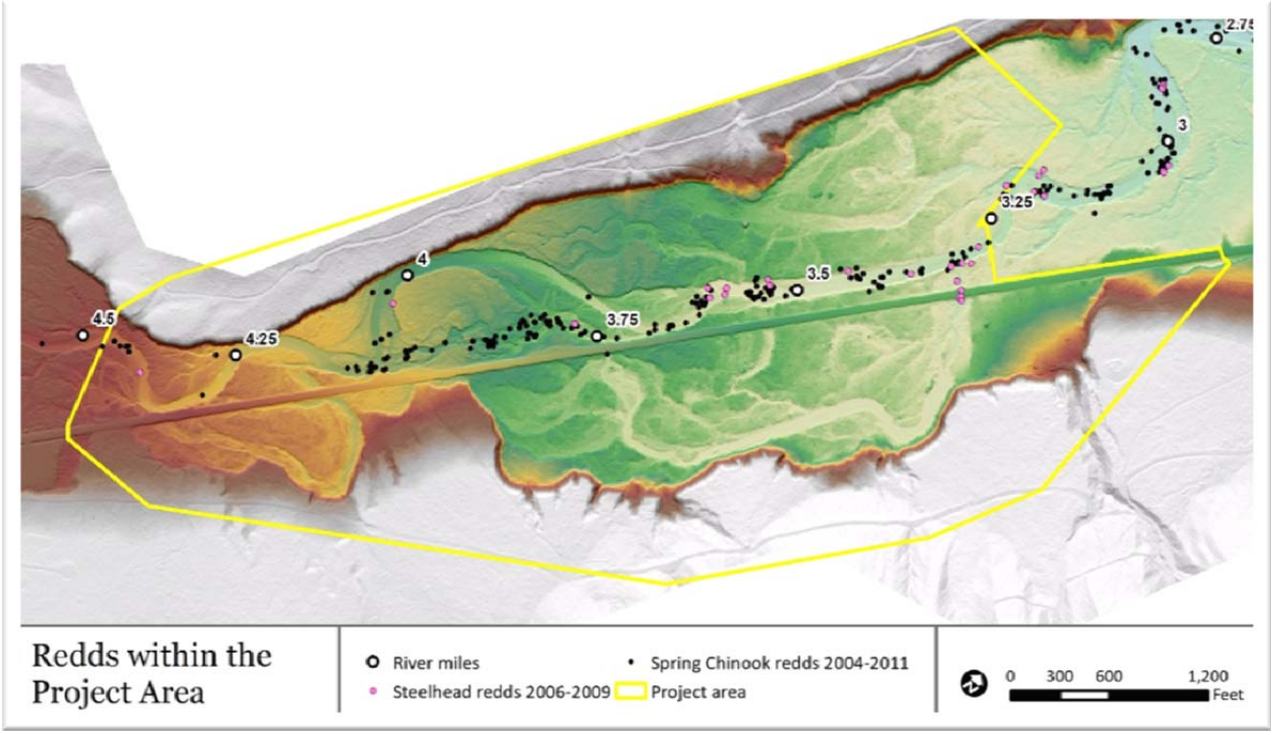

Figure 7 - Steelhead and spring Chinook redds recorded in the project area for the specified years over LiDAR elevation data (Upper Columbia Salmon Recovery Board).

According to the Subbasin Plan (NWPCC 2004), habitat in the project area has high potential to improve populations of aquatic species, including ESA-listed salmonids within the lower Nason Creek. A summary of life history timing for aquatic species is presented in Figure 8. Detailed descriptions of habitat requirements by life stage for ESA-listed species are included in the following sections.

2.4.1 Steelhead

Adult steelhead enter the Wenatchee basin from August through April, holding in deep pools with overhead cover. Spawning begins in very late March, peaks in mid-April, and lasts through May. Egg survival is highly sensitive to intra-gravel flow and temperature (NWPCC 2004), and is particularly sensitive to siltation earlier in the incubation period (Healy 1991). Fry emerge from the redds 6-10 weeks after spawning (Peven 2003).

Age-0 juveniles spend their first year primarily in shallow riffle habitats, feeding on invertebrates and utilizing overhanging riparian vegetation and undercut banks for cover (Moyle et al. 2002, US Fish and Wildlife Service 1995). Age-0 steelhead use slower, shallower water than Chinook Salmon, preferring small boulder and large cobble substrate (Hillman et al. 1989). Older juveniles prefer faster moving water including deep pools and runs over cobble and boulder substrate (US Fish and Wildlife Service 1995). Juveniles outmigrate between ages one and three, though some hold over and display a resident life history form. Smolts begin migrating downstream from natal areas in March (NWPCC 2004).

Juvenile salmonid life-history timing

SPECIES	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Summer Steelhead												
Spring Chinook												
Bull Trout												
Coho Salmon												
Cutthroat Trout												
Pacific Lamprey												
Brook Trout												

Emergence
Juvenile rearing
Primary juvenile migration
Adult migration
Adult spawning

Adult salmonid life-history timing

SPECIES	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Summer Steelhead												
Spring Chinook												
Bull Trout												
Coho Salmon												
Cutthroat Trout												
Pacific Lamprey												
Brook Trout												

Figure 8 - Life history timing of target species within the project area

2.4.2 Chinook Salmon

Adult spring Chinook enter the Wenatchee in May, holding in deeper pools with overhanging cover until water temperatures are suitable for spawning. Spawning typically begins in very late July, peaks in late August, and ends in late September (NWPCC 2004). Eggs are very sensitive to changes in oxygen levels and percolation, both of which are affected by sediment deposition and siltation in the redd (Healy 1991, Peven 2003). Fry emerge in June and July, which coincides with the rising hydrograph, forcing juveniles to seek out backwater or margin areas with lower velocities, dense cover, and abundant food (Quinn 2005). Fry are extremely vulnerable when they emerge because their swimming ability is poor and flows are often high. Near-shore areas with eddies, large woody debris, undercut tree roots, and other cover are very important for post-emergent fry (Hillman et al. 1989, Healy 1991). The proposed floodplain enhancement area is expected to provide low velocity rearing habitat for post-emergent spring Chinook salmon fry because there are high redd densities immediately upstream, and the feature is on the outside of a meander bend where the majority of water and fry are expected to be during high flows (Figure 7).

As they increase in size, juveniles begin to select for deeper and faster moving water, particularly areas with overhanging cover (Moyle et al 2002b). These areas provide more holding and feeding habitat area for the larger juveniles to occupy. Upper-Columbia spring Chinook express a stream-type life history, meaning they rear in freshwater for at least one year before outmigrating as yearlings. Smolts begin migrating in March from natal areas (NWPCC 2004).

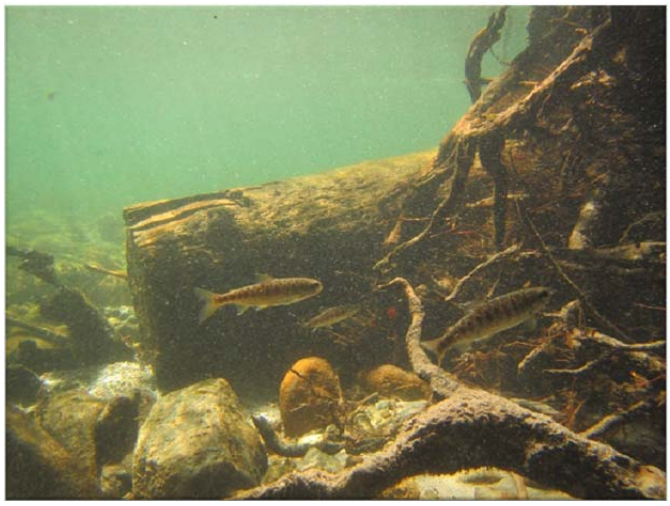

Figure 9 - Chinook Salmon parr resting behind a constructed log structure in the Entiat River between feeding forays

2.4.3 Bull trout

Nason Creek supports a population of resident and fluvial bull trout (NWPCC 2004). The project area is located in a reach of Nason Creek that is mapped as "possible bull trout spawning" in the Wenatchee Subbasin Plan (NWPCC 2004). Bull Trout spawn in the Wenatchee subbasin from August through October. Eggs incubate over the fall, winter, and spring, with fry emerging approximately 220 days after egg deposition. Juveniles select for margin habitat with overhanging cover, feeding primarily on aquatic insects until they grow larger and shift towards feeding on fish. Bull trout juveniles rear in headwater streams for at least two years before migrating downstream as adults or sub-adults to express fluvial life histories, or resident life histories in downstream reaches (McPhail and Baxter 1996). Downstream movement of bull trout in the nearby Chiwawa River has been documented as bimodal, with one pulse in the spring and a second in the fall (NWPCC 2004).

2.4.4 Limiting factors

Regional objectives for salmonid habitat protection and restoration in the Upper Columbia Region have been evaluated and summarized in the document *A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (2017) by the Upper Columbia Salmon Recovery Board (UCSRB) Regional Technical Team (RTT). This Biological Strategy is part of the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007) and recommends region-wide biological considerations and approaches for salmonid habitat restoration and protection actions. The RTT guides the development and evaluation of salmonid recovery projects within the Upper Columbia Region.

The Biological Strategy has identified several assessment units within the major watersheds of the Upper Wenatchee River. The Nason Floodplain project area falls within the Nason Creek Assessment Unit. Nason Creek is a Tier 1 watershed of highest priority for both protection and restoration.

All Chinook spawning that occurs in Nason Creek occurs in the lower 15 miles of the mainstem, which also contains the poorest quality habitat (UCRTT 2017). The RTT has prioritized a list of restoration actions to address key ecological concerns in the Nason Creek Assessment Unit, and are listed below in priority order (UCRTT 2017):

1. **Peripheral and transitional habitat**: Reconnect side channels and off-channel habitat.
2. **Channel structure and form**: Increase large wood complexes, remove or modify levees and roads where feasible, and restore channel structure and form to reduce sediment transport capacity to counteract recent incision and confinement.
3. **Riparian condition:** Improve riparian conditions to improve long term LWM recruitment.
4. **Channel structure and form:** Restore instream habitat diversity by enhancing large wood recruitment, retention, and complexity.
5. **Food**
6. **Sediment conditions:** Decommission roads that are affecting sediment delivery to the stream.
7. **Species interaction (competition)**

2.5 Existing Infrastructure

In addition to SR 207, there is additional infrastructure within the Nason Creek project reach. In 2007 Chelan County and WSDOT constructed two twelve-foot diameter culverts under SR 207 near RM 3.3 and 3.8 to provide fish access to a historic stream oxbow that was cut off by the 1941 SR 207 highway realignment in the North floodplain area (Figure 10).

Figure 10 - Downstream culvert outlet (looking upstream)

Riprap has been installed at two of the three CED locations to maintain the existing road alignment following active erosion of the road embankment. Riprap installation at CED Site #1 near RM 4.4 that occurred following a flood in 1995 that washed out part of Highway 207 can be viewed in Figure 11. Improvements to the original 1995 emergency repair work were undertaken and include additional rock barbs and riprap to restore the SR 207 road shoulder to WSDOT standards. CED Site #2 near RM 4.1 downstream also required repair in 2010 due to lateral migration. This area was further stabilized with rock and large wood in 2018 (Figure 12).

Figure 11 - CED Site #1 near RM 4.4 riprap revetment and stone barbs

Figure 12 - CED Site #2 near RM 4.1 riprap revetment and stone barbs

There are two sets of power lines (Figure 13) and two buried fiber optic lines within the Highway 207 right of way.

1. Bonneville Power Administration (BPA) Chief Joseph-Snohomish above ground power lines cross Nason Creek near RM 4.1.
2. Chelan Public Utilities District (CPUD) double circuit above ground transmission lines run along Highway 207.
3. Sprint fiber optic lines are buried within the SR 207 right of way.
4. Frontier fiber optic lines are buried within the SR 207 right of way.

Figure 13 - Looking upstream from CED Site #3 (RM 3.7)

3. Project Alternatives

There are two basic strategies to protect the road and enhance salmonid habitat. One strategy is to move the road and allow natural channel migration processes to create habitat. The second strategy protects the road in place by various means and mitigates the future loss of naturally created habitat with constructed habitat. Each strategy includes varying levels of costs, benefits, and potentially undesirable outcomes that need to be considered in determining the best course of action for moving forward. These considerations are contemplated in the following sections.

3.1 SR 207 Re-Alignment Alternatives

There are seven SR 207 re-alignment alternatives. Six were developed by Chelan County in 2012 (Alternatives 1-6) and one alternative (Alternative 7) developed by the Yakama Nation in 2019. All alternatives are designed to meet WSDOT highway standards. Below are descriptions and illustration of the seven alternative road alignments. Note, figures are not the same scale. See road stationing in each figure to determine scale distance. Chelan County cost estimates for alternatives 1 through 6 were prepared in 2011 and included a forecast at 5 and 10 years at 4% inflation. To update the cost estimates, Perteet reviewed typical unit costs and updated to today's values; quantities were not adjusted. Perteet's adjusted cost estimates agreed remarkably well with the Chelan County 10 year forecast to 2021 values. The Yakama Nation alignment alternative cost estimate was prepared by Perteet in their feasibility analysis.

Areas for roadway removal included in Alternatives One through Six appear to have been estimated using generalized mapping as shown in Figure 14 (ICF 2011). The north and south floodplain areas were estimated to be 54.4 and 12.9 acres, respectively. The 1.6 mile long roadway footprint is estimated to be 9.8 acres in size. These area calculations appear to be larger than the areas estimated in the YN study based on topographic information of the floodplain area values. Despite the discrepancy, the areas for Alternative One through Six are retained in the discussion below in order to retain consistency with the 2012 Feasibility Study by Chelan County. The YN study estimated floodplain areas based on LiDAR and site survey topography for the north and south floodplain areas to be approximately 47.1 and 12.6 acres, respectively. The North Floodplain is partially connected by the two 12ft culverts near RM 3.3 and 3.8 conveying Nason Creek flow along an historic oxbow channel. The 1.04 mile long highway road embankment segments adjacent to the north and south floodplains have footprint areas of 5.3 and 2.6 acres, respectively. These segments have a cumulative area of 67.5 acres.

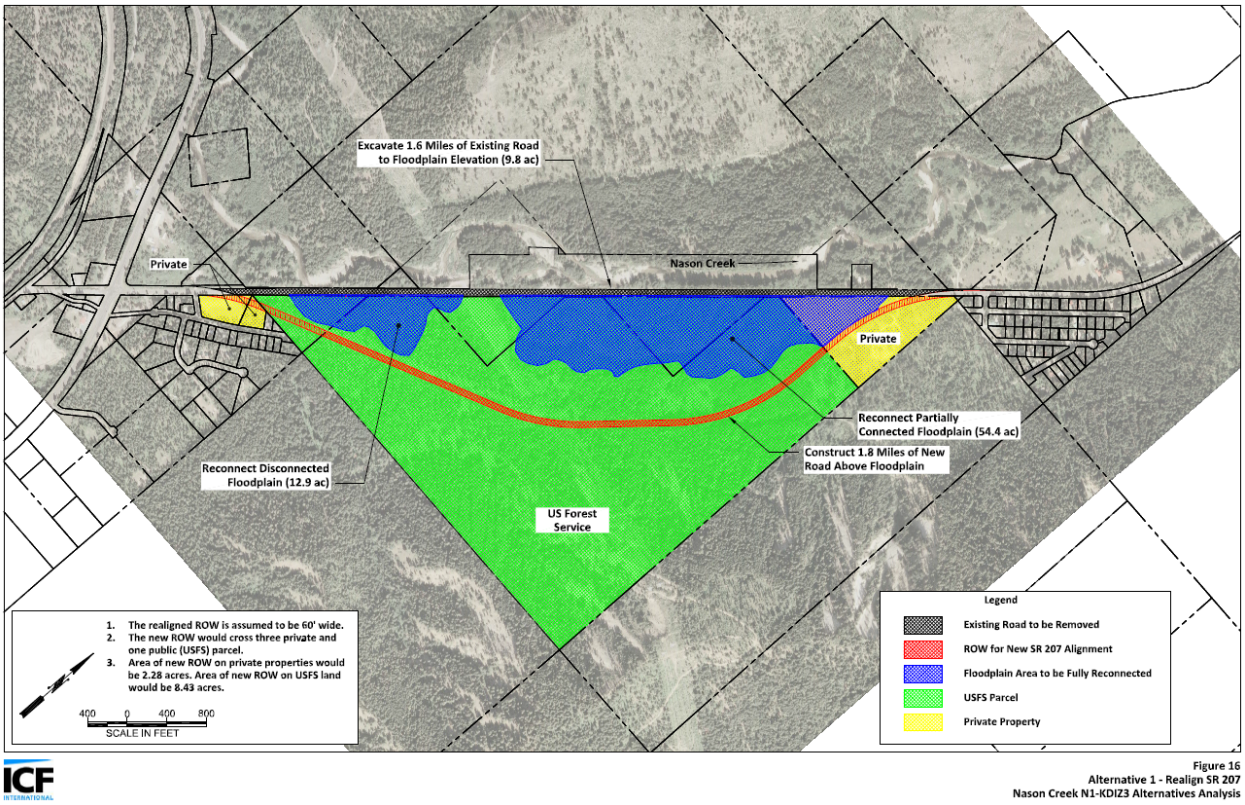

Figure 14. Feasibility Study (Chelan Co., 2011) Floodplain and Roadway areas

3.1.1 Re-alignment - Alternative One

The Chelan County report notes that this alternative re-connects approximately 68.4 acres of Nason Creek floodplain. YN estimated floodplain and roadway area minus Chelan County's estimate of wetland fill and indirect floodplain wetland impacts area is approximately 58.9 acres of floodplain reconnection. The new road would run along the edge of the existing floodplain and be approximately 9,804 feet long. The maximum road slope is 1.76 percent. To construct the road, it is estimated 4.5 acres of wetland will be filled. This option would require moving one BPA tower. The estimated cost in 2022 dollars is $16.8M.

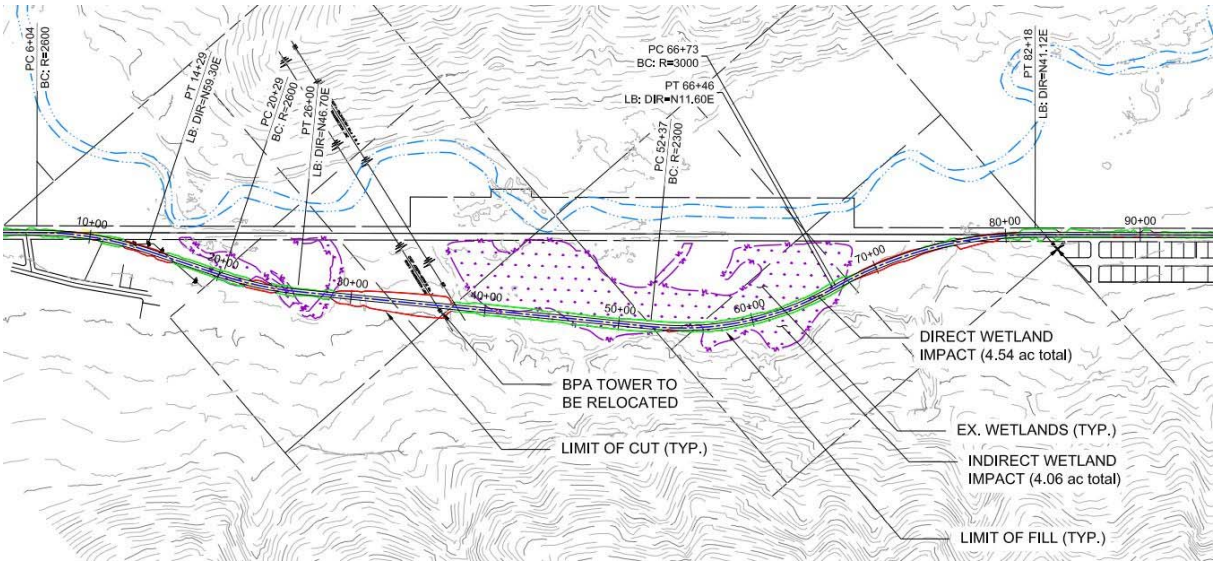

Figure 15. Alternative 1

Advantages of Alternative One include:

- Meets AASHTO criteria with moderate (1.76%) grade.
- Moves the road away from Nason Creek eliminating the three CED sites and restores much of the historic floodplain connectivity, channel migration zone and aquatic habitat complexity.
- Avoids avalanche hazard areas.

Disadvantages of Alternative One include:

- Approximately 4.5 acres of wetland fill and 4.0 acres of indirect floodplain wetland impact may be difficult to permit.
- Fill is placed in approximately half of the existing north floodplain side channel, and across multiple portions of the south floodplain side channel, not achieving full restoration of floodplain function and likely requiring future maintenance from river processes.
- Alignment has some risk of destabilizing valley slope.
- Lengthy utility relocations will be required.

- Cost is moderately high ($16.8M).
- Direct impacts to private properties to realign the roadway.

3.1.2 Re-alignment Alternative Two

The Chelan County report notes that this alternative re-connects approximately 75.6 acres of Nason Creek floodplain. YN estimated floodplain and roadway area minus Chelan County's estimate of wetland fill and indirect floodplain wetland impacts area is approximately 66.1 acres of floodplain reconnection. The new road would run along the edge of the existing floodplain and be approximately 8,800 feet long. The maximum road slope is 3.85 percent. To construct the road, it is estimated 1.45 acres of wetland will be filled. The estimated cost in 2022 dollars is $19.3M.

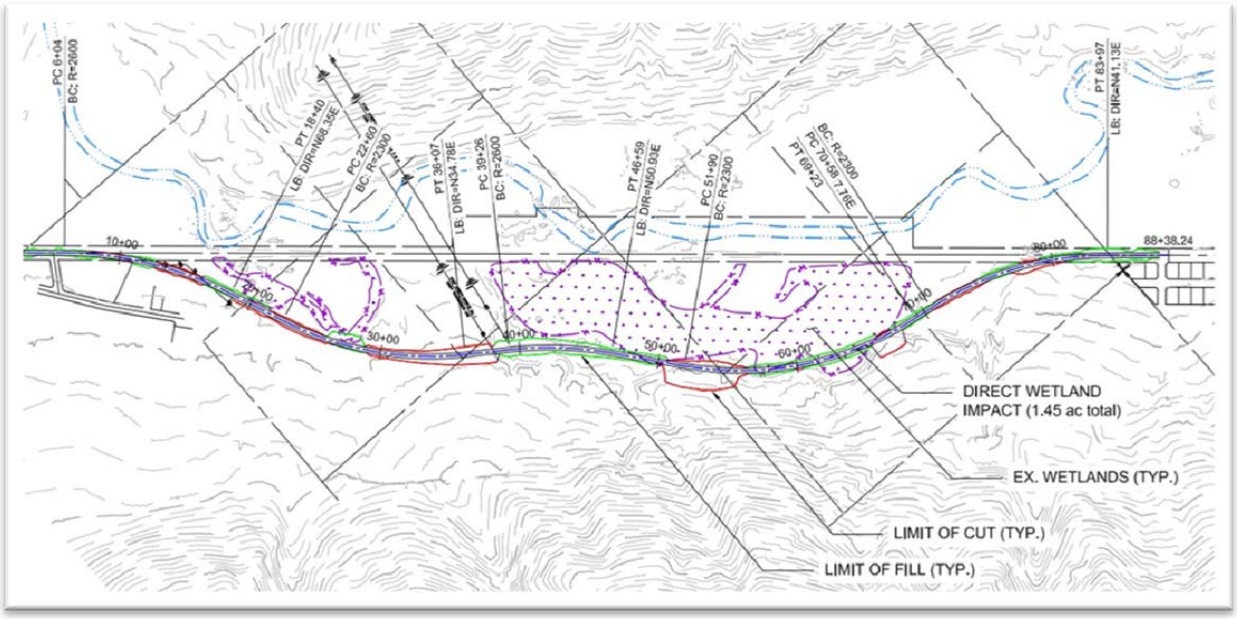

Figure 16. Alternative 2

Advantages of Alternative Two include:

- Meets AASHTO criteria with moderately steep (3.85%) grade.
- Moving the road away from Nason Creek eliminates the three CED sites and restores much of the historic floodplain connectivity, channel migration zone and aquatic habitat complexity.
- Avoids avalanche hazard areas.

Disadvantages of Alternative Two include:

- Approximately 1.45 acres of wetland fill and small area of indirect floodplain wetland impact.
- Fill is placed in a portion of the existing north floodplain side channel, not achieving full restoration of floodplain function and possibly requiring future maintenance from river processes.
- Alignment has some risk of destabilizing valley slope.
- Lengthy utility relocations
- Cost is moderately high ($19.3M).
- Direct impacts to private properties to realign the roadway.

3.1.3 Re-alignment Alternative Three

The Chelan County report notes that this alternative re-connects approximately 71.5 acres of Nason Creek floodplain. YN estimated floodplain and roadway area minus Chelan County's estimate of wetland fill and indirect floodplain wetland impacts area is approximately 62.0 acres of floodplain reconnection. The new road would run along the edge of the existing floodplain and be approximately 7,350 feet long. The maximum road slope is 4.0 percent. To construct the road, it is estimated 2.0 acres of wetland will be filled. The estimated cost in 2022 dollars is $18.5M.

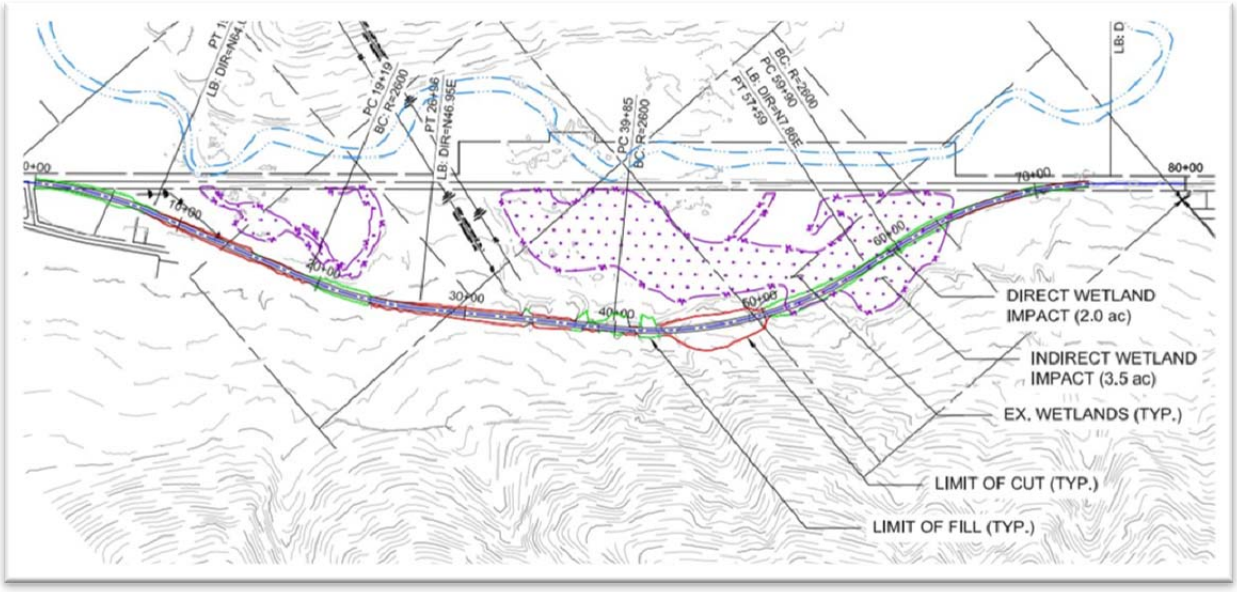

Figure 17. Alternative 3

Advantages of Alternative Three include:

- Meets AASHTO criteria with moderately steep (4%) grade.
- Moving the road away from Nason Creek eliminates the three CED sites and restores much of the historic floodplain connectivity, channel migration zone and aquatic habitat complexity.
- Avoids avalanche hazard areas.

Disadvantages of Alternative Three include:

- Approximately 2.0 acres of wetland fill and 3.5 acres of indirect floodplain wetland impact.
- Fill is placed in a large segment of the existing north floodplain side channel and wetlands, not achieving full restoration of floodplain function and likely requiring future maintenance from river processes.
- Alignment has some risk of destabilizing slope.
- Lengthy utility relocations.
- Cost is moderately high ($18.5M).
- Direct impacts to private properties to realign the roadway.

3.1.4 Re-alignment Alternative Four

The Chelan County report notes that this alternative re-connects approximately 74.7 acres of Nason Creek floodplain. YN estimated floodplain and roadway area minus wetland fill and impacts area is approximately 65.2 acres. The new road would run along the edge of the existing floodplain and be approximately 9,996 feet long. The maximum road slope is 4.00 percent. To construct the road, it is estimated 2.3 acres of wetland will be filled plus a small amount of indirect floodplain wetland impact. The estimated cost in 2022 dollars is $16.3M.

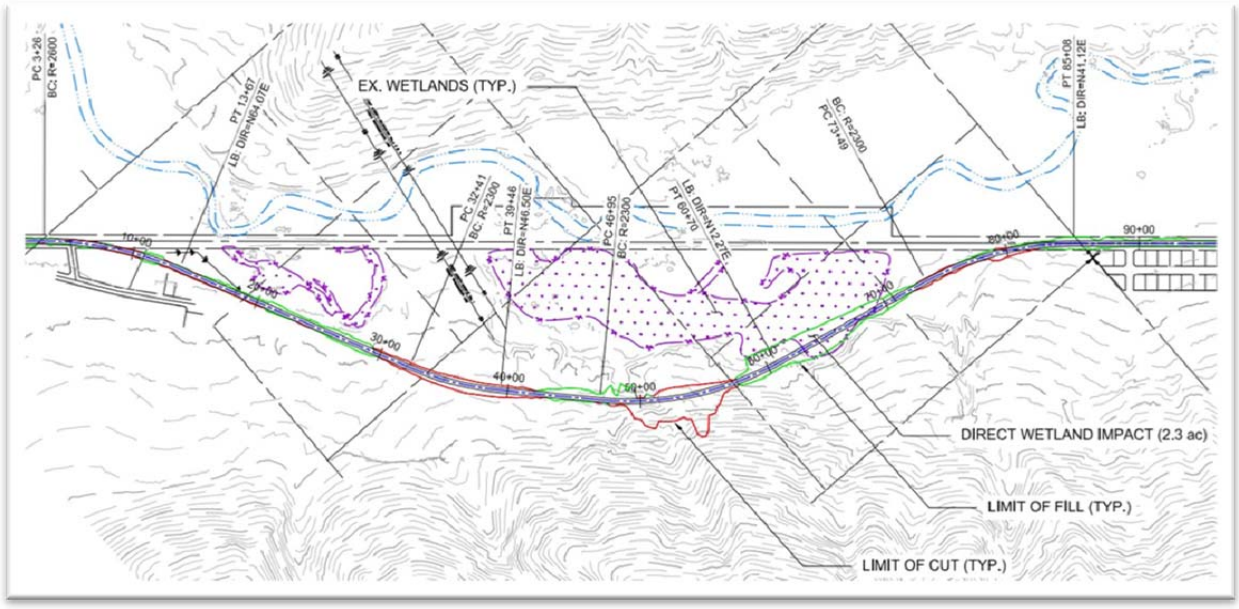

Figure 18. Alternative 4

Advantages of Alternative Four include:

- Meets AASHTO criteria with moderately steep (4%) grade.
- Moving the road away from Nason Creek eliminates the three CED sites and restores much of the historic floodplain connectivity, channel migration zone and aquatic habitat complexity.
- Avoids avalanche hazard areas.

Disadvantages of Alternative Four include:

- Approximately 2.3 acres of wetland fill and small area of indirect floodplain wetland impact.
- Some fill is placed in a small segment of the existing north floodplain side channel and wetlands, not achieving full restoration of floodplain function and possibly requiring future maintenance from river processes.
- Alignment has some risk of destabilizing slope.
- Lengthy utility relocations.

- Cost is moderately high ($16.3M).
- Direct impacts to private properties to realign the roadway

3.1.5 Re-alignment Alternative Five

The Chelan County report notes that this alternative re-connects approximately 77 acres of Nason Creek floodplain. YN estimated floodplain and roadway area minus Chelan County's estimate of wetland fill and indirect floodplain wetland impacts area is approximately 67.5 acres of floodplain reconnection. The new road would run along the edge of the existing floodplain and be approximately 9,950 feet long and follows approximately 3,500 feet of historic SR 207 alignment. The maximum road slope is 4.0 percent. No wetland would be filled in this alternative. Private property will be affected. The estimated cost in 2022 dollars is $19.1M.

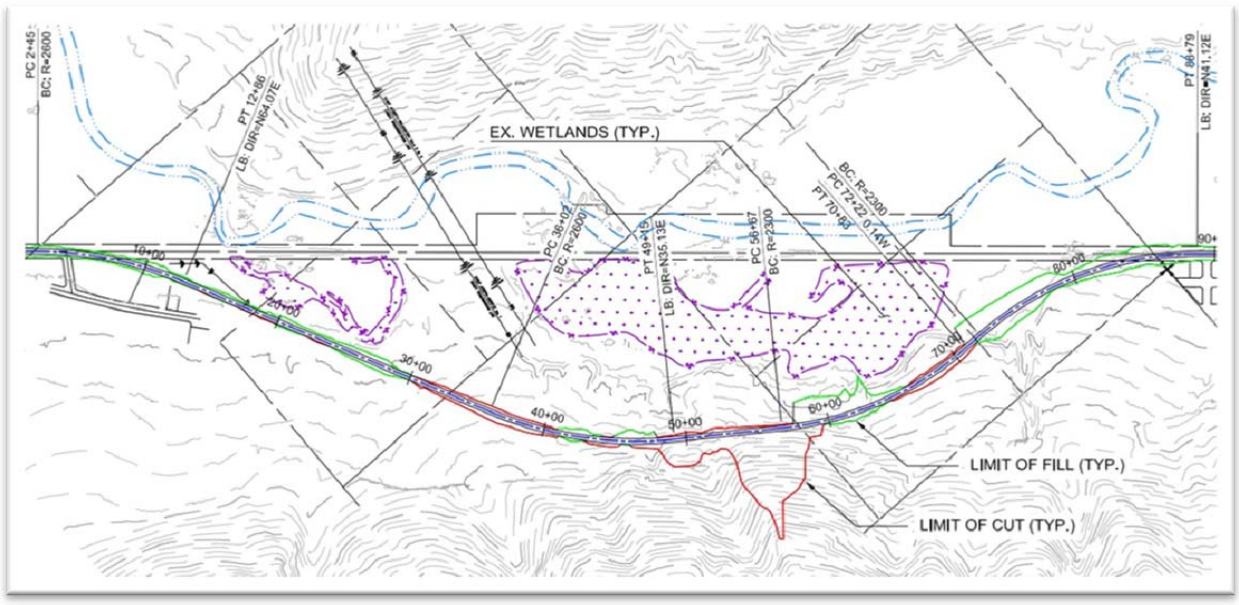

Figure 19. Alternative 5

Advantages of Alternative Five include:

- Meets AASHTO criteria with moderately steep (4%) grade.
- Moving the road away from Nason Creek eliminates the three CED sites and restores historic floodplain connectivity, channel migration zone and aquatic habitat complexity.
- Alignment follows terrace with low risk to destabilizing slope.
- Avoids all floodplain wetland and side channel impacts.

Disadvantages of Alternative Five include:

- Introduces new roadway risks from avalanche zones.
- Lengthy utility relocations.
- Cost is moderately high ($19.1M).
- Direct impacts to private properties to realign the roadway.

3.1.6 Re-alignment Alternative Six

The Chelan County report notes that this alternative re-connects approximately 77 acres of Nason Creek floodplain. YN estimated floodplain and roadway area minus Chelan County's estimate of wetland fill and indirect floodplain wetland impacts area is approximately 67.5 acres of floodplain reconnection. The new road would be 13,300 feet long and follow the historical road alignment for 5,500 feet. It will be outside of existing floodplain. The maximum road slope is 4.01 percent. This alternative will cross a ravine that will require a bridge. No wetlands are impacted. The alignment will cross private property. The estimated cost in 2022 dollars is $29.3M.

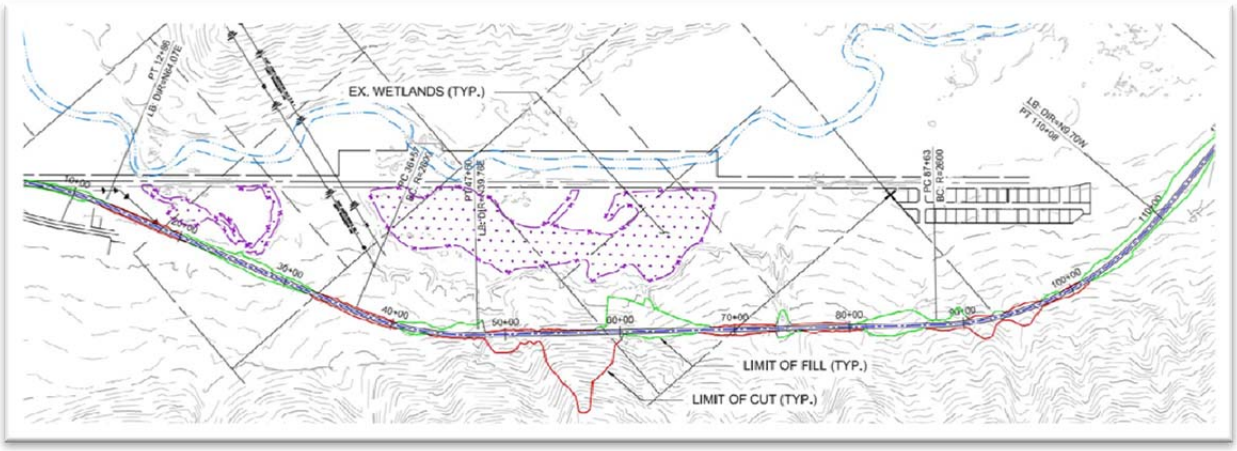

Figure 20. Alternative 6

Advantages of Alternative Six include:

- Meets AASHTO criteria with moderately steep (4%) grade.
- Moving the road away from Nason Creek eliminates the CED sites and restores historic floodplain connectivity, channel migration zone and aquatic habitat complexity.
- Avoids all floodplain wetland and side channel impacts.

Disadvantages of Alternative Six include:

- Introduces new roadway risks from avalanche zones..
- Lengthy utility relocations.
- Cost is very high ($29.3M).
- Direct impacts to private properties to realign the roadway.

3.1.7 Re-alignment Alternative Seven

Yakama Nation Fisheries staff and the Inter-Fluve design team proposed another highway realignment alternative along the southern half of the project reach that could have substantial road protection and fish habitat benefits. In 2020, the Yakama Nation brought this new road realignment concept to the attention of WSDOT and USFS, and it was determined that the new concept likely avoided some of the shortcomings of previous road realignment alternatives and should be considered before moving ahead with conducting the 2019 proposed actions.

To provide further detail to the new road relocation concept, a brief feasibility study was completed in the summer of 2021 by Perteet, Inc. that included engineering concepts and estimated costs for the shorter road realignment. The new road re-alignment strategy would remove approximately a half mile of road from the Nason Creek meander corridor and eliminates the two worst Chronic Environmental Deficiency sites from the river corridor. This concept avoids geographic constraints that impacted previous alignments while the road itself would remain on USFS land for the entire length.

This alternative re-connects approximately 12.9 acres of Nason Creek floodplain. The new road would be 4,000 feet long and outside of existing floodplain. The maximum road slope is 4.31 percent. To construct the road, it is estimated that approximately 0.9 acres of wetlands would be filled in the north floodplain. This alternative has three grading options based on vehicle speed limits. To maintain consistency, the 55 mile per hour road design will be used for comparison with the Chelan County alternatives.

The estimated cost in 2022 dollars is $10.8M.

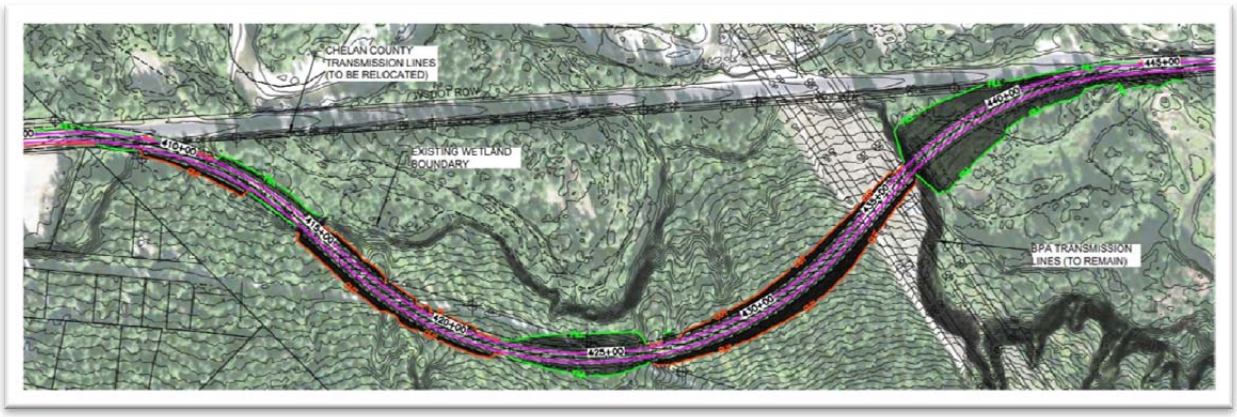

Figure 21. Alternative 7

Advantages of Alternative Seven include:

- Meets AASHTO criteria with moderately steep (4.3%) grade.
- Moving the road away from Nason Creek from RM 4.1 through 4.5 eliminates the two most active CED Sites 1 and 2. Also, removes the road inhibiting river access to the historic floodplain, channel migration zone and improves aquatic habitat complexity for the South Floodplain.
- Avoids avalanche hazard areas.
- Avoids private property.
- Cost is moderate ($10.8M).

Disadvantages of Alternative Seven include:

- Approximately 0.95 acres of fill for 55MPH alignment option. Approximately 0.1 acres of fill for 45MPH alignment option.
- Highway embankment remains from RM 3.3 to 4.1.
- Moderate length of utility relocations.

3.2 SR 207 Protection Alternatives

Protecting the road within its current right of way is possible but requires additional infrastructure to reduce channel migration forces on the roadway. These methods do not provide as great a benefit to natural processes and fish habitat as road re-alignment would.

Four alternatives that keep the road in its current alignment while providing roadway protection and habitat enhancements were developed by Chelan County in 2012 (Alternatives 8-11). Cost estimates are based on the Chelan County 2011 values forecasted to 2022 values based on 4% inflation. As noted, for Alternatives 1-6, the forecasted values matched remarkably well to Perteet's adjustments to current typical unit costs.

3.2.1 Raised Road Causeway Alternative Eight

This alternative reconnects the 12.9 acres of disconnected floodplain south of the BPA power lines. It does so by maintaining the existing alignment but raises the road with a causeway over a distance of 1,800 feet. The causeway is 36 feet wide and be supported by concrete piers. The design structure enables Nason Creek to migrate beneath the causeway and allows inundation to historical floodplain areas at all flows. Life of the structure is similar to a bridge and is expected to be between 75 and 100 years. Design and construction cost estimates were $20 million in 2022 dollars . The benefit to salmon habitat and stream processes would be similar to that found in alternatives one and two. The area of habitat benefit would be less than the earlier alternatives.

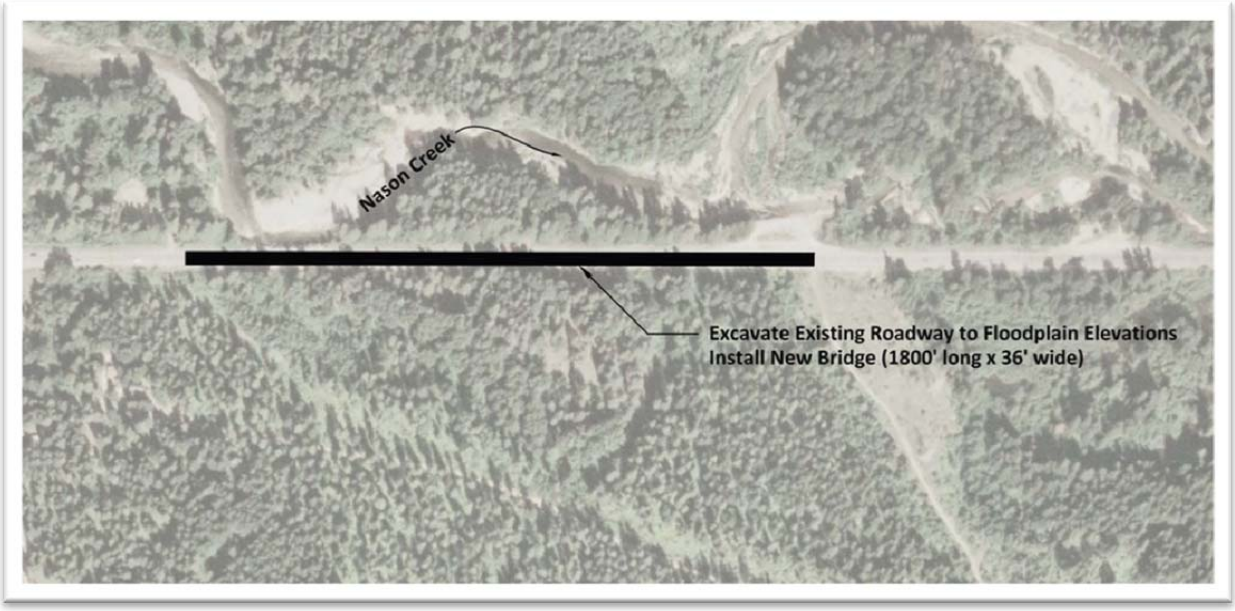

Figure 22. Alternative 8

Advantages of Alternative Eight include:

- Placing the road on piers for RM 4.1-4.5 allows significant reconnection of the South Floodplain.
- Changes the hydraulic dynamics at the two most active CED Sites 1 and 2.
- No change to grade or alignment of current roadway.
- Avoids avalanche hazard areas.
- Avoids private property.

Disadvantages of Alternative Eight include:

- Piers remain in active river/floodplain with risk of erosion, racking of LW debris and ongoing maintenance.
- Moderate length of utility relocations
- Cost is moderately high ($20.0M).

3.2.2 Full floodplain reconnection with Bridges - Alternative Nine

This alternative reconnects and allows inundation of 12.9 acres of floodplain using two bridges. This alternative allows good floodplain access and inundation at all flows but does not allow migration processes to occur into the southern floodplain east of the current highway alignment. The inlet and outlet of each bridge will require armoring, and will constrain the river passing the road embankment to specific locations. It is possible future roadway armoring will be required along the road prism between the two bridges. Each bridge would be 200 feet long and 36 feet wide. Based on Chelan County's preliminary hydraulic modelling, flows into the floodplain would begin during the 2-year discharge event. During the 100-year return event, approximately 1,000 cubic feet per second (cfs) would flow under the bridges. The alternative includes excavation at the downstream third of a historic Nason Creek channel to enhance high flow (May-June) backwater habitat for rearing spring Chinook and steelhead. The design and construction estimate for this alternative is $8.8 million in 2022 dollars.

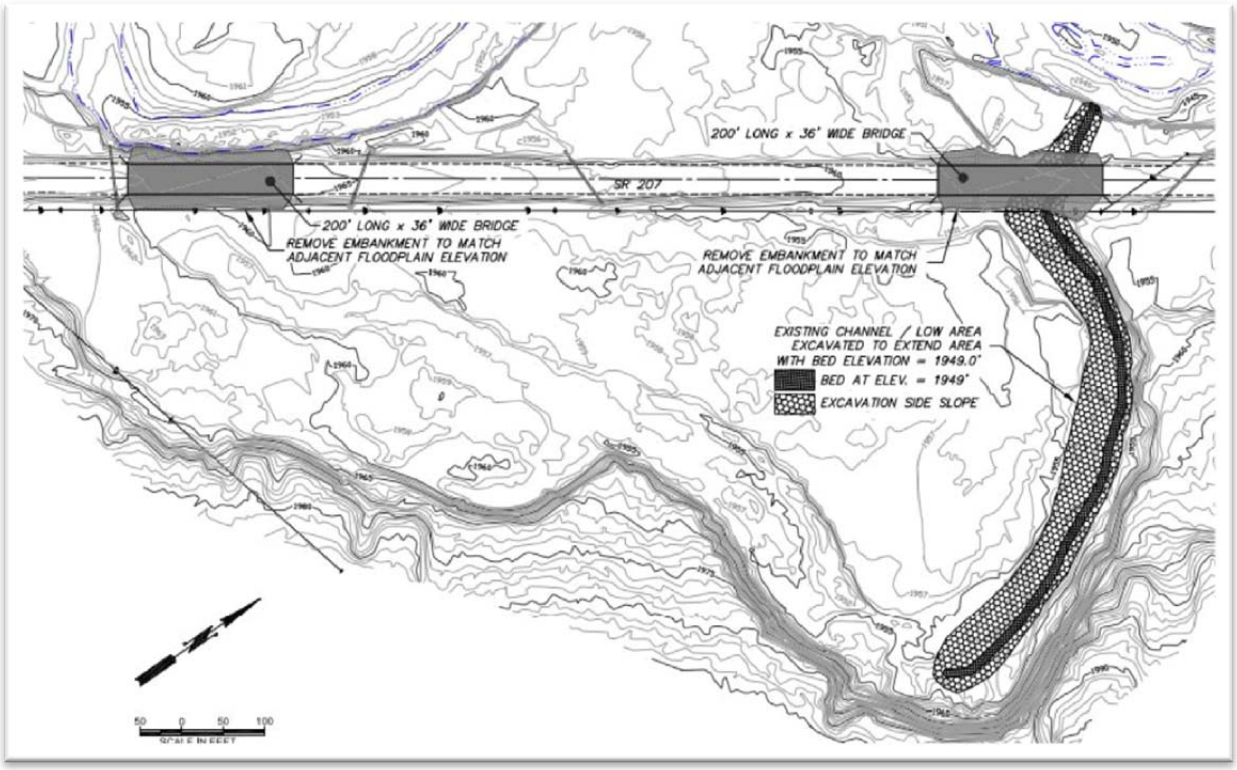

Figure 23. Alternative 9

Advantages of Alternative Nine include:

- Installing bridges could temporarily improve through flow through the South Floodplain.
- No change to grade or alignment of current roadway.
- Utility relocation only needed at new bridges.
- Avoids avalanche hazard areas.

- Avoids private property.

Disadvantages of Alternative Nine include:

- CED sites remain.
- Bridges susceptible to debris, erosion and required inspections and maintenance.
- Remaining roadway blocks full floodplain connectivity and prevents channel migration.
- Down-valley bridge alignments present risk that the creek channel could migrate away from the bridges over time.
- Some wetland impacts would be required from side channel excavation.
- Cost is moderate ($8.8M).

3.2.3 Partial floodplain reconnection with culverts - Alternative Ten

This alternative allows the inundation of 12.9 acres of floodplain by installing two culverts to convey water through the SR 207 road prism. The culverts would be designed to meet WDFW fish passage criteria. The degree of inundation is significantly less than alternative nine with 300 cfs running through the culverts during a 100-year return event. The high flow (May-June) backwater habitat available to salmonids would be similar to the bridge alternative nine. The cost of installing two thirty-foot box culverts is approximately $1.2 million in 2022 dollars.

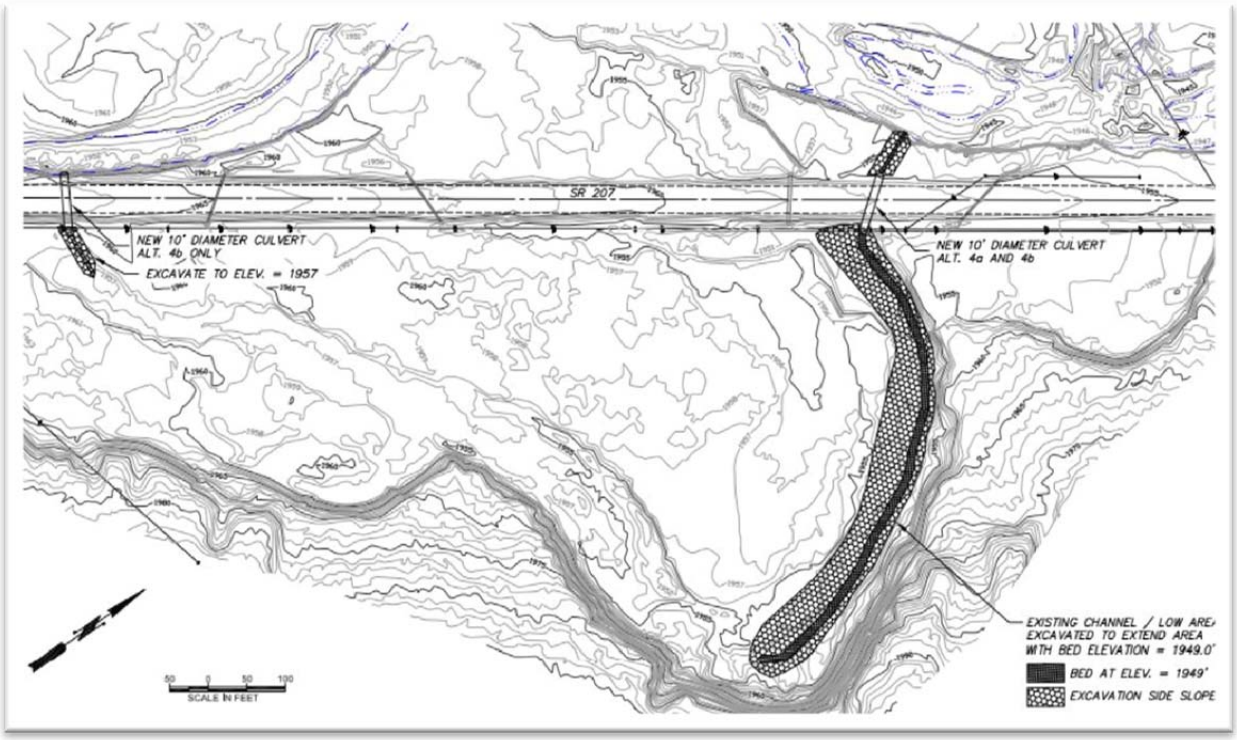

Figure 24. Alternative 10

Advantages of Alternative Ten include:

- Installing culverts moderately improves through flow through the South Floodplain.
- No change to grade or current roadway conditions.
- Utility relocation only needed at new culverts.
- Avoids avalanche hazard areas.
- Avoids private property.
- Cost is low ($1.8M)

Disadvantages of Alternative Ten include:

- CED sites remain.

- Culverts highly susceptible to debris, erosion and required inspections and maintenance.
- Remaining roadway blocks full floodplain connectivity and prevents channel migration.
- Down-valley culvert alignments present risk that the creek channel could migrate away from the culverts over time, negating the environmental benefits
- Some wetland impacts would be required from side channel excavation.
- Achieves limited habitat or floodplain connectivity benefit and no increase in channel migration zone

3.2.4 Stabilize with large wood jams - Alternative Eleven

There is wide agreement that the existing road prism could be stabilized using engineered log jams to both stop further channel migration and to create localized rearing and cover habitat for salmonids. Conceptually, this idea has been presented in several reports and assessments (Chelan County, 2011), (WSDOT, 2019) (Inter-Fluve, 2019) and (BOR, 2008). In this alternative, riprap work completed by WSDOT since 1995 would be partially replaced by a series of engineered logjams capable of resisting erosive forces but also provide complex holding and rearing habitat for both juvenile and adult salmon and steelhead. This alternative would work in areas that have actively eroded in the past and anticipate areas that could eroded in the future. Inter-Fluve concept designs in project areas 1 and 2 estimated the cost to protect the road in place with engineered log jams and placement of LWM and created side channels for additional habitats would cost roughly $1,750,000 .

Advantages of Alternative Eleven include:

- Provides some increased fisheries habitat from LWM and channel enhancements.
- Minimal roadway, utilities, and private property impacts: no changes to grade of road, no utility relocations required, avoids avalanche hazard areas and avoids private property.
- Cost is low ($1.8M)
- Placement of LWM structures could be designed to reduce risk of future channel capture along the road prism, and provide habitat and enhance road stability conditions.
-

Disadvantages of Alternative Eleven include:

- CED sites remain.
- No improvement to floodplain connectivity or channel migration zone.
- LWM may have limited service life.

3.2.5 No Action - Alternative Twelve

No action will result in continued natural lateral migration and future road embankment erosion riprap armoring and maintenance. Most of the remaining road alignment is at risk of future erosion and only a small percentage has been armored to date. Emergency actions during flood migration and erosion into the road are generally detrimental to fish habitats. Continued habitat degradation and chronic road maintenance can be expected over a decadal time scale. Total cost for road armoring, timing and need are not possible to predict or estimate.

Advantages of Alternative Twelve include:

- No direct roadway, utilities, and private property impacts.
- No implementation cost.
- Avoids private property.

Disadvantages of Alternative Twelve include:

- CED sites remain.
- No improvement to road embankment stability or reduction in road maintenance needs.
- No habitat improvements.
- No floodplain connectivity or channel migration zone improvement.
- Existing risk of future channel capture along the road prism remains high, endangering future habitat and road stability conditions.

4. Preliminary Alternative Evaluations

4.1 Road Relocation Geologic Evaluation

In 2011, engineering geologist Ken Neal provided a summary of likely impacts of highway construction and possible mitigation within the context of the geologic terrain and processes acting within the project reach. The report addressed SR 207 re-alignment alternatives one through six. The following (italics) are conclusions taken directly from the report:

> *Optional locations are being considered as alternatives to the existing alignment of SR 207 to allow for channel migration across the entire Nason Creek flood plain, improving fish habitat. A secondary objective is to provide a stable highway location that is not periodically damaged by stream flow, particularly during flood events.*
>
> *Option* (Alternative) *1 does not appear to meet these objectives, as the location follows along the channel Nason Creek occupied prior to construction along the existing alignment, which means that, during high flow, the new location would be subject to erosional forces similar to the existing fill. The earthwork along the base of the bluff required by Option 1 would likely destabilize the bluff, increasing the financial impact to agencies responsible for road maintenance.*
>
> *Options* (Alternatives) *2, 3 and 4 all would require deep excavations into the alluvial fans and through the bluff, as well as constructing bridges across the old channel and, possibly, fill embankments within the floodplain. These options would all, without significant mitigation, likely destabilize slopes along and adjacent to the bluff. These options would also cross a significant parcel of Parcel 261709110050.*
>
> *Option* (Alternative) *5 would likely result in the fewest impacts on geomorphic processes, since it avoids the Nason Creek channel area and, for much of its length, crosses relatively gentle slopes. Option 5 would also cross a significant part of Parcel 261709110050.*
>
> *Option* (Alternative) *6 avoids areas of potential slope movement and the Nason Creek drainage, however, it is significantly longer than any of the other alternatives, requiring much more removal of vegetation, earthwork, and modification of drainage patterns.*

The Yakama Nation road realignment Alternative 7 was not addressed since it did not exist at the time of the 2011 report. Alternative 7 has very few impacts, avoids the Nason Creek historical channel through the south floodplain, and runs entirely on United States Forest Service (USFS) Land. It has a very low relative impact compared to the other re-alignment alternatives.

4.2 Road Relocation USFS Evaluation

As noted in the Chelan County Feasibility study, the USFS evaluated road re-alignment Alternatives 1-6 with regard to Northwest Forest Plan management directives and forest level resource management planning. Alternative 7 was not evaluated by the USFS because it has just recently been proposed. Soils, hydrology, wildlife, fisheries, botany, fire/fuels, vegetation management, scenery, cultural resources, recreation, special uses, engineering, and public scoping were examined within the USFS land management framework.

There is agreement that re-aligning SR 207 could provide a long-term solution to chronic maintenance issues and associated impacts to fisheries resources and natural river migration processes. A no action alternative would continue to impair riparian and floodplain function and negatively impact water quality and habitat diversity for threatened and endangered fish species. Future maintenance activities may have negative direct effect on fish and fish habitats.

Some road re-alignments were found to have far greater impacts than others. Alternatives 1-4 would impact riparian and floodplain/wetland function and be inconsistent with Northwest Forest Plan standards outlined in the Aquatic Conservation Strategy *RF -g. – Avoid wetlands entirely when constructing new roads.* From a USFS management perspective, Alternatives 5 and 6 would be preferred because of the low fisheries, aquatic and wetland impacts. Alternatives 1-4 do not realize management objects for Nason Creek to *Improve Aquatic Conservation Strategy objectives at the watershed scale by functionally connecting Nason Creek to its floodplain.* Alternative 7 appears to meet USFS land management objectives by not impacting floodplain and wetlands in the southern floodplain and minimal floodplain and wetland impact in the northern floodplain. It also seeks to functionally connect Nason Creek to its southern floodplain and would be consistent with actions that meet Aquatic Conservation Strategy objectives at the watershed scale.

> To complete a road re-alignment on USFS land, a completed NEPA document with public scoping will be required. Additional survey for cultural resources and other resources will be required. Alternatives with less ground disturbance will likely require less mitigation. Construction ground disturbance mitigation, post construction revegetation, fuels treatment/reductions, and construction timing are some of the items that would be analyzed during USFS survey and NEPA analysis.

Following review of the new Alternatives 7 option, USFS provided the following discussion (Matt Karrer, USFS, personal communication, August 22, 2022)

> *Alternative 7 has two options described with differing potential impacts regarding wetland fill on the northern end of the re-alignment. The 55 mph option would result in impacts to approximately 0.9 acres of wetland while the 45 mph option would result in approximately 0.1 acres of impact. From an aquatics standpoint, the Forest service considers the 45 mph option to be preferable. Further, the Forest Service considers either option of Alternative 7 to be preferable to protect in place options of the current highway location due to feasibility, cost of ongoing maintenance, and lack of restoration to the floodplain/meander habitat with these protect in place scenarios.*

Both options for Alternative 7 may be in conflict with NWFP RF-2.g, which describes standards used to meet the Aquatic Conservation Strategy when constructing new roads. While the alternative would be a re-alignment of an existing road in order to reduce current ecologic impacts and restore and increase ecologic function to Nason Creek, there would still likely be minor impacts to existing wetlands. The area impacted by alignment is likely the result of current highway and powerline location and embankments. Due to dynamic geomorphic process, it is likely that re-alignment of the highway would result in the creation of larger wetland complex than those impacted by re-alignment.

Alternative 7 would meet ACS objectives 1-9. Specifically:

ACS 1) Re-alignment of HWY 207 would restore the "distribution, diversity and complexity of watershed and landcape-scale features" by reconnecting approximately 12.9 acres of Nason Creek floodplain and allowing for dynamic geomorphic processes within the river corridor.

ACS 2) Re-alignment of HWY 207 restores spatial and temporal connectivity between Nason Creek and approximately 12.9 acres of its historic floodplain.

ACS 3) Re-alignment would restore the physical integrity of the aquatic system. Particularly shorelines by removing hardened areas used for highway protection, and bottom configurations by restoring floodplain connectivity.

ACS 4) Re-alignment would restore and maintain Water Quality by providing Nason Creek access to 12.9 acres of floodplain and all of the hydrologic functions floodplains provide such as sediment filtering, flow attenuation, infiltration, and maintenance of hyporheic conditions, etc.

ACS 5) By providing access to 12.9 acres of historic floodplain, highway re-alignment would directly serve to restore a portion of the sediment regime under which Nason Creek evolved.

ACS 6) By providing access to 12.9 acres of historic floodplain, highway re-alignment would restore floodplain/meander wetland habitat and restore historic patterns of sediment, nutrient, and wood routing that existed before being cut off by highway construction. Loss of 0.9 acres of wetland on the northern end of the re-alignment, would likely be offset by wetland creation as a result of floodplain/meander reconnection resulting from re-alignment.

ACS 7) Highway re-alignment would directly restore the timing, variability, and duration of floodplain inundation and water table elevation to 12.9 acres of historic floodplain/meander habitat.

ACS 8) By re-connecting 12.9 acres of floodplain/meander habitat to Nason Creek, highway re-alignment would likely restore species composition, and structural diversity of plant communities through time due to dynamic geomorphic processes. By allowing dynamic geomorphic process to occur on this section of Nason Creek, associated processes such as thermal regulation, nutrient filtering, natural erosion and migration processes would provide for physical complexity in the reconnected floodplain.

ACS 9) Re-alignment of the highway and subsequent re-connection of 12.9 acres of floodplain/meander habitat would, through time, help to restore population of native plan, invertebrate and vertebrate riparian dependent species.

4.3 Road Relocation WSDOT Evaluation

Also noted in the Chelan County Feasibility study, WSDOT evaluated alternatives 1-6 but did not evaluate the recently proposed alternative 7. WSDOT preferred Alternatives 1-4 due to lower grades and in part due to elevated risk from potential avalanche conditions associated with Alternatives 5 and 6. Potential avalanche risk was evaluated by Mike Stanford, WSDOT North Central Regional Avalanche Forecaster and Avalanche Control Supervisor. His input was as follows:

> *Option* (Alternative) *6 and to a lesser extent option* (Alternative) *5 could have potential avalanche problems affecting them at some point. Given that the risk is low due to the location east of the crest and that the area does not receive huge amounts of snow, there is evidence that snow slides have occurred here and could potentially affect the road if conditions were just right.*

A geology report by Neal (2011) also identifies the 1,600-foot-long full bench road of Alternative 6 as having potential avalanche problems because the slope angle is greater than thirty degrees and the area above the slope is more open. WSDOT believed there may be ways the avalanche risk could be mitigated during final design. However, WSDOT would need upper management, funding and legislative direction for WSDOT to further work on a SR 207 relocation project. We do not know how WSDOT would evaluate alternative 7. However, it seems unlikely to have as large an avalanche risk as alternatives 5 or 6 because it is shorter, located along the southern half of the project area, and returns to the existing road alignment near the BPA power line corridor, avoiding potential avalanche runout zones.

YNF followed up with WSDOT for comment on the additional alternatives. WSDOT responded with the following (Joe Williams, WSDOT, personal communication, August 9, 2022):

> *WSDOT's position has not changed for the alternatives presented in the county's original study and WSDOT could support either of the two additional alternatives developed by the YN Fisheries – as these would both provide a long term solution to the chronic stream bank erosion taking place along SR 207.*

5. Alternatives Analysis

5.1 Evaluation Criteria

To establish a relative score for comparing the seven alternatives, a matrix was constructed. It uses the attributes identified below which follow methods used by Chelan County in their 2012 feasibility analysis. As scoring is somewhat subjective, each scored alternative was given a color code:

- Green = exceeds objective/criteria.
- Yellow = adequately meets objective/criteria.
- Orange = only partially meets objective/criteria.
- Red = does not meet objective/criteria, potential fatal flaws.

Some attributes are non-numerical in that they either pass, fail, or are currently unknown.

A summary evaluation matrix is provided with attributes for each alternative and is included in Appendix A.

5.1.1 Does the project meet AASHTO design safety standards?

This attribute is a non-numerical check box for road projects. All road realignment alternatives will meet design safety standards.

5.1.2 Grade changes

Driving conditions prefer straight and level. Road grade changes are considered a negative in attribute scoring. No grade changes are scored green, 1-2% are scored yellow, 2-5% are scored orange.

5.1.3 Maintenance

Future roadway maintenance costs, impacts to fish habitat and potential roadway erosion risk were evaluated for each alternative. Each of the three attributes was given a rating. Alternatives Five and Six were scored green in each attribute as these alignments remove three CED sites and the roadway is removed from the floodplain. Alternatives one through four were scored yellow as they place fill in the floodplains. Alternative seven was scored yellow as it removed two CED sites and roadway from the South Floodplain, but does not address CED site 3 or the roadway along the North Floodplain. Alternatives Eight through Twelve were scored orange as they do not move the road from its current location nor remove the CED sites.

5.1.4 Constructability

Two important components to some projects are the need to relocate utilities and detour impacts to the traveling public. Detour impacts and utility relocation impacts were scored between orange (significant impact) to green (no impact) for each alternative.

5.1.5 Geologic hazards

Geologic hazards identified by Chelan County and shown in Figure 3 were evaluated for each alternative. These hazards include geomorphic hazards associated with meander migration and hillslope failures that could impact road re-alignment alternatives. A score of red (significant risk), to green (low risk), were given to each alternative.

5.1.6 Snow-avalanche hazards

WSDOT North Central Regional Avalanche evaluation indicated some alternatives posed a risk for future snow avalanche hazard based on location, snow loading potential, and slope. Alternatives that had a potential avalanche hazard were given a score of red. Those that did not were given a score of green.

5.1.7 Cost

Original cost estimates for the Chelan County and Yakama Fisheries work products were inflated to 2022 dollars from their original estimates to maintain a consistent comparison. Alternatives 1-6 estimates were adjusted to current unit costs by Perteet, Alternative 7 estimate was prepared by Perteet, and remaining alternatives were adjusted to 2022 dollars from the 2011 estimates by 4% inflation. The Perteet adjusted costs for Alternatives 1-6 were remarkably close to 2011 estimates inflated at 4% to current costs. Projects that were less than $2 million received a score of green. Those between $2 and $11 million a score of yellow. Those between $11M and $20M scored yellow. Alternatives with costs greater than $20M received a score of red.

5.1.8 Natural environment

Biological benefit to fish habitat, wetland/floodplain impacts, and floodplain connectivity or access are three attributes important to the natural environment. All three were evaluated against each alternative and given a score of green through red. Projects that create a high benefit to fish habitat, a low impact to wetlands/floodplains, and larger floodplain connectivity (in acres) were given a higher score than those that did not. To fully evaluate wetlands impacts, existing wetland category will need to be assessed to determine if and how much mitigation is required. Wetland fill and impacts less than 0.5 acre were scored green; 0.5 to 2.0 acres scored yellow; 2.0 to 3.0 acres were scored orange; and, greater than 3.0 acres scored red.

5.1.9 Meets project objectives

Three key project objects are: 1) travel safety, 2) a reduction in current and future road maintenance, and 3) impacts to fish habitat and natural stream process restoration. These three attributes were scored from green to yellow. Alternatives that better meet each objective received a higher score than those that do not.

5.1.10 Landowner willingness

Public and Private lands are factors in road re-alignment alternatives. Alternatives that had public land support were given a score of green whereas Alternatives that lacked public land support were

scored orange. Private land impacts were scored based on number of private parcels impacted as approximated using Chelan County GIS data base. Private lands scored green for no private parcels impacted, orange for one private parcel, and red if multiple private parcels are impacted. Outreach to private landowners would be required to determine actual Landowner willingness.

5.2 Alternative Analysis Results

As discussed above and summarized in the Alternatives matrix, a number of factors are considered in selection of a preferred alternative. Each of these factors is provided a semi quantitative/qualitative scoring from desirable to undesirable. While all of these factors are to be considered in selection of a preferred alternative, factors that standout include:

- All Alternatives meet AASHTO requirements. Alternatives Two through Seven have moderate to moderately steep grades. Other Alternatives have no grade change or slight grade changes.
- Alternatives One through Six move the road away from the Nason Creek from RM 3.3 to 4.5 eliminating the three CED sites and improving floodplain connection to the North and South Floodplains.
    - Alternative One places fill along about half of an active side channel with large wetland impacts and some potential to destabilize the valley slope.
    - Alternatives Two through Four place varying amounts of fill in an active side channel and have wetlands impacts and some potential to destabilize the valley slope.
    - Alternatives Five and Six avoid the North and South Floodplain but have exposure to existing avalanche hazard areas.
    - Alternative Six impacts multiple private properties and has a very high cost.
- Alternative Seven removes the road from Nason Creek from RM 4.1 through 4.5, eliminating the two most active CED Sites 1 and 2 and provides floodplain connection to the entire South Floodplain.
- Alternative Eight replaces the two most active CED Sites 1 and 2 with a pier supported causeway. This alternative provides reconnection of the South Floodplain somewhat hindered by the piers and will require maintenance.
- Alternatives Nine through Twelve do not remove any CED sites nor create unhindered floodplain reconnection.
- Construction costs for:
    - Alternatives One through Five are moderately high to high.
    - Alternative Six is very high.
    - Alternative Seven is moderate.

- Alternatives Eight and Nine are moderately high.
- Alternative Ten is moderate.
- Alternatives Eleven and Twelve are low and none, respectively.

- As noted in Section 5.1, each factor was ranked green, yellow, orange or red. A summary graphic of the scoring is shown in Figure 25. A detailed matrix is included in Appendix A.

Alternative ID:	Alternative Description	*Count of Occurences*	*Sum of Occurences*			
1	Chelan County Road Re-alignment		6	6	5	1
2	Chelan County Road Re-alignment		6	5	7	0
3	Chelan County Road Re-alignment		6	5	7	0
4	Chelan County Road Re-alignment		6	5	7	0
5	Chelan County Road Re-alignment		11	1	5	1
6	Chelan County Road Re-alignment		11	1	3	3
7	Yakama Nation Road Re-alignment		8	9	1	0
8	Chelan County Raised Road Causeway		7	3	8	0
9	Chelan County Floodplain Reconnect (Bridges)		7	3	8	0
10	Chelan County Floodplain Reconnect (Culverts)		8	2	8	0
11	Engineered Large Wood Jams		9	3	4	2
12	No Action		10	0	4	4

Green=exceeds objective/criteria.
Yellow=adequately meets objective/criteria.
Orange=only partially meets objective/criteria.
Red=does not meet objective/criteria, potential fatal flaws.

Figure 25. Scoring summary

Future Project Development Recommendations:

Alternative 7 has the most criteria meeting or exceeding the project objectives and has only one mark as "meets partial objective/criteria". Alternative 7 has no marks as "potential fatal flaw". Based on the output of the alternatives analysis matrix, the Yakama Nation, WSDOT, and USFS recommend further work be immediately conducted regarding Alternative 7. It should also be noted that despite the feasibility and high cost concerns noted for some of the other road realignment alternatives, the Yakama Nation will be monitoring funding, design and private property access opportunities for future road realignment out of the northern floodplain area.

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7. Appendix A: Alternatives Evaluation Summary Matrix

8. Appendix B: Chelan County Feasibility Study

9. Appendix C: YN Project Area 1 Report

10. Appendix D: YN Project Area 2 Report

11. Appendix E: YN Project Area 3 Report