PRELIMINARY
TUMWATER CANYON REACH ANALYSIS OF WENATCHEE RIVER AND US 2, MILEPOST 94 TO 98
Project Number 4129403

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Glossary of Geologic Terms

Aggradation: (ag'-gra-da'-tion) The process of building up a surface by deposition. See also: *Aggrading Stream*.

Aggrading stream: (ag-grad'-ing) A stream that is actively building up its channel or floodplain due to sediment load exceeding transport capability. **Alluvial:** (al-lu'-vi-al) Pertaining to or composed of *alluvium*, or sediment deposited by a stream or running water.

Alluvial Fan: An outspread, gently sloping mass of *alluvium* deposited by a stream, where it issues from a narrow canyon onto a plain or valley floor, especially in an arid or semiarid region. Viewed from above, it has the shape of an open fan, the apex being at the valley mouth.

Alluvium: (al-lu'-vi-um): A general term for detrital deposits made by streams on river beds, floodplains, and *alluvial fans*; especially a deposit of *silt* or silty *clay* laid down during time of a flood. The term applies to stream deposits of *recent* time (see *Holocene*). It does not include subaqueous sediments of seas and lakes.

Anastomosing: (a-nas'-to-mos-ing) Branching and recombining, as in a *braided stream*.

Avalanche: (av'-a-lanche) A large mass of snow, ice, soil, rocks, or mixtures of these materials, that falls, slides, or flows very rapidly under the force of gravity. Velocities may exceed 500 km per hour.

Bankfull stage: The elevation of the water surface in a stream flowing at its channel capacity. Discharge at this stage is called *bankfull discharge*. Also spelled: *Bankful*.

Batholith: (bath'-o-lith) A large, generally discordant *plutonic* mass of rock that has more than 40 square miles (100 square kilometers) of surface exposure and no known floor. Its formation is believed by most investigators to involve magmatic processes. Also spelled: *bathylith*.

Boulder: (boul'-der) A detached rock mass larger than a *cobble* with a diameter greater than 256 mm (~10 inches)that is somewhat rounded or otherwise distinctively shaped by abrasion in the course of transport, the largest rock fragments recognized by sedimentologists.

Braided stream: A stream that divides into an interlacing network of branching and reuniting shallow channels, separated from each other by islands or channel bars, resembling the strands of a complex braid in plan view; especially an overloaded and *aggrading stream* flowing into a wide channel on a floodplain.

Clast: An individual constituent, grain, or fragment of a detrital *sediment* or *sedimentary* rock, produced by the physical disintegration of a larger rock mass.

Clay: A detrital mineral particle of any composition having a diameter less than $^{1}/_{256}$ mm (4 microns).

Cobble: A rock fragment between 64 and 256 mm in diameter, thus larger than a *pebble* and smaller than a *boulder*, rounded or otherwise abraded in the course of aqueous, eolian or glacial transport.

Debris: (de-bree') Any surficial accumulation of loose material detached from rock masses by decay and disintegration, mainly rock fragments and soil.

Debris avalanche: The sudden downslope movement of the soil mantle on steep slopes, often caused by saturation from heavy rains.

Debris flow: A moving mass of rock fragments, soil and mud, where more than half of the particles are larger than *sand* size. Slow debris flows may move less than 1 m per year; rapid ones reach 160 km per hour.

Degradation: (deg-ra-da'-tion) The general lowering of the surface of the land by erosive processes, especially by the removal of material through erosion and transportation by flowing water.

Diorite: (di'-o-rite) A group of *plutonic* rocks intermediate in composition between acidic and basic, characteristically composed of hornblende, oligocase or andesine, pyroxene, and sometimes a little quartz; the approximate *intrusive* equivalent of andesite. Diorite grades into *monzonite* with an increase in the alkali feldspar content.

Dune-ripple morphology: A stream channel form associated with a specific flow regime in mountainous areas that is dominated by low-gradient, *sand*-bed channels which have mobile bedforms. Some *gravel*-bed channels can exhibit bedforms during extreme discharges. Bedform configuration depends on flow depth, velocity, bed-surface grain size and sediment transport rate.

Extrusive: (ex-tru'-sive) Said of an *igneous* rock that has been erupted onto the surface of the earth. Extrusive rocks include lava flows and pyroclastic materials such as volcanic ash.

Felsic: (fel'-sic) A mnemonic adjective derived from *fe*ldspar + *l*enad (feldspathoid) + *si*lica + *c*, and applied to an *igneous* rock having abundant light-colored minerals; also, applied to those minerals (e.g., *quartz*, feldspars, feldspathoids, muscovite) as a group. It is the compliment to *mafic*.

Geology: The study of the earth – the materials of which it is made, the processes that act on these materials, the products formed, and the history of the planet and its life forms since its origin.

Geomorphology: (ge'-o-mor-phol-o-gy) The science that treats the general configuration of the earth's surface; specifically the study of the classification, description, nature, origin and development of landforms and their relationships to underlying structures, and the history of geologic changes as recorded by these surface features.

Gneiss: A foliated rock formed by regional *metamorphism*, in which bands or lenticles of granular minerals alternate with bands or lenticles of minerals with flaky or elongate prismatic habit. Generally less than 50% of the minerals show preferred parallel orientation. Although gneiss is commonly feldspar and *quartz*-rich, mineral

composition is not an essential factor in its definition. Varieties are distinguished by texture, characteristic minerals, or general composition and/or origin.

Graben: (gra'-ben) An elongated, relatively depressed crustal unit or block that is bounded by faults on its long sides. It is a structural form, which may or may not be geomorphologically expressed as a rift valley.

Granite: (gran'-ite) A *plutonic* rock in which *quartz* makes up 10-50% of the *felsic* components and the alkali feldspar/total feldspar ratio is 65-90%.

Granitic: (gra-nit'-ic) Pertaining to or composed of *granite*.

Granodiorite: (gran-o-di'-o-rite) A group of coarse-grained *plutonic* rocks intermediate in composition between *quartz diorite* (*tonalite*) and *quartz monzonite*, containing *quartz*, oligocase or andesine, and potassium feldspar, with biotite, hornblende,or, more rarely pyroxene, as the *mafic* components; also, any member of that group; the approximate *intrusive* equivalent of *rhyodacite*.

Granule: (gran'-ule) A rock fragment larger than a very coarse *sand* grain and smaller than a *pebble*, having a diameter in the range of 2-4 mm.

Gravel: (grav'-el) 1. An unconsolidated natural accumulation of rounded rock fragments, mostly of particles larger than *sand* (diameter greater than 2 mm), such as *boulders*, *cobbles*, *pebbles*, *granules*, or any combination of these; the unconsolidated equivalent of a *conglomerate*. 2. A popular term for detrital sediment along streams or beaches, composed chiefly of *pebbles* and *sand*. 3. An engineering term for rounded fragments with diameters in the range of 4.76 mm to 76 mm (0.2 to 3 inches).

Holocene: (Hol'-o-cene) An epoch of the *Quaternary* period, from the end of the *Pleistocene*, approximately 8,000 years ago, to present time; also, the corresponding series of rocks and deposits. When the *Quaternary* is designated as an era, the Holocene is considered to be a period. Also used as *recent* geologic time.

Igneous: (ig'-ne-ous) Said of a rock or mineral that solidified from molten or partly molten material, i.e. from *magma*; also, applied to processes related to the formation of such rocks. Igneous rocks constitute one of the three main classes into which rocks are divided, the others being *metamorphic* and *sedimentary*.

Intrusion: (in-tru'-sion) The process of emplacement of *magma* in pre-existing rock; magmatic activity. Also, the *igneous* rock mass so formed.

Intrusive: (in-tru'-sive) Of or pertaining to *intrusion*, both the process and the rock so formed.

Jurassic: (Ju-ras'-sic) The second period of the Mesozoic era (after the Triassic and before the Cretaceous), thought to have covered the span of geologic time between 190 and 135 million years ago; also, the corresponding system of rocks. It is named after the Jura Mountains between France and Switzerland, in which rocks of this age were first studied.

Lava: Fluid rock that issues from a volcano or fissure onto the surface of the earth; also, the same material solidified by cooling.

LiDAR: An acronym for "*li*ght *d*etection *a*nd *r*anging;" an optical remote sensing technique that measures properties of scattered light (mainly laser pulses) to find range and/or other information of a distant target.

Mafic: Said of an *igneous* rock composed chiefly of dark, ferromagnesian minerals. It is the compliment of *felsic*. Etymology: a mnemonic term derived from *ma*gnesium + *f*err*ic*.

Magma: (mag'-ma) Naturally-occurring molten rock generated within the earth and capable of *intrusion* and *extrusion* (as *lava*) from which *igneous* rocks have been derived through solidification and related processes. It may or may not contain suspended solids (such as crystals and rock fragments) and/or gas phases.

Manning's *n*: A hydraulic coefficient for open-channel flow that accounts for the roughness of a surface, originally described by Irish engineer Robert Manning in 1889.

Metadiorite: The name applied to a metamorphosed *diorite* rock.

Metamorphic: Any rock derived from pre-existing rocks by mineralogical, chemical, and/or structural changes that occur essentially in the solid state in response to marked changes in temperature, pressure, shearing stress, and the chemical environment, generally at depth in the earth's crust.

Pebble: A rock fragment, generally rounded by abrasion, larger than a *granule* and smaller than a *cobble*; it has a diameter in the range of 4-64 mm, or a size between that of a pea and that of a tennis ball.

Plane bed morphology: A stream channel form associated with a specific flow regime in mountainous areas that has relatively featureless bedforms and lacks discrete bars, low width-to-depth ratios, and large values of relative roughness .

Pleistocene: (Pleis'-to-cene) An epoch of the *Quaternary* period, after the Pliocene of the Tertiary and before the *Holocene*; also, the corresponding worldwide series of rocks. It began two to three million years ago and lasted to the start of the *Holocene*, some 8,000 years ago. When the *Quaternary* is designated as an era, the Pleistocene is considered to be a period.

Pluton: (plu'-ton) An *igneous intrusion*.

Plutonic: (plu-ton'-ic) Pertaining to *igneous* rocks formed at a great depth.

Pool-riffle morphology: Stream channel forms within a specific flow regime in mountainous areas that have sequences of bars, pools and riffles and which occur at moderate gradients.

Quaternary: (Qua-ter'-na-ry) The second period of the Cenozoic era, following the Tertiary; also, the corresponding system of rocks. It began two to three million years ago and extends to the present. It consists of two grossly unequal epochs: The *Pleistocene*, up to about 8,000 years ago, and the *Holocene* since that time. The Quaternary may also

be incorporated into the Neogene, when the Neogene is designated as a period of the Tertiary era.

Quartz: Crystalline silica, an important rock-forming mineral whose composition is silicon dioxide, SiO_2. It is, next to feldspar, the most common mineral, occurring either in transparent hexagonal crystals or in crystalline or cryptocrystalline masses. Quartz forms the major proportion of most sands and has a widespread distribution in *igneous* (especially *granitic*), *metamorphic* and *sedimentary* rocks. It has a greasy luster, a conchoidal fracture, an absence of cleavage, and a hardness of 7 on the Mohs scale.

Quartz monzanite: A *granitic* rock in which quartz comprises 10-50% of the *felsic* constituents and in which the alkali feldspar/total feldspar ratio is between 35-65%; the approximate *intrusive* equivalent of rhyodacite. With an increase in plagioclase and femic minerals, it grades into *granodiorite* and with more alkali feldspar, into *granite*.

Ravelling (or ravelling slopes): The gradual roughening of a weathered surface texture caused by the dislodging of individual aggregate pieces as fine particles wash or fall away. Also spelled: *Raveling*.

Riparian: (ri-par'-i-an) Pertaining to or situated on the bank of a body of water, especially of a river.

Sand: 1. A detrital particle smaller than a *granule* and larger than a *silt* grain, having a diameter in the range of $^1/_{16}$ to 2 mm. 2. A loose aggregate of such particles, most commonly of *quartz*.

Schist: A strongly foliated crystalline rock, formed by dynamic *metamorphism*, that has well developed parallelism of more than 50% of the minerals present, particularly those of lamellar or elongate prismatic habit, e.g. mica and hornblende.

Sediment: (sed'-i-ment) 1. Solid material that has settled down from a state of suspension in a liquid. 2. More generally, solid fragmental material transported and deposited by wind, water or ice, chemically precipitated from solution, or secreted by organisms, and that forms in layers in loose unconsolidated form, e.g., *sand*, mud, till. In this sense, the term is often used in the plural.

Sedimentary: (sed-i-men'-ta-ry) Pertaining to or containing *sediment*, or any rock formed by the deposition of pre-existing rocks and/or chemical precipitates.

Silt: 1. A detrital particle finer than fine *sand* and coarser than *clay*, commonly in the range of $^1/_{16}$ to $^1/_{256}$ mm. 2. A loose aggregate of rock or mineral particles of silt size, commonly with a high concentration of *clay* minerals. 3. Mud or fine earth in suspension in water.

Step-pool morphology: A stream channel associated with a specific flow regime in mountainous areas dominated by longitudinal steps formed by large *clasts* that are organized into discrete channel-spanning accumulations that separate pools containing finer materials, generally occurring at higher gradients.

Tectonic: (tec-ton'-ic) Pertaining to the forces involved in or the resulting structures of *tectonics*.

Tectonic terrain: (tec-ton'-ic ter-rain') A tract or region of the earth's surface considered as a physical feature that is dominantly formed by the resulting *tectonic* features.

Tectonics: A branch of geology dealing with the broad architecture of the outer part of the earth, that is, the major structural or deformational features and their relations, origin, and historical evolution. It is closely related to structural geology, but generally deals with larger features.

Thalweg: (thal'weg) 1. The line connecting the lowest points along a streambed or valley; a longitudinal profile. 2. The line of continuous maximum descent from any point on a land surface, e.g. the line crossing all contour lines at right angles. 3. A ground-water stream percolating beneath and in the same direction as a surface stream. 4. The deepest or best navigable channel, used in defining water boundaries between states.

Thrust fault: A fault with a dip of 45° or less over much of its extent, on which the hanging wall appears to have moved upward relative to the footwall. Horizontal compression rather than vertical displacement is its characteristic feature.

Tonalite: (to'-nal-ite) The name of an *igneous* rock whose composition is *quartz diorite*.

Ultramafic: (ul-tra-maf'-ic) Said of an *igneous* rock composed chiefly of *mafic* materials, e.g. monomineralic rocks composed of hypersthene, augite or olivine.

1. Introduction

United States Route 2 (US 2) through the Tumwater Canyon of the Wenatchee River has experienced repeated road failures, specifically in a four-mile stretch from Mile Post (MP) 94 to 98 (River Mile [RM] 32 to 28) (Figure 1-1). US 2 through the canyon, west of the City of Leavenworth in Chelan County, Washington, is a vital transportation corridor for the region. Records from the Washington State Department of Transportation (WSDOT) over the last 18 years clearly document a history of chronic road maintenance issues ranging from debris clearing and re-surfacing to reconstruction of the entire road prism. Tumwater Canyon is subjected to a range of natural hazards throughout the year that directly or indirectly impacts the highway, including washouts and flood inundations during Wenatchee River peak flow events, forest fires, mudflows, landslides, rockfalls, and snow avalanches. Records indicate that WSDOT maintenance costs from 1990 to 2006 for this four-mile section of US 2 have exceeded five million dollars. While it is clear that the chronic road maintenance needs present environmental costs, these issues also directly affect regulatory and stakeholder relationships of importance to WSDOT. As a result, the WSDOT Chronic Environmental Deficiencies (CED) Program has identified the Tumwater section of US 2 to be one of the highest road maintenance priorities within Washington State.

Based on the current state of US 2 in Tumwater Canyon, the need for periodic road repairs can be expected to continue indefinitely. Costly emergency repairs often result in temporary measures meant to facilitate immediate vehicular use and do not allow decision makers to consider the full array of possible impacts. One of the chronic maintenance sites is at US 2 MP 95.2, immediately downstream of the Chelan County Public Utility District (PUD) Tumwater Dam located at MP 95 (RM 33) (Figure 1-1). Historic observations from WSDOT maintenance personnel indicate that the dam, a large “L” shaped weir, may be contributing to road damage. The dam is a historic structure critical to regulatory commitments made by Chelan County PUD and will remain in place. This constraint must be considered in developing any long-term solutions for protecting US 2.

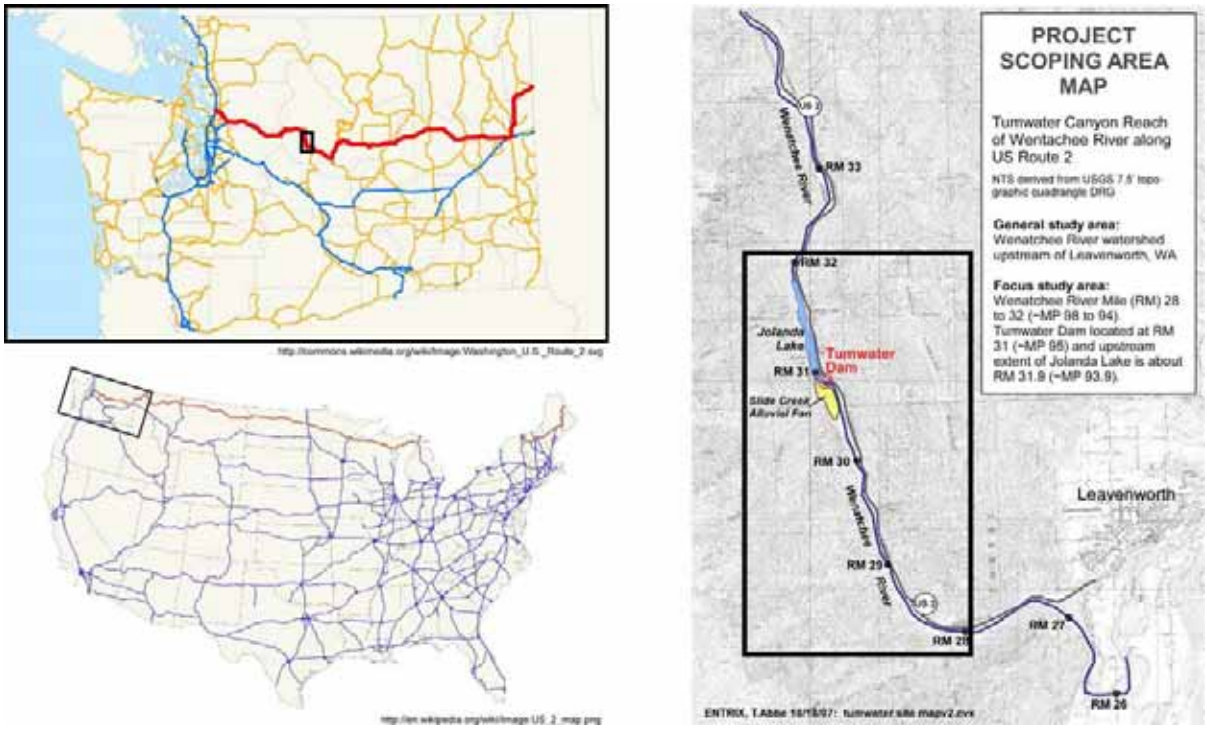


Figure 1-1. Project Area Map, Including MP 94 to 98 of US 2 through Tumwater Canyon, and RM 32 to 28 of the Wenatchee River.

ENTRIX was contracted by WSDOT to prepare a reach analysis for the four-mile stretch from MP 94 to 98 (RM 32 to 28) to determine the causal mechanisms behind the chronic road failures and to determine how much the Tumwater Dam may be contributing. This analysis includes the following components:

- Identification of those areas of US 2 where chronic maintenance issues have been reported and are expected in the future;
- Assessment of the geomorphic and hydraulic conditions in the project reach and how these conditions may be contributing to the chronic road maintenance problems on US 2;
- Alternative solutions for stabilizing the bank of the Wenatchee River along the US 2 road prism in the project reach, thus preventing or reducing future needs for road maintenance; and
- Planning-level cost estimates for the identified preferred alternatives.

After this introductory section, this reach analysis document is organized as follows:

- **Section 2**, Summary of the Road Maintenance Issues, identifies the section of US 2 requiring chronic maintenance, presents the dates of the historic road repair events due to flooding and other natural hazards, and summarizes the road failure issues.
- **Section 3**, Preliminary Geologic and Geomorphic Reach Analysis, describes bedrock geology and geomorphology through the project reach with a focus on geological and geomorphic factors that may influence road washouts along US 2.

- **Section 4**, Preliminary Hydrologic Assessment, presents information needed to develop an understanding of the magnitude of flows associated with historic flood events through the project reach, and develops flow rate values for use in the hydraulic analysis.
- **Section 5**, Preliminary Hydraulic Assessment, estimates water surface profiles, flow velocities, flow direction, stream power, shear stress, and other hydraulic parameters for the Wenatchee River using available data. This information is critical to understanding the impacts on US 2 that are causing the repeated and chronic road maintenance issues, and supports the subsequent alternative analysis.
- **Section 6**, Preliminary Fisheries Assessment, discusses the issues associated with the fish species in the area, specifically bull trout, Upper Columbia Chinook and Upper Columbia steelhead; to inform on how the diversity and status of the salmonids may impact the identification of a solution to the chronic road maintenance issues on US 2 in the project reach.
- **Section 7**, Preliminary Cultural and Historic Assessment, addresses the prehistoric and historic context of the project reach to identify important cultural resources so informed decisions concerning project permitting can be made.
- **Section 8**, Recommended Alternatives and Cost Estimates, details the three recommended alternatives for addressing the chronic road maintenance issues and provides a planning level estimate of construction costs.
- **Section 9**, Diagnosis, provides a summary of the key components of the reach analysis.

2. Summary of Road Maintenance Issues

2.1. Importance

US 2 through the project reach is subject to repeated road failures and subsequent debris clearing, re-surfacing, or reconstruction of the entire road prism. WSDOT recognizes that the periodic need for repairs can be expected to continue indefinitely unless these issues are addressed. A viable and effective solution to these issues will require an understanding of the causal mechanisms underlying the damage to US 2. The first step is to determine where and how often road maintenance has occurred by identifying the sections of the road requiring chronic maintenance and the dates of road repairs due to flooding and other natural hazards. The recorded events can then be classified, and hypotheses about causal mechanisms that incorporate geologic and hydrologic factors can be developed and investigated.

2.2. Methodology

Road repair information was acquired from the following sources: electronic mail correspondence between WSDOT and ENTRIX, electronic mail correspondence between PUD and ENTRIX, telephone conversations between Michael Exner-Kittridge of ENTRIX and Dave Toften of WSDOT on 03/12/08, telephone conversations between Michael Exner-Kittridge of ENTRIX and Richard Wood of WSDOT on 03/14/08, and a search of the archives of the Wenatchee Daily World/Wenatchee World Newspaper, Wenatchee, WA, from 1932-1975. River stage data used in assessing impacts to US 2 through Tumwater Canyon were acquired from the United States Geological Survey (USGS) stage gage 12457000 at Plain, WA, located approximately 10 miles upstream of the project site (Figure 2-1).

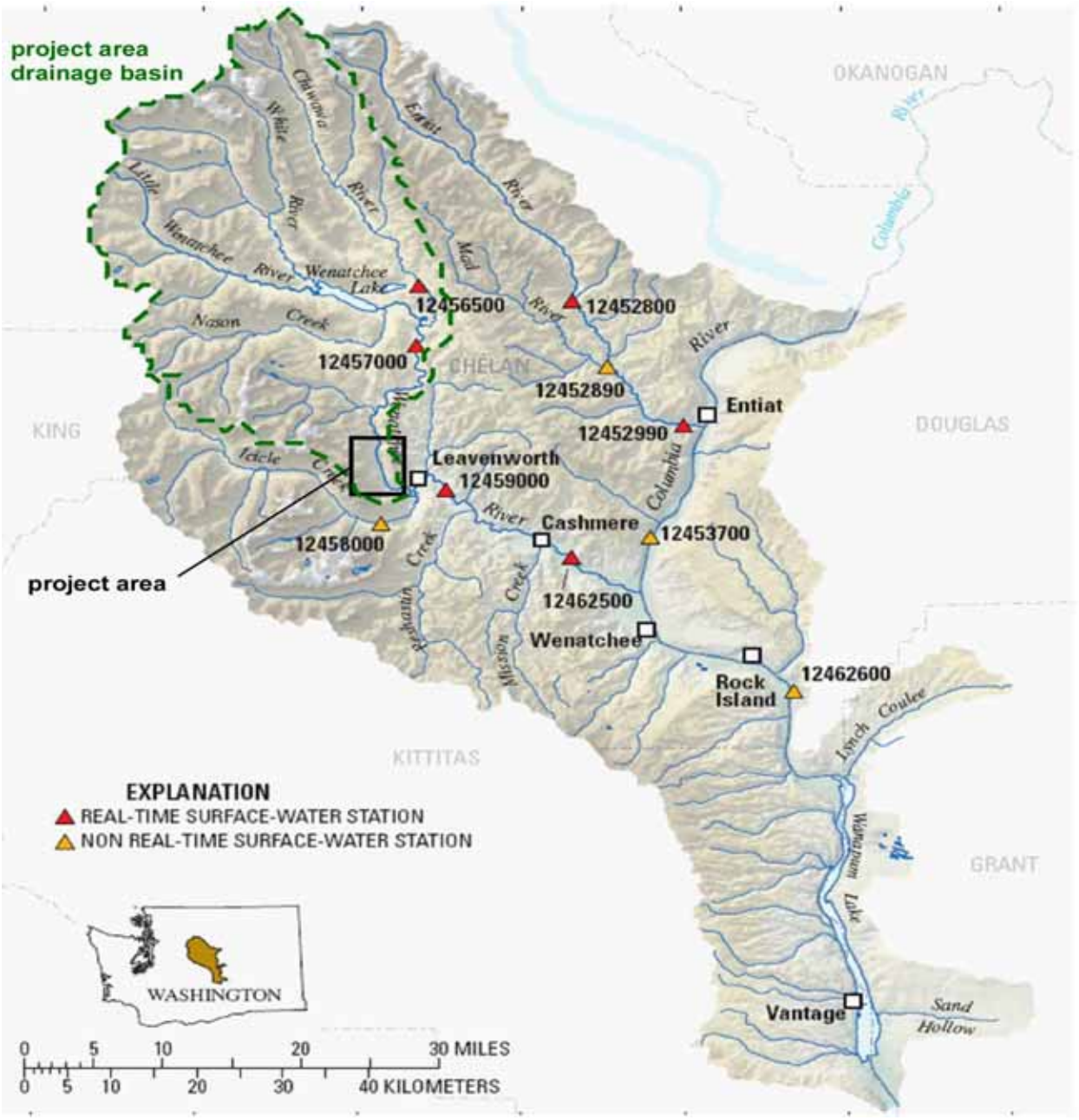


Figure 2-1. Project Reach Drainage Area and Identification of USGS Gage #12457000.

2.3. Road Repair History: 1990 to the Present

Tumwater Canyon is an inherently high-maintenance location for a road; therefore, a thorough understanding of the mechanisms that result in frequent maintenance is essential. In addition to the washout hazard posed by the Wenatchee River, US 2 is subject to snow avalanches, landslides, rockfalls, and debris flows from the steep unstable slopes to the east of the road. In the case of minor rockfalls, landslides, and snow avalanches, maintenance consists of clearing the fallen debris from the road and repairing damaged guard-rails. Major rockfalls have required resurfacing of the road. In the case of river-caused washouts in 1990 and 1995, maintenance consisted of rebuilding the road prism and/or armoring the embankment. WSDOT rebuilds the road prisms in Tumwater Canyon by filling the embankment with a gravelly sand mix and armoring the fill with one or two layers of riprap of approximately one to two times the median grain size (D50) of the surrounding area (Christman, 2007). Review of historical road maintenance costs indicate that repairs required due to major road washouts from the Wenatchee River (1990 and 1995) have been the most costly type of maintenance along US 2 in Tumwater Canyon (Table 2-1). Locations requiring road repair are shown in Figure 2-2 along with the year the event occurred.

Table 2-1. Major WSDOT Repair Projects on US 2 between MP 94.00 and 98.00 associated with Flood Events (1948 through 2006).

Mile Post	Project #	Date of Event	Cost ($)[a]	Flow (cfs)[b]	Type of Damage
95.2	C3539	5/29/1948	72,550	22,700	Partial Road Washout
95.2	XE2868	11/25/1990	744,820	33,200	Major Road Washout
97.0					
94.0			567,714		Undermining of Retaining Wall
95.2	C4794	11/30/1995	3,656,218	36,100	Major Road Washout
97.0					Complete Road Washout
91.0	N/A	5/17/1997	N/A	15,800	Partial Road Washout
95.2					
97.0					
95.2 97.0 97.8	DMB015	5/19//2006	184,000	16,100	Partial Road Washout
		Total	5,152,752		

N/A = Not Available
cfs = cubic feet per second
a = Cost in 2007 dollars
b = Flow at Plain, WA USGS gage #12457000

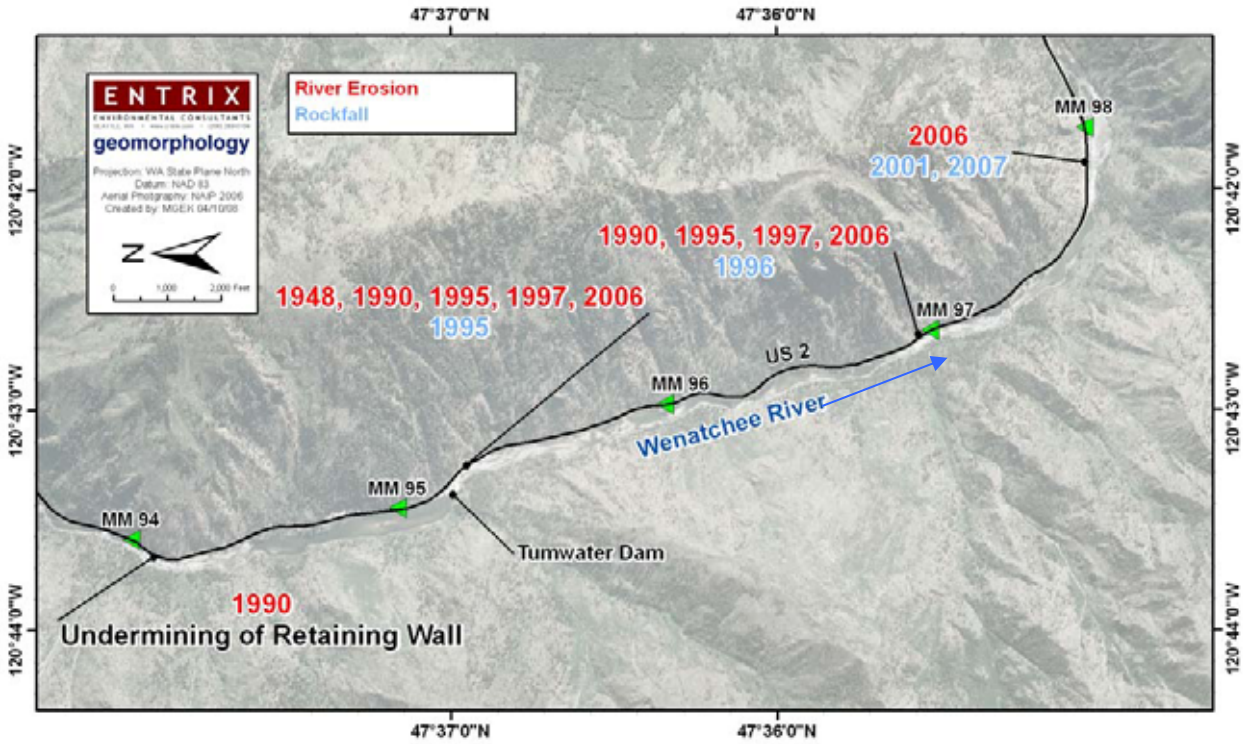


Figure 2-2. Dates and Location of Road Repair from 1948 to 2007 in the Project Reach.

2.4. November 1990 Flood Event

An unusually high flow event occurred on November 25, 1990 when the Wenatchee River at Plain received a discharge of 33,200 cubic feet per second (cfs), equivalent to a 200-year Mean Recurrence Interval (MRI) event. In this event, three sections of US 2 within the project reach suffered significant damage. The first was in the north end of the project reach at approximately MP 94.00, where the flow undermined the existing retaining wall, requiring almost $600,000 in repairs,. The second section to be damaged in the November 1990 event was directly below the dam at MP 95.20. Half of the width of road in this section was washed out during the flood and was promptly repaired by WSDOT. The last section to be damaged was near the southern end of the project reach, at MP 97.00. Like the section immediately below the dam, a portion of the road at MP 97.00 was washed out at a narrow section of the river.

2.5. November 1995 Flood Event

Five years later, on November 30, 1995, the Wenatchee River again experienced a very high flow event with a discharge recorded at Plain at 36,100 cfs, equivalent to a 500-year MRI event. This very high flow event resulted in similar damage to that suffered during the 1990 flood. Sections of the road near MP 95.20 and MP 97.00 were severely damaged, with an entire portion of the road near MP 97.10 completely washed out (Figure 2-3). The combined cost of the road repair work for these two sections of the river was over $3.5 million (Table 2-1).

Figure 2-3. Road Washout at MP 97.10 on November 30, 1995.

2.6. May 1997 and May 2006 Flood Events

Similar road damage was sustained during two less intense floods. These events occurred on May 17, 1997 and May 19, 2006, with flows recorded at the USGS Plain gage at 15,800 cfs and 16,100 cfs respectively. With about half the flow of the 1990 and 1995 floods, the 1997 and the 2006 floods caused relatively minor damage to MP 95.20 and MP 97.00, but the cost of road repair associated with the 2006 flood still approached $200,000 (Table 2-1).

2.7. Landslides and Rockfall Events

Other damage to the road requiring significant WSDOT repair includes a landslide in 1996 at MP 91.4 with a repair cost of $36,872, a landslide in 1997 at MP 101.00 with a repair cost of $10,731, and a rockfall with adjacent bank slope improvement at MP 97.80 in 2007 at a cost of $100,000. Other maintenance costs not associated with a specific road washout include WSDOT rock fall protection installations at MP 97.05, 95.50, 95.35, and 90.90. Table 2-2 lists major WSDOT repair projects in the project reach associated with rockfalls in Tumwater Canyon between 1995 and 2007.

Table 2-2. Major WSDOT Repair Projects on US 2 between MP 94.00 and MP 98.00 from Rock Fall in Tumwater Canyon.

Mile Post	Project #	Date	Type of Repair	Cause of Repair
95.3	L2186	1/24/1995	Rock Slope Stabilization	Rockfall Events Attributed to Deforestation 1994 Fires
95.5				
91.0	L2377	9/3/1996	Rock Slope Stabilization	Rockfall Events Attributed to Deforestation from 1994 Fires
97.0				
98.0	XL1053	3/5/2001	Rock Slope Stabilization	Chronic Rockfall Events
97.8	4794	3/27/2007	Rock Slope Stabilization	Rockfall Event

2.8. Road Repair History: Before 1990

WSDOT and the Chelan PUD provided information for only one road failure event for US 2 in the project reach prior to 1990: on May 29, 1948.. Although data is sparse for this event, gage information indicates that the Wenatchee River at Plain was flowing at approximately 22,700 cfs, or a 25-year MRI, Damage was sustained directly below the dam at MP 95.2 with a partial road washout.

ENTRIX searched the archives of the Wenatchee Daily World/Wenatchee World newspapers for historical information regarding events resulting in road repairs and closures, and obtained a number of reports of road closures between 1932 and 1990, which are summarized in Table 2-3. References with the year in bold are possible road washout events, however more definitive investigation is needed for confirmation. No relevant information was found between 1975 and 1990.

Table 2-3. Tumwater Canyon Snow/Rock Slides and Road Closures, 1932-1990 (as reported in Wenatchee Daily World/Wenatchee World Newspaper).

Year	Reference/Citation
1932	"Tumwater Canyon Road blocked by slides," February 26, 1932, page 1
1932	"Heavy slides in Tumwater Canyon," February 27, 1932, page 2
1932	"Landslides . . . 150 ft. wide and over 20 feet deep . . . removed several feet of the highway," February 29, 1932, page 1
1933	"North central Washington flood," (Tumwater Canyon blocked by slides), February 23, 1933, page 9
1933	"Great Northern Rushes Job," (Tumwater Canyon closed by slides), February 27, 1933, page 7
1937	"State calls bids for Tumwater job," (highway reconstruction), August 1, 1937, page 1
1937	"Tumwater Canyon once a railroad, then a road . . . to be a boulevard," November 29, 1937, page 5
1938	"Tumwater Open," October 22, 1938, pages 1, 10
1941	"August Deluge," August 27, 1941, page 10
1948	"Tumwater Canyon Approach to the Pass," (photograph of snow removal), February 21, 1948, page 1
1949	"Passes closed," (including Tumwater Canyon), February 10, 1949, pages 1, 8
1949	"Slide isolates . . . State traffic snarled," February 11, 1949, page 12.
1949	"All traffic over Passes . . . halted," February 16, 1949, page 1
1949	"Highways closed," February 17, 1949, page 1
1950	"15 slides in six miles on Tumwater," February 17, 1950, page 1
1954	"Concrete and Logs to guard Tumwater, September 3, 1954, pages 1, 7
1955	"86 snow slides block Tumwater," December 23, 1955, page 2
1955	"Tumwater slides are worst yet," December 25, 1955. pages 1, 14
1975	"Tumwater Canyon-Stevens Pass to Reopen," January 13, 1975, page 1

All citations from Wenatchee Daily World/Wenatchee World Newspaper, Wenatchee, WA

2.9. Hazard Area Classification of US 2

Based on the road closures and road repairs to US 2 in the project reach, it appears that the primary threats to US 2 prior to the 1990s were landslides and avalanches. Some landslides, such as the one that occurred in 1993, are clearly associated with high river flows. In order to identify potential locations of road vulnerability, hazard areas were designated based on the historical

record and rated on a scale from Severe to Slight. The indicators of road vulnerability considered in the hazard area rankings are the following (from most influential to least influential):

- the presence of historical records of road repair from washouts
- severely constrained portions of the river
- steep sloping banks from the road to the river
- the lack of trees and vegetation along the banks of the river
- steep bedrock slopes above the road
- cracks along the road that are parallel to the river

A chronology of US 2 road repair history is presented in Figure 2-4 along with the locations of the hazard areas and their classification using the criteria above.

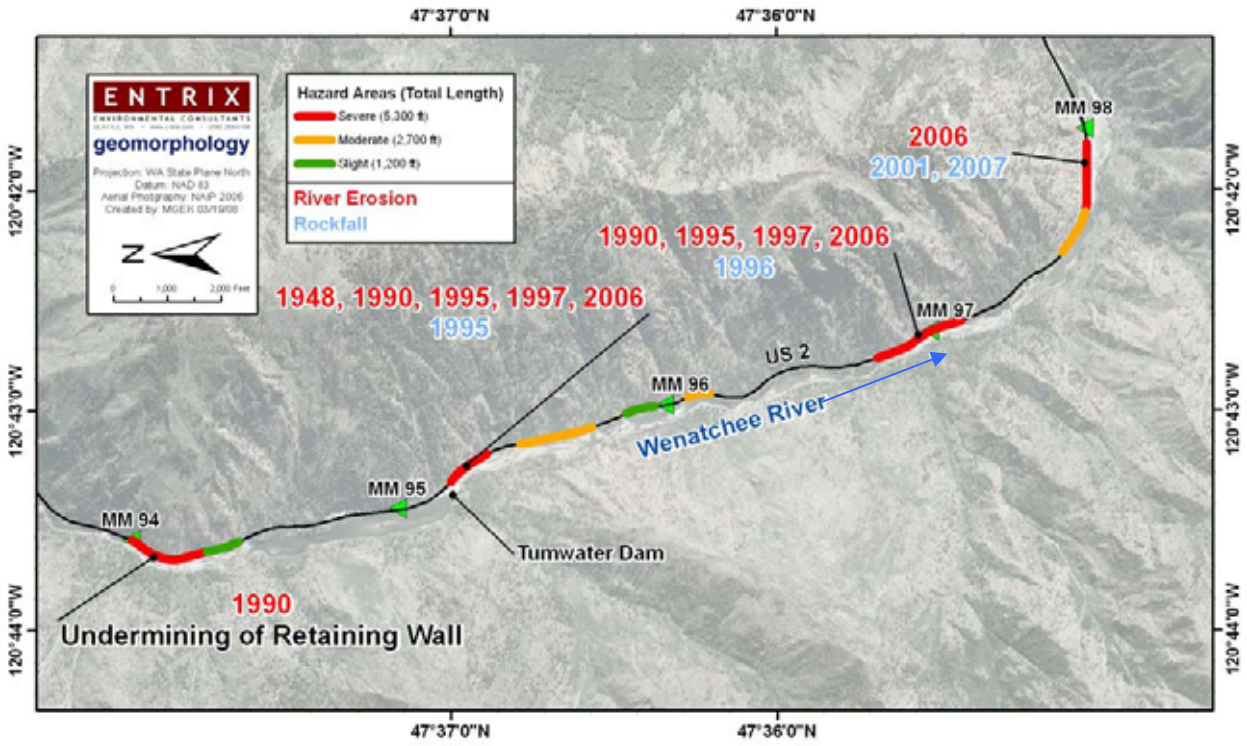


Figure 2-4. Dates and Locations of Road Repair from 1948 to 2007 and Associated Road Hazard Area Classifications.

2.10. Summary of Road Maintenance Issues

US 2 in the project reach is subject to chronic damage primarily associated with floods and washouts from high flow events in the Wenatchee River. Available data indicate that the frequency of high flow events, often resulting in road damage or washout, has increased dramatically since the flood of November 1990. Review of historical records indicates that specific sections of US 2 are more likely to be adversely affected during high flow events. Recurring road washouts have been focused in the following two distinct locations on US 2: MP 95.2 directly below the Tumwater Dam, and MP 97.0. The washout damage in these two areas is proportional to the magnitude of the flood event and ranges from minor bank undercutting to complete washouts of the road prism. Mitigation that involves long-term planning and implementation of an effective solution will be required for US 2 in the project reach to avoid frequent and expensive road failures in the future.

2.11. Additional Assessment Needs

No additional information is needed to assess the road maintenance issues in Tumwater Canyon.

3. Preliminary Geological and Geomorphic Reach Analysis

3.1. Importance

This section of the report describes bedrock geology and geomorphology of the Wenatchee River in Tumwater Canyon. Particular attention is given to geological and geomorphic factors that may influence road washouts along US 2. Tumwater Canyon is near the eastern margin of the tectonically active, geologically complex Cascade Mountains. Geology directly affects US 2 through landslide, rock-fall, and debris-flow hazards, and indirectly through its control on the gradient and confinement of the Wenatchee River as it passes through Tumwater Canyon. Understanding the geological and geomorphic factors affecting US 2 is critical to identifying a permanent solution to the chronic road maintenance issues in the project reach.

3.2. Methodology

Geologic information was compiled from the USGS publication, "Geologic Map of the Chelan 30-minute by 60-minute Quadrangle, Washington" (Tabor et al., 1987). Geologic cross sections through the four principal road failure sites at approximate MP 94, 95, 97 and 98 were constructed from field data gathered by ENTRIX staff. Foliation strike and dip were extrapolated to the cross-sections from the nearest measured strike and dip locations and below-ground contacts were inferred using professional judgment.

ENTRIX teams visited the project reach six times between November 2007 and April 2008 to observe and record geologic and geomorphic characteristics of the canyon. At each site visit the following data were recorded:

- water surface elevations
- bed and bank material
- road prism slope angles
- stress and fatigue cracking on US 2
- flow hydraulics
- sources of incoming sediment and discharge into the river
- other geologic and geomorphic characteristics

In addition, aerial photographs from 1959, 1960, 2005 and 2006 were obtained, georeferenced, and interpreted by ENTRIX geomorphologists. Project area elevation and slope information was derived from USGS 7.5 minute topographic quadrangles and supplemented by limited topographic survey data provided by WSDOT. A planned ground-based Light Detection and Ranging (LiDAR) survey of the project area was not completed before snow blanketed the canyon. LiDAR surveys require snow-free ground, therefore these data were not available for this analysis.

3.3. Regional and Local Geology

The Wenatchee River basin is characterized by several tectonic terranes ranging in age from the late Jurassic to Quaternary (see Figure 3-1). The oldest terranes are adjacent to Tumwater Canyon. They are composed of lenses of ultamafic rocks of the Ingalls Tectonic Complex thrust over the younger Chiwaukum schist and gneiss of the Nason Terrane in the late Jurassic or early Cretaceous period (Tabor et al., 1987). The Mount Stuart batholith was subsequently intruded into both the Ingalls and Nason Terranes across the thrust fault boundary.

Tumwater Canyon is located at the northeastern margin of the Mt. Stuart batholith, adjacent to the contact between the plutonic intrusion and the remnants of the Ingalls Tectonic Complex. Tumwater Canyon is also adjacent and roughly parallel to the Leavenworth fault bounding the Chiwaukum graben. The Leavenworth fault is the boundary between the older igneous and metamorphic rocks surrounding Tumwater Canyon to the west and younger sedimentary rocks in the east (Figures 3-1 and 3-2). These sedimentary rocks, called the Chumstick Formation, range from conglomerates to shale and are formed from erosional remnants of the adjacent bedrock (Tabor et al., 1987). The Quaternary alluvial deposits within Tumwater Canyon consist of moderately sorted cobble gravel grading to poorly sorted gravelly sand dating from the Holocene and Pleistocene.

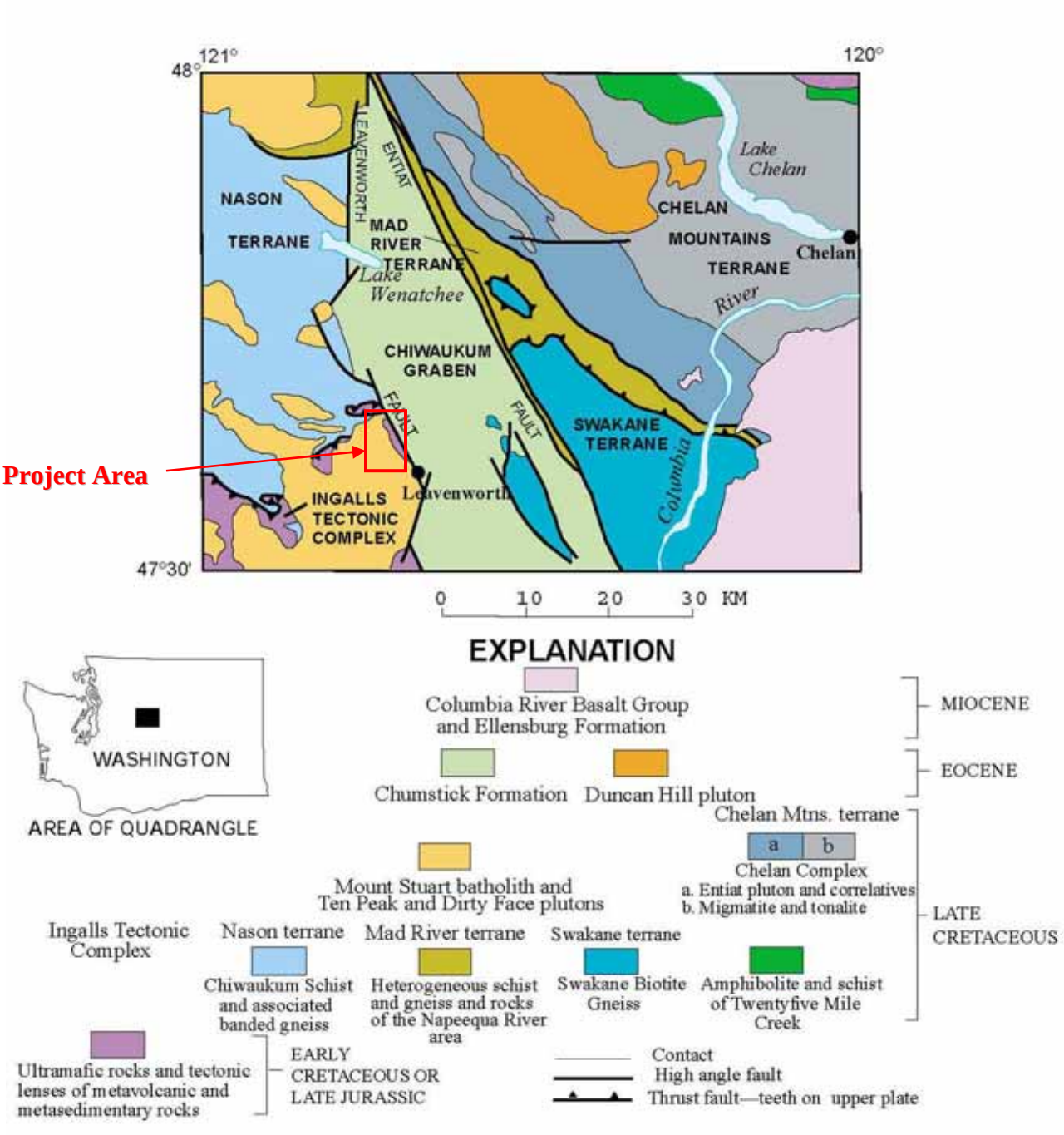


Figure 3-1. Geologic Context of Tumwater Canyon Project Reach, modified from Tabor et al., 1987

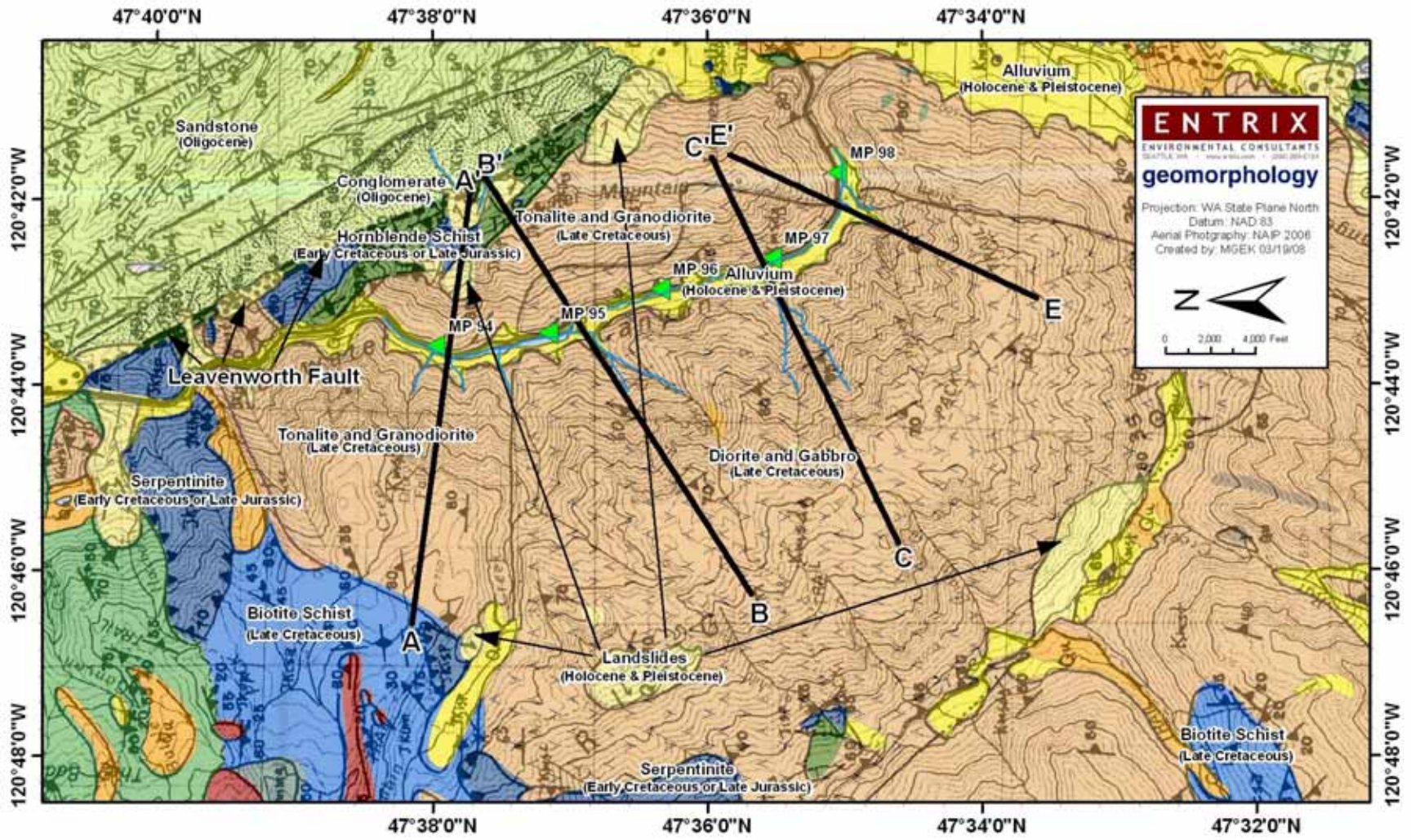


Figure 3-2. Local Geologic Map of the Tumwater Canyon Area, modified from USGS, 1975.

Geologic mapping (USGS, 1987) indicates that bedrock within the project area consists of diorite and gabbro between US 2 MP 94.5 and MP 97.7, and tonalite/granodiorite between MP 94 and 94.5 and between MP 97.7 and 98. Both types of rock are prone to weathering and eventual disintegration when exposed at the surface; the mafic diorite/gabbro more so than the tonalite/granodiorite.

WSDOT reports describe exposed rock in Tumwater Canyon as typically light to medium grey, medium to coarse grained, slightly weathered, strong metadiorite (at an outcrop located at MP 97.75 to 98.00; WSDOT, 2001). Some portions of the exposed rock, however, are moderately weak, with open, very closely spaced fractures in very poor condition. The rock contains moderately to widely spaced discontinuities that are commonly filled with soil (WSDOT, 2001).

ENTRIX field observations indicate that these locations are coincident with the severe hazard road sections identified above. Quaternary landslides on the east valley wall are mainly near the mountain ridge at the contact between the hornblende schist and tonalite/granodiorite units. The only significant influence the current landslides have on the road is the landslide deposit that feeds a debris fan at MP 94.50.

3.4. Project Reach Geomorphology

Tumwater Canyon is a steep, V-shaped valley with bedrock foliations generally dipping between 65 and 80 degrees to the southwest on both sides of the river (USGS, 1987). More precise measurements from WSDOT (2001) provide dips ranging from 35 to 85 degrees along road-cuts within Tumwater Canyon. Bedrock foliation dips are sub-parallel to east canyon wall slopes, except at severe hazard road sections (identified above), where slopes are roughly parallel to foliation dip. The slope of the east valley wall tends to be consistent throughout the project reach; the mean valley-wall slope is 36.3% with a standard deviation of 2.1%. The average slope of the four alluvial fans on the west valley wall is 19.5%, with a standard deviation of 3.41%. The east valley slope is similar to that found across the river, but much of the east side of the canyon is taken up by gentler slopes of the alluvial fans and tributary stream valleys draining the uplands of the Mt. Stuart batholith. The elevation of the east valley wall ranges from approximately 3,940 ft at its peak to 1,740 ft at the base of the river, while the elevation on the west valley wall ranges from approximately 5,500 ft at its peak to 1,740 ft. This information is presented on Figures 3-3 through 3-6 for MP 94, MP 95.3, MP 97.1, and MP 97.8, respectively.

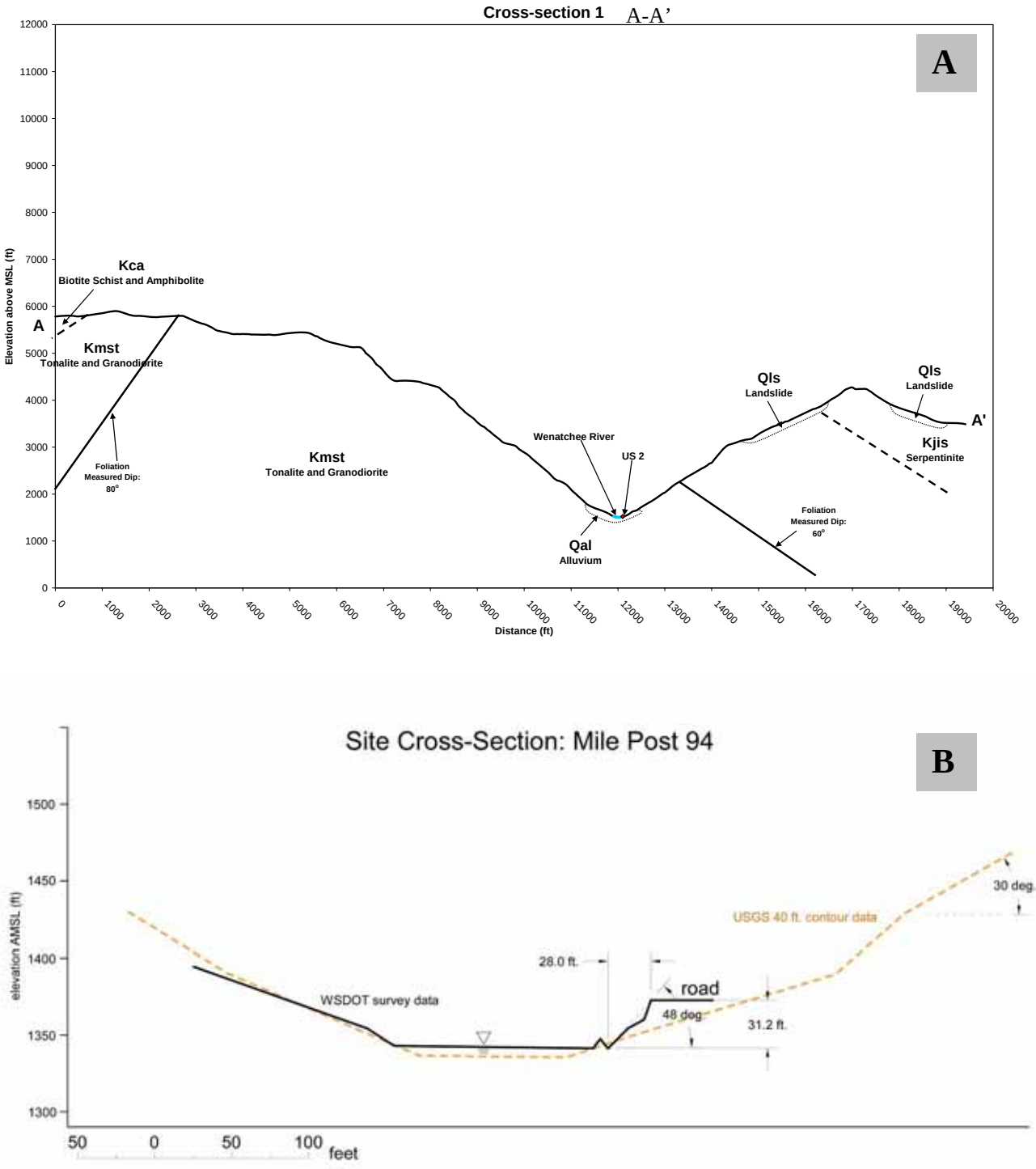
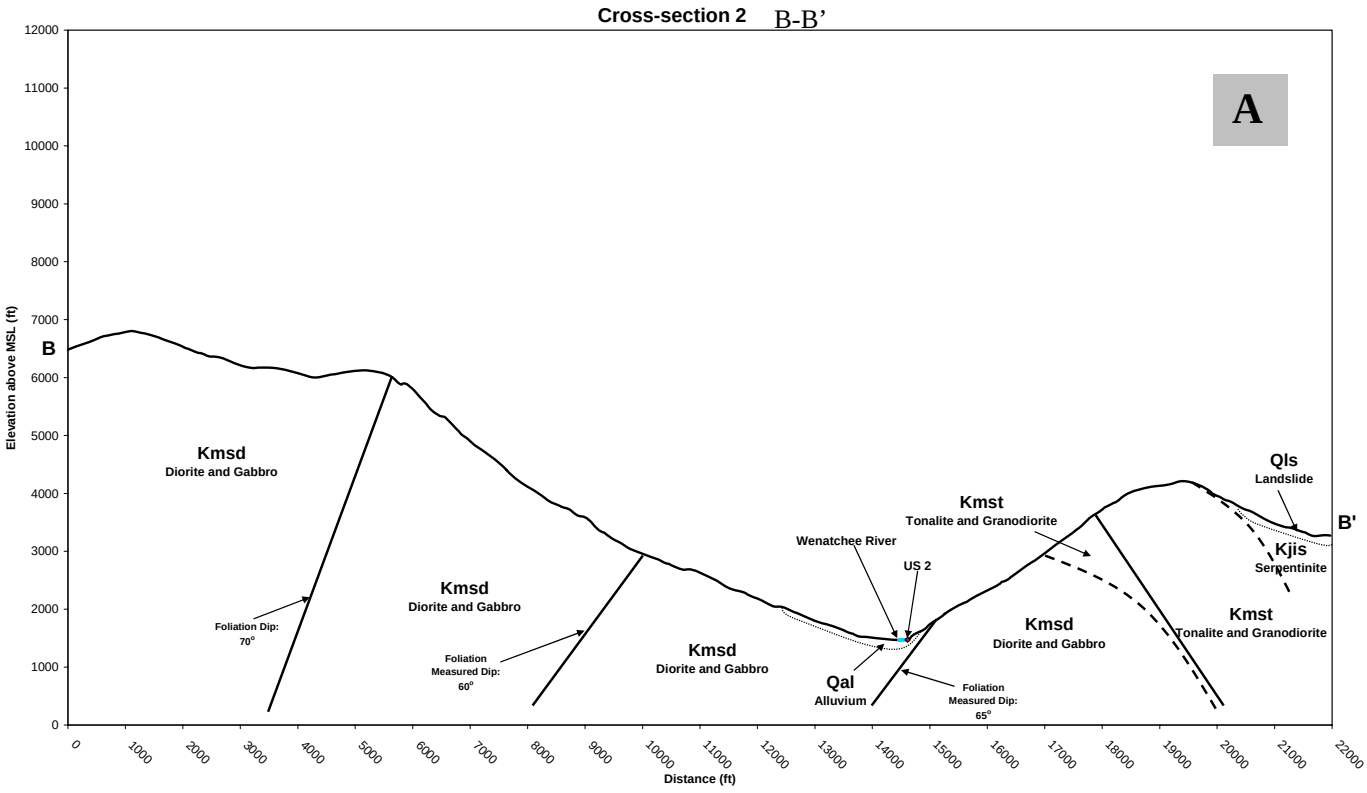


Figure 3-3. Geologic (A) and Topographic (B) Cross Sections through US 2 MP 94.



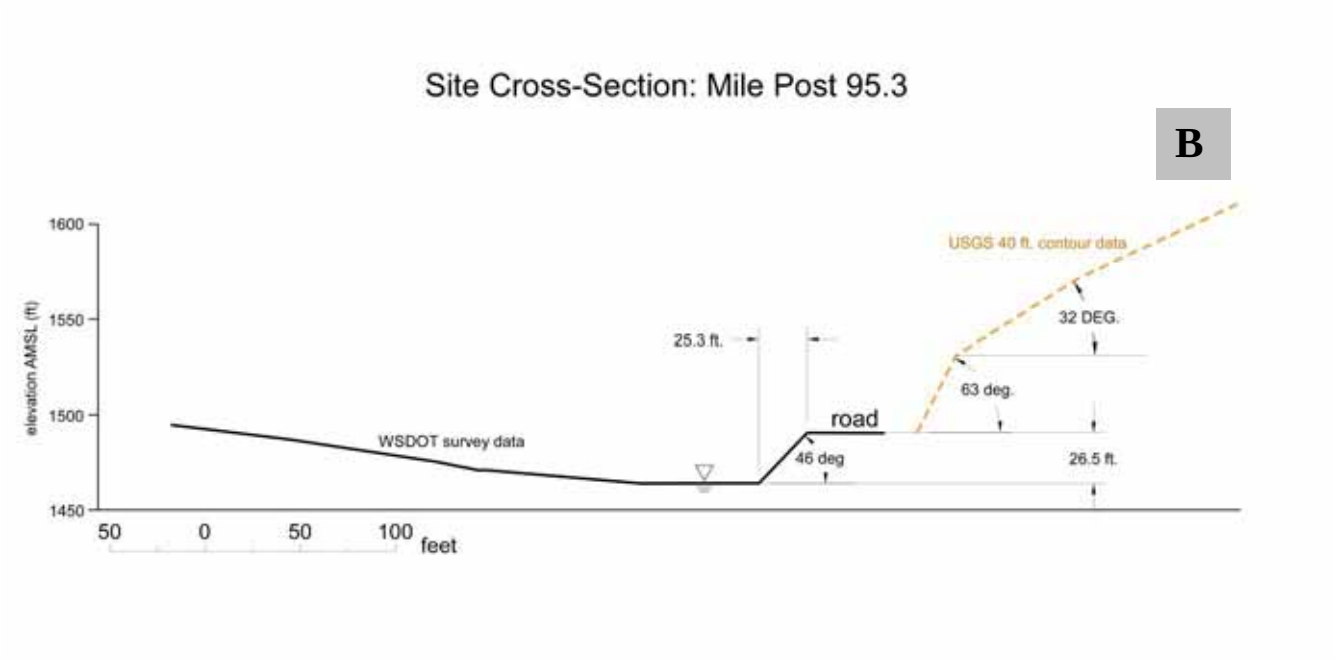
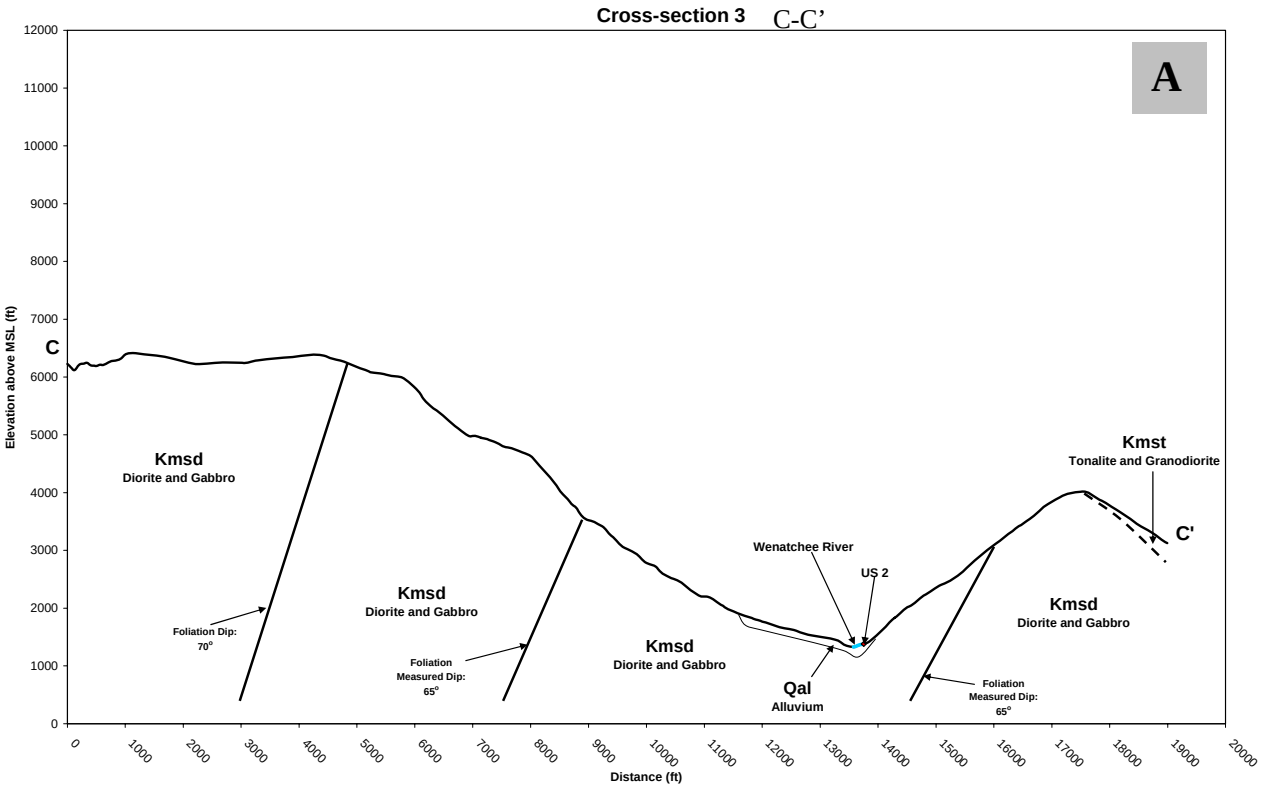


Figure 3-4. Geologic (A) and Topographic (B) Cross Sections through US 2 MP 95.3.



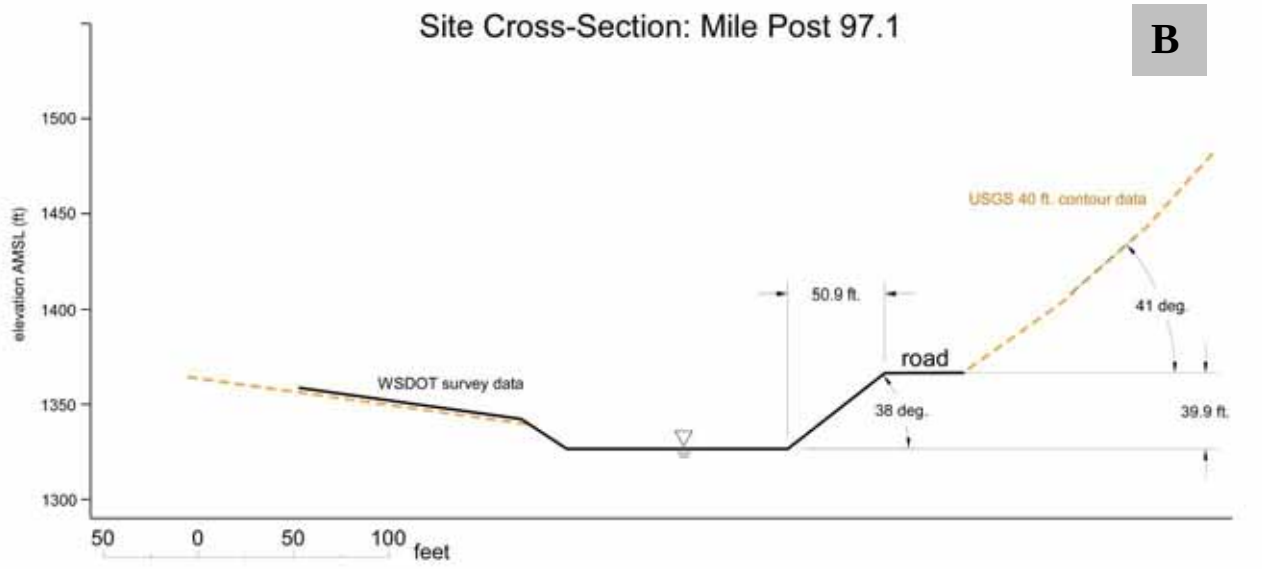


Figure 3-5. Geologic (A) and Topographic (B) Cross Sections through US 2 MP 97.1.

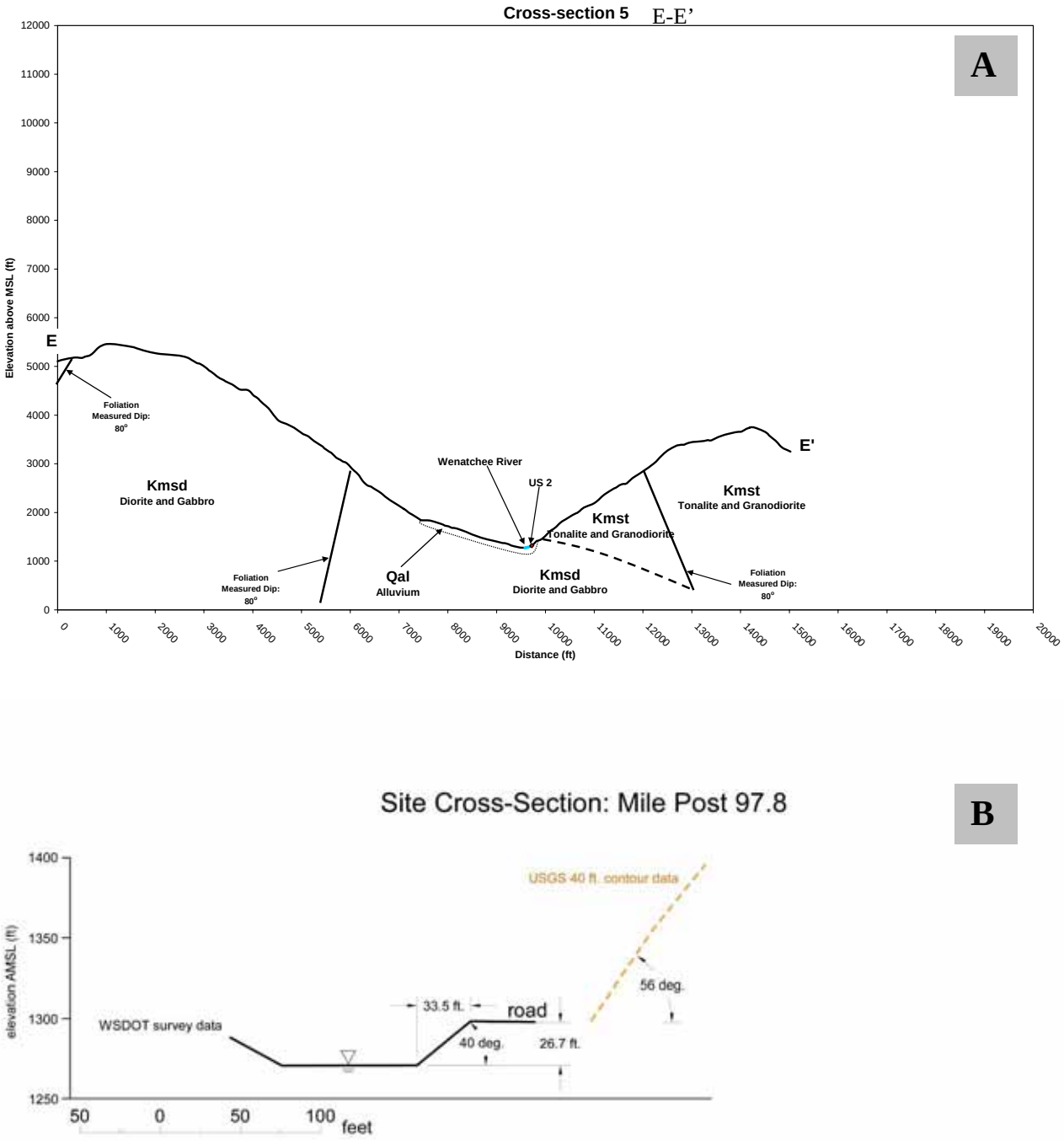


Figure 3-6. Geologic (A) and Topographic (B) Cross Sections through US 2 MP 97.8.

The hillsides surrounding Tumwater Canyon are characterized by steep slopes, shallow soil, and periodic fires. Debris flows, landslides, and snow avalanches are relatively common within Tumwater Canyon and can further constrict the channel already confined by bedrock. These events can also pose direct hazards to the road.

Debris fans on the east valley wall form below areas with a combination of steep slopes, absence of vegetation, and recent forest fires. There are four distinct debris fans on the east valley wall (Figure 3-7) at approximately MP 94.50, 96.00, 96.20, and 97.25 that collectively span approximately 0.90 miles of the east bank of the Wenatchee River. There is a single debris fan on the west valley wall (Figure 3-7). The west-bank debris fan is at MP 97.40 and extends approximately 0.20 miles along the river. The debris fans on the east valley wall are not associated with recorded road failures or ENTRIX-designated hazard areas. There are four alluvial fans on the west valley wall at MP 94.20, 95.20, 97.00, and 97.75 that comprise approximately 1.25 miles of the west bank (Figure 3-7). They result from periodic debris-flow events from the low-order streams above each alluvial fan. Tumwater Dam is built on the largest of the west-bank alluvial fans. All four alluvial fans, which create a significant constriction of the river, are directly across from the four ENTRIX-designated severe hazard areas.

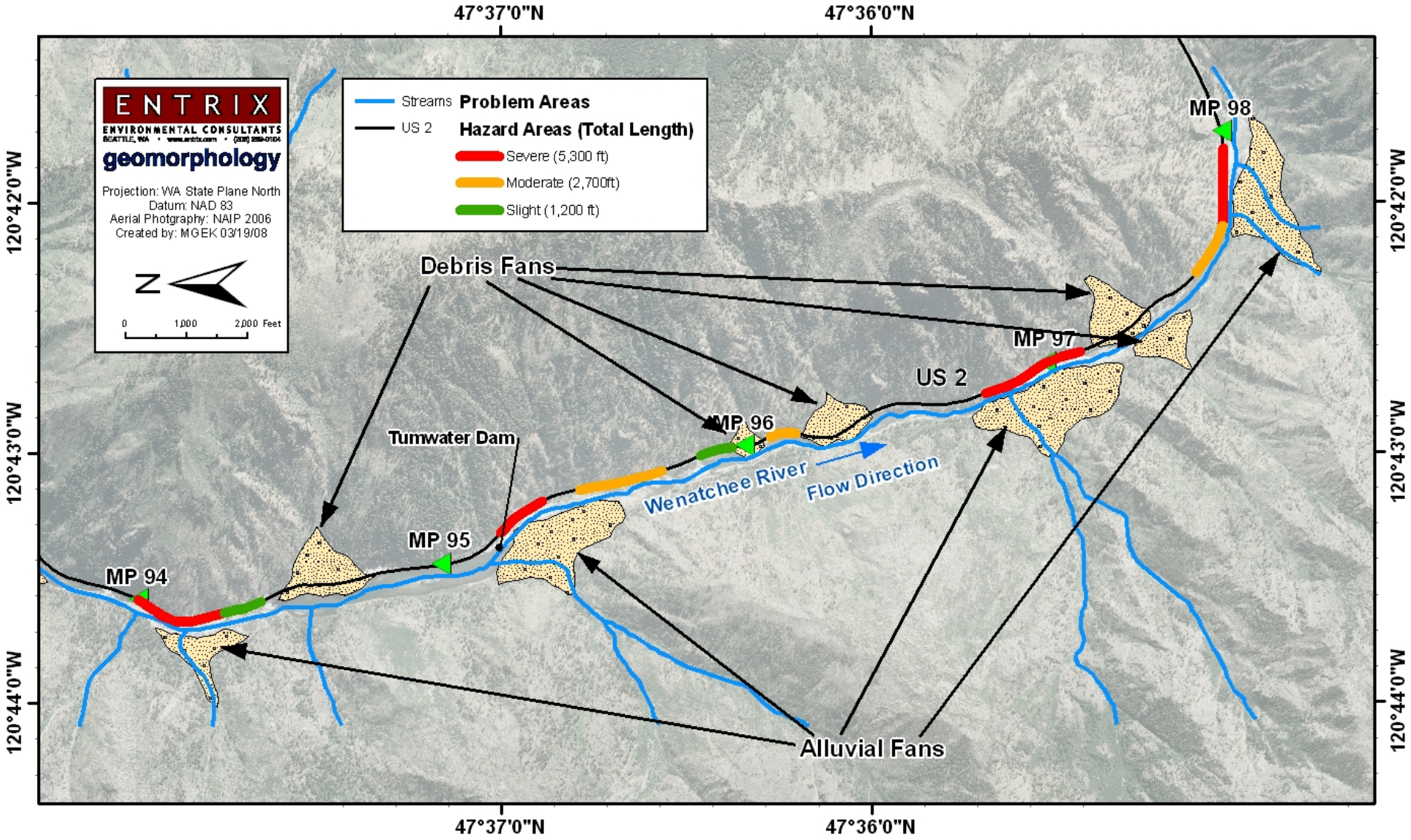


Figure 3-7. Debris and Alluvial Fans within the Project Reach with Designated Hazard Areas.

Raveling slopes occur on steep unvegetated valley walls across from the west-bank alluvial fans. Raveling is indicative of unstable slopes and locally weak rock, and the raveling slopes generally coincide with severe hazard area locations, except for the reservoir directly above the dam. This association reveals that severe hazard sections of US 2 are coincident with both areas where east canyon wall bedrock shows evidence of being weaker than surrounding rock, and where west wall alluvial fans constrict the river and force it against the weaker east canyon wall. There are three such constrictions in the project reach, each of which has experienced road failure in the past. At the fourth constriction, which does not show signs or weak east-wall bedrock but does have a west-wall alluvial fan constricting the channel, the existing retaining wall has needed repair.

3.4.1. Elevation and Slope

The upper extent of the project area near MP 94 has an elevation of 1,550 ft. above mean sea level (MSL) and the lower extent near MP 98 has an elevation of 1,232 ft above MSL. The gradient of the Wenatchee River exhibits variations in magnitude throughout the project reach (Figure 3-8). Consequently, the channel contains distinct sequences of Dune-Riffle, Pool-Riffle, Plane Bed and Step Pool classes (Montgomery and Buffington, 1993).

The overall average slope of the project reach is approximately 1.5%. Channel slope varies from less than 1% to 8%. The most notable gradient increase is directly below the dam, where recurrent road failures have occurred (Figure 3-8). A similar gradient increase also occurs at MP 97.75, another location of frequent washouts. This suggests that channel gradient is a factor in road failures.

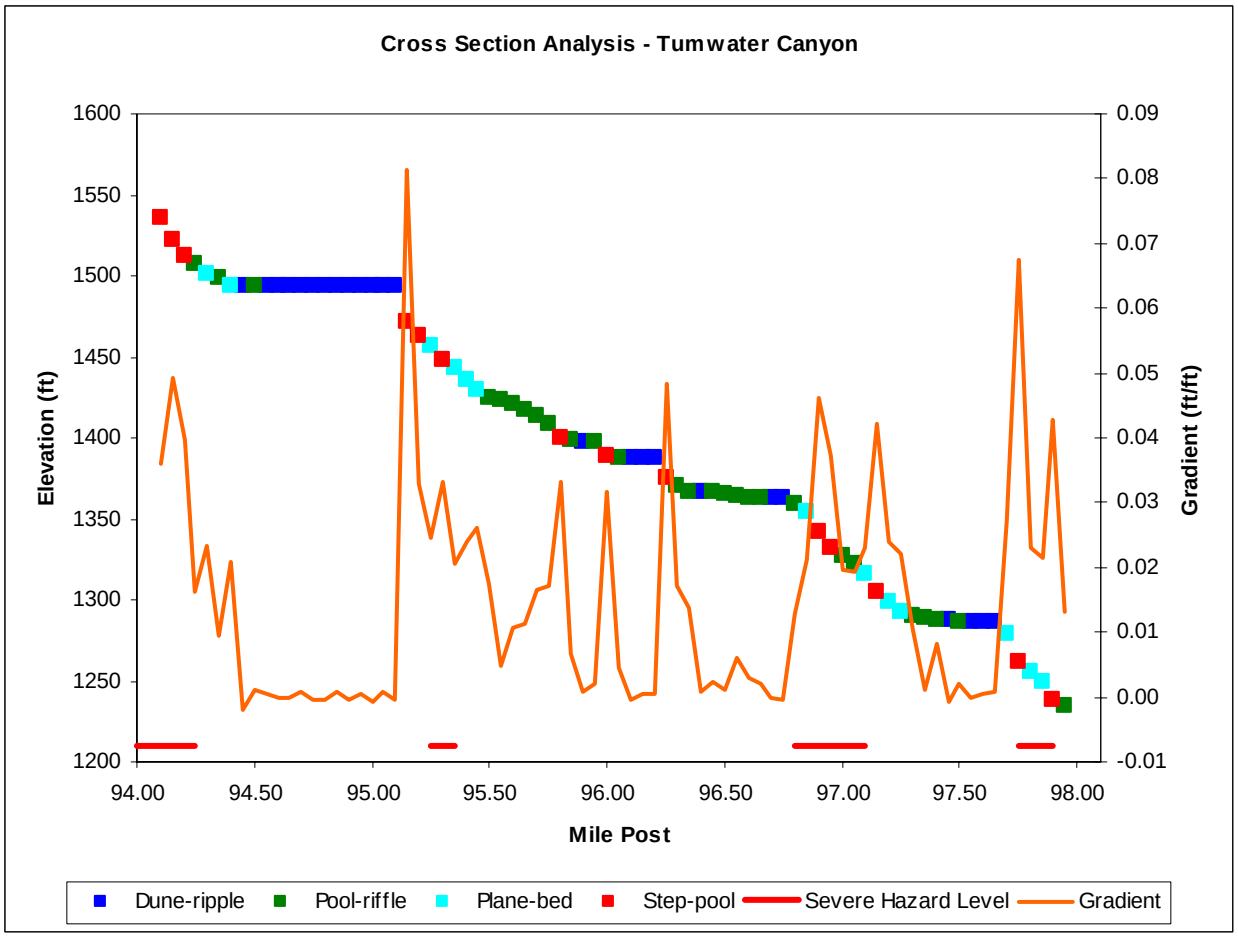


Figure 3-8. Project Reach Channel Elevation, Gradient and Geomorphic Classification.

3.4.2. Confinement and Channel Width

The Wenatchee River is highly confined within Tumwater Canyon. The narrowest constrictions coincide with debris fans on either side of the river. Channel width varies between 50 and 400 feet, with the most confined sections at the west bank alluvial fans and coinciding with severe hazard sections at approximate MP 94, 95, 97 and 98 (Figure 3-9). In several locations, low flow and bank-full channel width (as surveyed by WSDOT) are essentially the same. These locations have experienced bank failure and road damage during large floods.

Tumwater Dam is at the upstream end of the largest, most constricting alluvial fan and at the steepest river gradient. The dam spillway exacerbates the channel constriction by directing flow away from the toe of the alluvial fan and increases local gradient through its elevation above the channel bed. However, the site would be as steep and constricted as the other severe hazard road sections even without the presence of the dam.

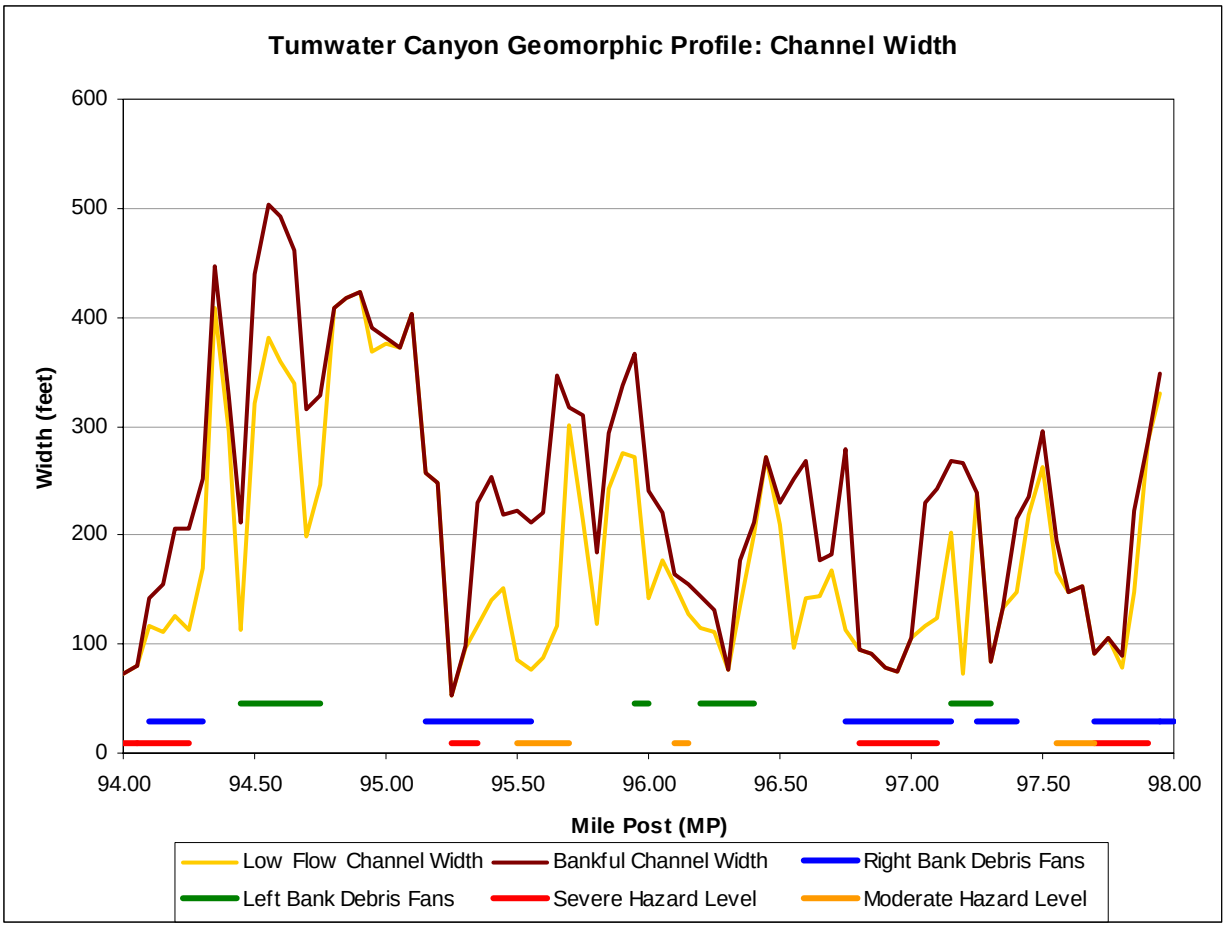


Figure 3-9. Channel Width, Alluvial and Debris Fan Locations through the Project Reach.

Bedrock confinement has resulted in very little lateral channel migration in the last 100 years. In a canyon environment, channel migration is typically not a significant geomorphic hazard. Based on the available information, the only observed channel migration in Tumwater Canyon has occurred during high flow events, as the river migrates into the readily erodible material that makes up the US 2 road prism. The section of the river immediately downstream of Tumwater Dam, however, shows evidence of bank erosion and bar formation between 1960 and 2007 (Figure 3-10).

Figure 3-10. Aerial Photography from 2007 and 1960 of the Area Immediately Downstream of Tumwater Dam.

3.4.3. Bed Material

The size of channel bed material varies widely through the project reach. In the confined higher-gradient areas, bed material is much coarser than that seen in the wider, low-gradient locations. Bed material in the project reach is derived from nearby sources and contains large amounts of igneous and metamorphic country rock. The field-estimated 84th-percentile diameter (D84) of sediment in the channel varies between one and eight feet (Figure 3-11), with larger clasts noted in areas of high, turbulent flow.

It is unknown whether sediment loads in the Wenatchee River have increased following forest fires. No recent landslide scars that would be attributed to forest fires were observed. Despite the lack of landslide scars, fine sediment input to the Wenatchee River probably increases following forest fires. According to Moody (2001), it is likely that sediment loads have increased in burned areas of Tumwater Canyon.

Bank material generally consists of finer sediment than is observed in the river channel, which suggests that the river is more than competent to transport material that is deposited in the channel through bank erosion. However, large clasts that are comparable in size to the largest of the D84 estimates are observed at the toe of the west bank alluvial fans. On the east bank, several areas have been repaired by WSDOT and have imported riprap on the bank toe. This bank material is generally much smaller than material observed in the river channel at those locations, and varies in size between two to four feet (note that the field estimated D84 for sediment in the channel is between one and eight feet). At all of the severe hazard road sections identified by ENTRIX, the stable clasts in the river and at the toe of the west-bank fans are larger than the rip-rap used for road protection. The upper portions of the east bank exhibit many “rills” that indicate that overland flow is eroding the surface, carrying weathered material into the river during high precipitation events.

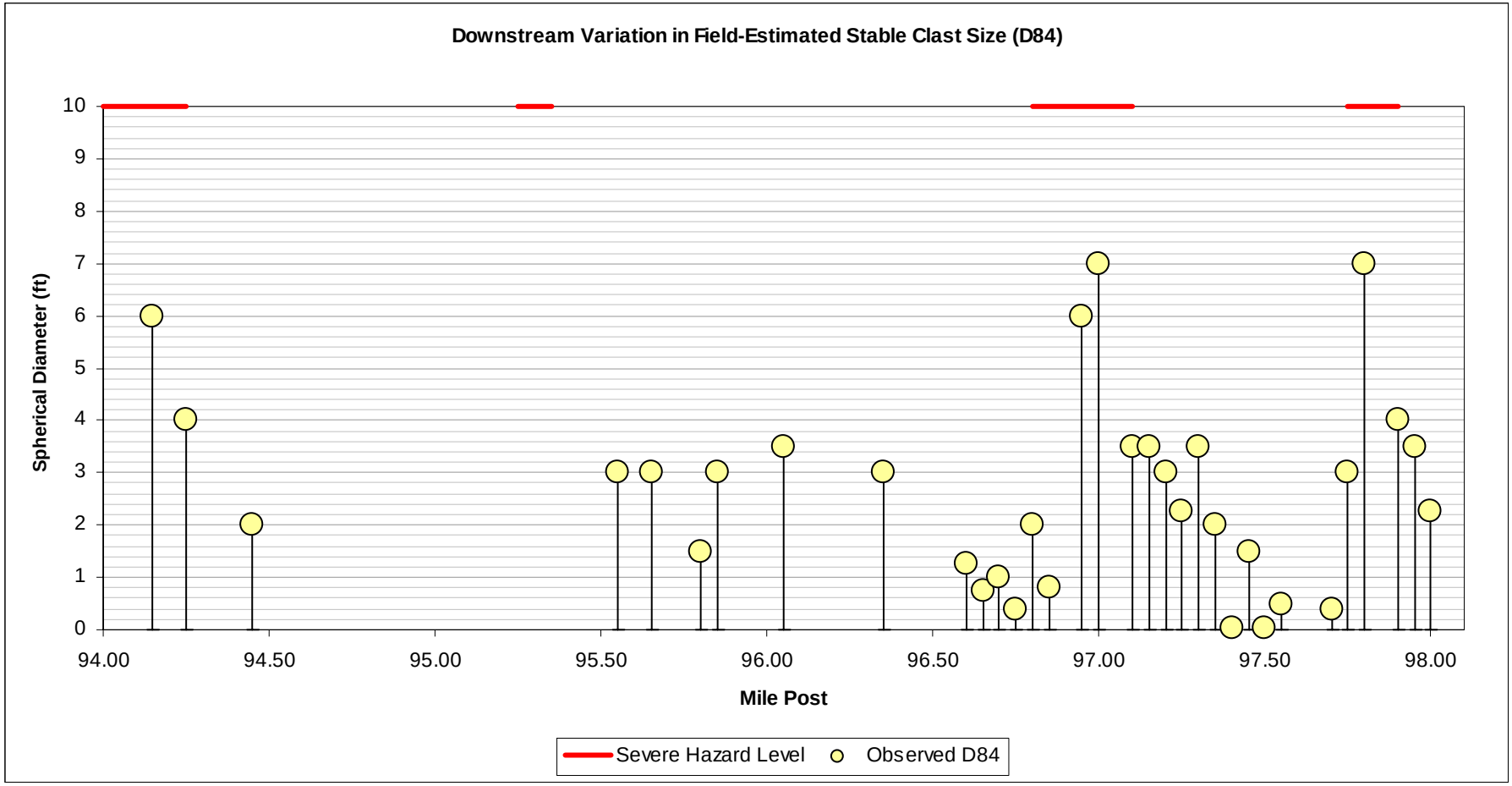


Figure 3-11. Observed D84 Variation in Wenatchee River along Project Reach.

3.4.4. Riparian Vegetation

Riparian zones, especially those with large old-growth forest, tend to control shallow landslides in steep terrain (Montgomery *et al*., 2000) and contribute to soil cohesion and more stable slopes (Schmidt *et al*., 2001). A distinct riparian zone consisting of a shrub and canopy layer is not continuous through the project reach. Continuous and persistent riparian zones have likely never been a feature of the canyon. This is due to two conditions: the valley floor is narrow and almost entirely taken up by the active channel, and young vegetation that is not well established is likely to be washed away by the natural high water velocities and shear stresses generated in large floods in the canyon. Riparian habitat is also limited by high energy flows and widely fluctuating water surface elevations. Nonetheless, riparian zones do exist where there is soil-bearing land between the road and the river at the toe of the east bank debris-fans. These intermittent trees appear to be providing some protection from hydraulic forces. Additionally, many small bedrock "knobs" support small to medium trees extending into the river channel and offer some protection for US 2 within the project reach. Further investigation into the presence of sensitive plant species in the area may be required before construction activities that would potentially have deleterious effects on vegetation.

3.4.5. Large Woody Debris

LWD is not a significant element in Tumwater Canyon outside of the broad, lower-gradient, lower-velocity reaches. Some LWD was observed in a few locations in the project reach. However, there were no large organized clusters or log jams observed in this section of the river. Wood was found in backwater locations or in eddies during large floods and more wood was seen in the lower stretches of the river than upstream of the dam. This part of the river is considered a "transport reach" where wood may move through, but does not accumulate.

There is an overall lack of large woody debris (LWD) in the Wenatchee system. Some attribute this to log/rail drives and some to deliberate clearing of wood in an attempt to "clean" the river. Additionally, US 2 significantly interrupts potential wood recruitment from upslope into the channel; any wood that lands on the road is probably not placed in the channel during road-maintenance activities.

3.5. Summary of Geologic and Geomorphic Reach Analysis

Available data indicate that a number of conditions are acting in concert in the areas of US 2 with significant and chronic road failures. Bedrock is generally strong throughout the project reach; however, this reach is characterized by soil-filled fractures and raveling slopes at all but the most upstream of the severe hazard road sections identified above. Bedrock foliation dips are sub-parallel to east canyon wall slopes, except at severe hazard road sections. Here slopes are roughly parallel to foliation dip, indicating that slope stability may be a contributing factor to road failures. Canyon walls are steep (≈ 35° slopes), except where the

west wall is broken by tributary drainages that form debris-flow fed alluvial fans, constricting the river and delivering large sediment across from the severe hazard road sections.

River gradient varies from <1% to >8%, and channel width varies between 50 and 400 feet. The steepest gradients and the most confined sections are located at the west bank alluvial fans and at the severe hazard road sections. Tumwater Dam is at the upstream end of the largest, most constricting alluvial fan with the steepest river gradient. The dam exacerbates the constriction and steepness, but without the dam the site would still have the characteristics of a severe hazard road section. The size of clasts that are apparently stable within the channel varies through the project reach and the largest clasts are found at the severe hazard road sections.

This reconnaissance-level review of available geology and geomorphology information leads to the following recommendations to improve road stability when addressing the chronic road maintenance problems in the project reach:

- Construct improvements at all four severe hazard sections
- Use larger rock for embankment protection
- Remove the largest rocks from toe of west bank alluvial fans to enable the river to move away from the road embankment

3.5.1. Additional Assessment Needs

Because sufficiently detailed topographic and bathymetric data were not available for this assessment, it would be advisable to conduct a detailed topographic/bathymetric survey to refine the available geomorphic and hydraulic analyses and provide the basis for final engineering design. The available evidence suggests that side-slope stability may be a factor in road failures, so it will also be useful to conduct a full geotechnical investigation of the severe hazard section side-slopes to assess the suitability for viaduct construction and long-term rock-fall hazard. The construction of a detailed project reach sediment budget and sediment transport model would provide confidence in the long-term viability of proposed technical solutions to the problem of recurrent road failures in the face of potential channel aggradation or degradation, bank erosion, debris-flows, landslides, and rock-falls.

4. Preliminary Hydrology Assessment

4.1. Importance

The hydrologic study of the Wenatchee River through the project reach identifies the magnitude of flows associated with historic flood events and develops design flow rate values for use in the hydraulic analysis described in the next section. Knowledge of historic and predicted flows improves understanding of the hydrologic characteristics and associated hydraulic forces of the Wenatchee River affecting US 2. Determining the impacts the river has on the road prism furthers insight into the mechanisms of damage and possible alternatives for mitigating the chronic road maintenance issues.

4.2. Methodology

There are no recorded flow data directly within the project reach but there are two operating U.S. Geological Survey (USGS) stream gages on the Wenatchee River nearby: Gage number 12457000 at Plain and Gage number 12459000 at Peshastin. The gage at Plain is located about ten miles upstream of the project site with a drainage area of 591 square miles (mi^2); the gage at Peshastin is approximately 15 miles downstream with a drainage area of 1,000 mi^2 (Figure 4-1). Both gages have annual peak flow records spanning more than 50 years and also have daily average flow information. Data from these two gages was used to reconstruct the hydrology of the project reach.

The flood frequency analysis was conducted using the program PeakFQ, Version 5.2, the USGS Annual Flood Frequency Analysis (2007). This program methodology is based on the Interagency Advisory Committee on Water Data Guidelines for Determining Flood Flow Frequency (1982). The program uses the direct download of files for individual gages to estimate the flows associated with various recurrence intervals.

Figure 4-1. Project Reach Drainage Area in the Wenatchee River Basin and Gaging Stations.

4.3. Reconstruction of Hydrology in Project Reach Using Two USGS Gages

The location, drainage area, and years of record of each USGS gage are listed in Table 4-1. The gage at Plain has 85 years of records from 1911 to 2007, with a record break between water year 1979 and 1990. The Peshastin gage has a continuous peak flow record from 1929 to 2006. Figure 4-2 illustrates the annual peak flows in cubic feet per second (cfs) recorded at the two gages. The water year starts on October 1 and ends on September 30.

Table 4-1. USGS Gage Information Considered for Project Reach.

Gage Name	USGS Gage #	Latitude	Longitude	Drainage Area (sq mi)	Years of Record
Wenatchee River at Plain	12457000	47°45'47"	120°39'54"	591	85
Wenatchee River at Peshastin	12459000	47°35'00"	120°37'06"	1000	79

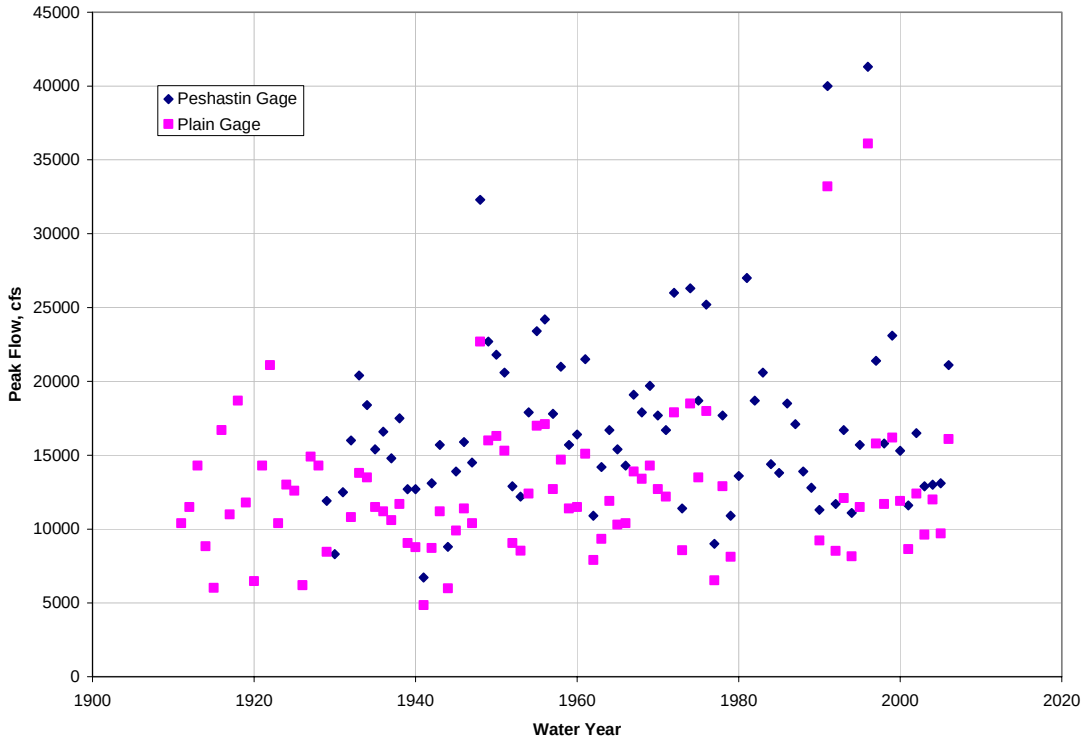


Figure 4-2. Annual Peak Flow for the USGS Plain and Peshastin Gages.

Due to the high elevations associated with the Wenatchee River watershed, a large portion of the winter precipitation falls as snow. As a result, the peak flow events recorded by the two gages are associated with spring snow melt, or perhaps rain in addition to the spring freshet. Figure 4-3 illustrates the number per month and monthly distribution of the peak flow events

recorded at the Plain and Peshastin gages over the years of record. Of the 67 years with annual peak flow data for both gages, 61 years have peak flows associated with the same storm event.

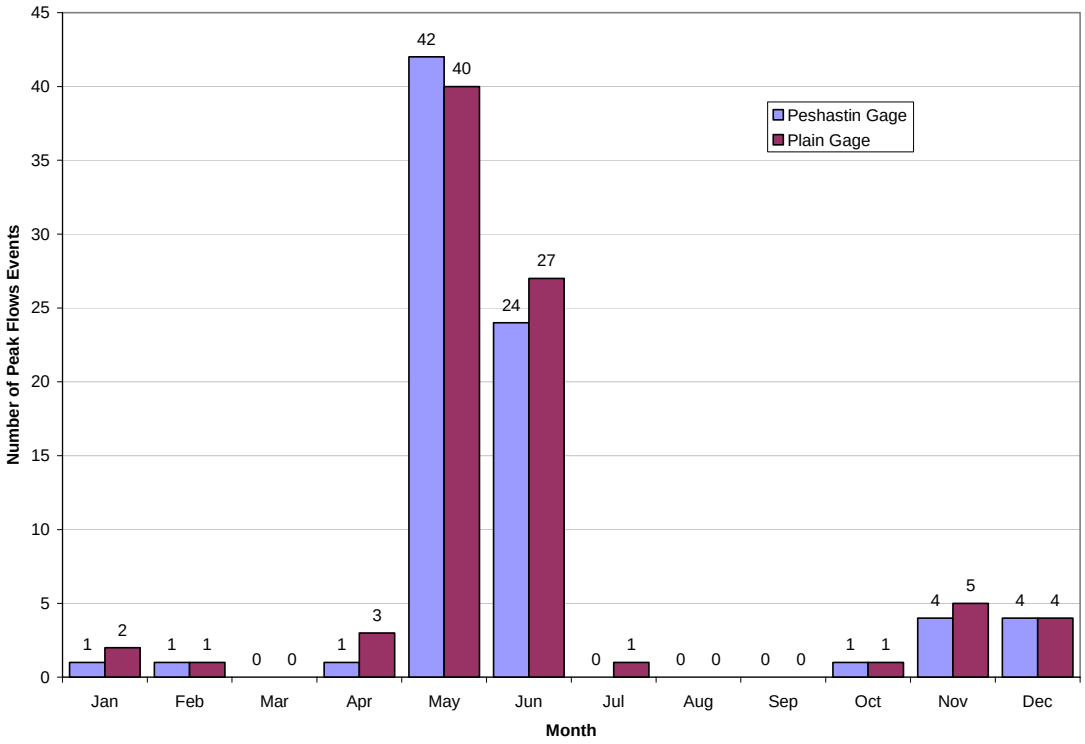


Figure 4-3. Monthly Distribution of Peak Flows for the USGS Plain and Peshastin Gages.

Although the majority of the annual peak flows occur in the late spring, the two largest recorded flows have occurred in November (Table 4-2). These high flow events were presumably caused by a rain-on-snow event early in the season.

Table 4-2. Largest Recorded Peak Flows for the USGS Plain and Peshastin Gages.

USGS Gage Location	Storm Event Date	
	Nov. 25, 1990	Nov. 30, 1995
Plain	33,200 cfs	36,100 cfs
Peshastin	40,000 cfs	41,300 cfs

Cfs cubic feet per second

An additional investigation into how daily flows vary between the two gages was conducted based on how often the same annual peak storm event was recorded at both locations. The analysis investigated the daily average flow for the two gages from September 26, 2001 through September 11, 2002 to compare the shape and timing of the flow hydrographs. Using the daily average flows from the USGS, hydrographs for each gage were plotted for the 2002 water year. The hydrographs are presented in Figure 4-4.

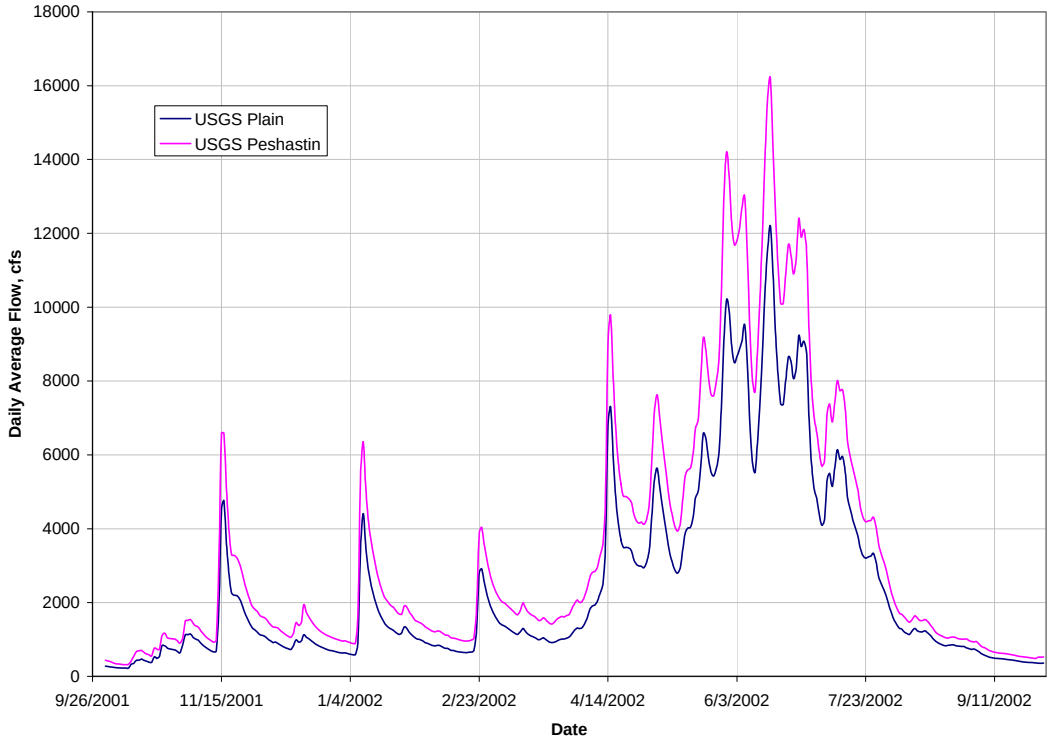


Figure 4-4. Daily Flow Hydrograph at USGS Gages at Plain and Peshastin.

As the figure illustrates, the peaks and dips of the storm hydrograph have similar shape and slope throughout the year. Based on this data, it is reasonable to assume that the flows within the project reach would fall between the flow rates recorded at the two gaged sites upstream and downstream.

4.4. Flood Frequency Analysis

Table 4-3 contains the flood frequency analysis results for the two USGS gages for eight recurrence intervals.

Table 4-3. Flood Frequency Analysis Results for USGS Plain and Peshastin Gages.

Recurrence Interval	USGS Plain Gage DA= 591 mi^2		USGS Peshastin Gage DA= 1000 mi^2	
	Peak Flow (cfs)	Unit Flow (cfs/mi^2)	Peak Flow (cfs)	Unit Flow (cfs/mi^2)
2-Year	11,670	19.7	16,050	16.0
5-Year	15,730	26.6	21,240	21.2
10-Year	18,540	31.4	24,750	24.7
25-Year	22,240	37.6	29,300	29.3
50-Year	25,110	42.5	32,760	32.8
100-Year	28,080	47.5	36,300	36.3
200-Year	31,160	52.7	39,930	39.9
500-Year	35,450	60.0	44,920	44.9

In order to estimate flood flows in the project reach, the average unit flows for the two USGS gages shown above were weighted by drainage area. The resulting unit flow was then multiplied by the approximate drainage area of the study reach, 689 mi^2. The final project reach estimates of average unit and peak flows are shown in Table 4-4.

Table 4-4. Estimated Average Unit and Peak Flows for Project Reach.

Recurrence Interval	Project Reach DA= 689 mi^2	
	Average Unit Flow (cfs/mi^2)	Estimated Peak Flow (cfs)
2-Year	17.9	12,237
5-Year	23.9	16,500
10-Year	28.1	19,447
25-Year	33.5	23,322
50-Year	37.6	26,322
100-Year	41.9	29,422
200-Year	46.3	32,633
500-Year	52.5	37,096

These estimated peak flow rate values are used in the HEC-RAS hydraulic analysis of the next section to estimate surface water elevations, velocities, stream power, and other hydraulic parameters for the Wenatchee River through the project reach.

4.5. Installation of Stream Gage at Tumwater Dam

In an effort to better understand the flows within the project reach, a stage gage was installed in the Wenatchee River at the Tumwater Dam. The gage collects water levels upstream of

the dam every 15 minutes. These data, along the elevation data for the dam crest and the dam crest length, will be used to develop a flow hydrograph record for the dam location using the general weir equation. When enough data have been collected, the relationship between the data recorded at the dam and either of the two USGS gages (Plain or Peshastin), can be developed using the USGS 15-minute recorded data. This relationship will provide a more accurate reconstruction of historic flows within the project.

4.6. Summary of Hydrology

The analysis of the two existing USGS gages, upstream at Plain (Gage number 12457000) and downstream at Peshastin (Gage number 12459000), revealed similar hydrologic responses allowing for relative confidence in using them to develop peak flows within the project reach. The reconstruction of the hydrologic regime in the project reach indicates it is reasonable to assume that flows within the project reach, which is between the two USGS gages, would fall between the flow rates recorded at the two gages. Therefore, reasonable estimates of peak flows could be developed for the project reach for use in the hydraulic modeling completed in the next section.

4.7. Additional Assessment Needs

The water level gage installed in the reservoir collects water levels upstream of the dam every 15 minutes. These data, along with the elevation data for the dam crest and the dam crest length, should be used to develop a flow hydrograph record for the dam location. When this is complete, a relationship between the data recorded at Tumwater Dam and either of the two USGS gages will be established using the USGS 15-minute recorded data. This relationship will allow the historic flow records to be scaled to reflect a continuous flow record for the project reach. This information will help determine impacts to US 2 associated with flow and facilitate the design of effective mitigation of those impacts.

The total flow through the dam consists of the flow over the dam and the flow through the fish ladder. Since the newly installed stage gage measures only flow over the dam, the flow through the fish ladder also needs to be determined. This data may be available from the Chelan PUD or other agencies involved with the ladder operations.

5. Preliminary Hydraulic Assessment

5.1. Importance

The project area is characterized as a series of steep channel sections separated by pool sections. Included in the project reach are Tumwater Dam and the adjoining fish ladder. The hydraulic analysis is intended to estimate water surface profiles, flow velocities, flow direction, stream power, shear stress, and other hydraulic parameters. This is accomplished using available data for the selected historical flood events and hypothesis flows in the portion of the Wenatchee River flowing through the project reach. The hydraulic analysis helps clarify the causal mechanisms of the chronic road maintenance issues on US 2 though the project reach and the contribution of the river to the multiple bank failures. One possible road failure mechanism being investigated is whether high flow over the dam is directed at the Severe Hazard site, increasing the flow energy at the rock protection.. Of particular interest for the hydraulic analysis is whether the alignment of Tumwater Dam may contribute to the repeated road failures that have occurred immediately below the dam. The computed hydraulic features will provide the basis for the subsequent project design, alternative analysis, hazard and risk assessment, construction implementation, and post-project management.

5.2. Methodology

The hydraulic analysis utilized both one-dimensional and two-dimensional modeling approaches. The one-dimensional steady flow HEC-RAS model (USACE, 2006) was used to model the flood flows along the study reach and overbank floodplain. The water surface elevations, velocities, stream powers, shear stresses and other hydraulic features of selected historical flood events and selected return-period flood events were computed using this model. The two-dimensional modeling incorporated River 2D (Univ. of Alberta, 2002) to develop a more detailed analysis of the hydraulic conditions associated with the Tumwater Dam facility. The modeling results from the River 2D analysis included flow velocities and flow directions for the area of the Tumwater Dam and shed light on how the alignment of Tumwater Dam may be contributing to the chronic road maintenance issues that have occurred on US 2 immediately below the dam..

The basic required data inputs for the hydraulic modeling include geometrical and flow data. The HEC-RAS model uses river cross section data to describe the physical characteristics of the area, while River 2D uses a continuous topographic surface. The peak flows used in the hydraulic modeling were developed as described in the preliminary hydrology assessment above.

5.3. Flow Data

In addition to the peak flows that were estimated for the project reach, historical flood events and typical flows of interest are also analyzed. The flow data used in the one-dimensional HEC-RAS model are presented in Table 5-1. The flow data for the historical flood events and typical low flow and snowmelt flow were calculated based on the flow records at the USGS stream gage at Plain (USGS Gage # 12457000) and the drainage area ratio between the gage and the project reach.

Table 5-1. Peak Flows Used in HEC-RAS Model for the Project Reach.

Event	Peak flow at USGS Plain Gage (cfs)*
5/28/1948	26,464
11/25/1990	38,705
11/30/1995	42,086
5/19/2006	18,420
11/7/2006	23,783
3/20/2007	5,643
3/25/2007	9,501
6/5/2007	13,873
Typical Low Flow	350
Typical Snowmelt Flow	8,161
100-year Flood	29,422
500-year Flood	37,096

*Cfs cubic feet per second.

The River 2D model run was conducted using a flow of 24,000 cfs. This flow rate approximates the November 2006 peak flow event, and is an approximately 13-yr MRI event. Because of the complexities associated with 2D modeling, only one flow event was modeled.

5.4. Geometry Data for the HEC-RAS Modeling Effort

All vertical geometry data and flood elevations in this report and on the related work maps are referenced to National Geodetic Vertical Datum of 1929 (NGVD 29). All the data with a different datum were converted to NGVD 29 by considering the datum difference at the specific location.

The HEC-RAS model assumes a single channel of approximately four miles and includes a man-made inline structure (Tumwater Dam). A total of 33 cross sections through the project reach were modeled. Figure 5-1 displays the layout of the HEC-RAS model. Denser cross section coverage was delineated at the problem areas: those areas identified by WSDOT and the review

of historical information as experiencing road failure in the past and those identified as Severe Hazard Areas above.

The geometric data used in the HEC-RAS model were obtained by using HEC-GeoRAS 4.0 software (USACE, 2005) on a digital terrain model derived from WSDOT topographic survey data and 40-foot elevation contour data downloaded from the USGS seamless data site (USGS, Map Server). The WSDOT survey data provided the elevation for the edge of the water along the banks, but there was no survey conducted within the active flowing channel. The channel geometry below the water edge was established with water depth that was estimated based on site photos taken by ENTRIX engineers during field surveys. The estimated water depth ranges from two feet to five feet.

The HEC-RAS model assumed all flow in the river went over the dam. There is not sufficient information at this time to take into account flow through the attached fish ladder. By assuming all flow is conveyed over the crest, the estimated water surface elevations upstream of the dam may be higher than expected. The difference in the modeled results and the actual water level will be dependent on how much flow actually passes through the fish ladder instead of over the dam. Tumwater Dam was incorporated into the model geometry file as an in-line structure. Chelan County PUD provided historic as-built plans of the dam including the crest elevation. To simplify the hydraulic model, the Tumwater Dam was assumed to be a broad-crested straight structure with a flat crest. The crest elevation was set at 1492.74 ft, based on recent surveys at the dam. While the top width of the dam was assumed in the model to be three feet, the HEC-RAS uses a standard weir equation to calculate the water surface at the dam; the top width is not a factor in the calculation, so the assumption will not have significant impact on the computational results.

To better understand the impacts the dam may have on the hydraulic regime of the river, a one-dimensional HEC-RAS model designed to represent the Wenatchee River without the influence of Tumwater Dam was also developed. The models assumed natural river condition was created by just removing the dam from the geometry file. By removing the in-line structure, the HEC-RAS estimates the water surface profile along the project reach using the existing cross-sections that were originally upstream and downstream of the dam.

5.5. River 2D Modeling Effort

The input data required for a River 2D hydraulic analysis is typically a dense collection of survey points for both in-stream and overbank areas. The stream cross-section geometry format used in one-dimensional models such as HEC-RAS does not provide representation of the river bathymetry at a level of detail adequate for conducting a 2D model. The point data for the River model includes X and Y coordinates, elevation, and a roughness coefficient.

The project reach was surveyed for this model. The survey extent stopped at the edge of water on both sides of the river and included limited overbank information. Figure 5-1 shows the locations of survey points that were collected in the vicinity of the dam, and the topographic representation of the bed elevation that was created using the point data in the River 2D modeling environment.

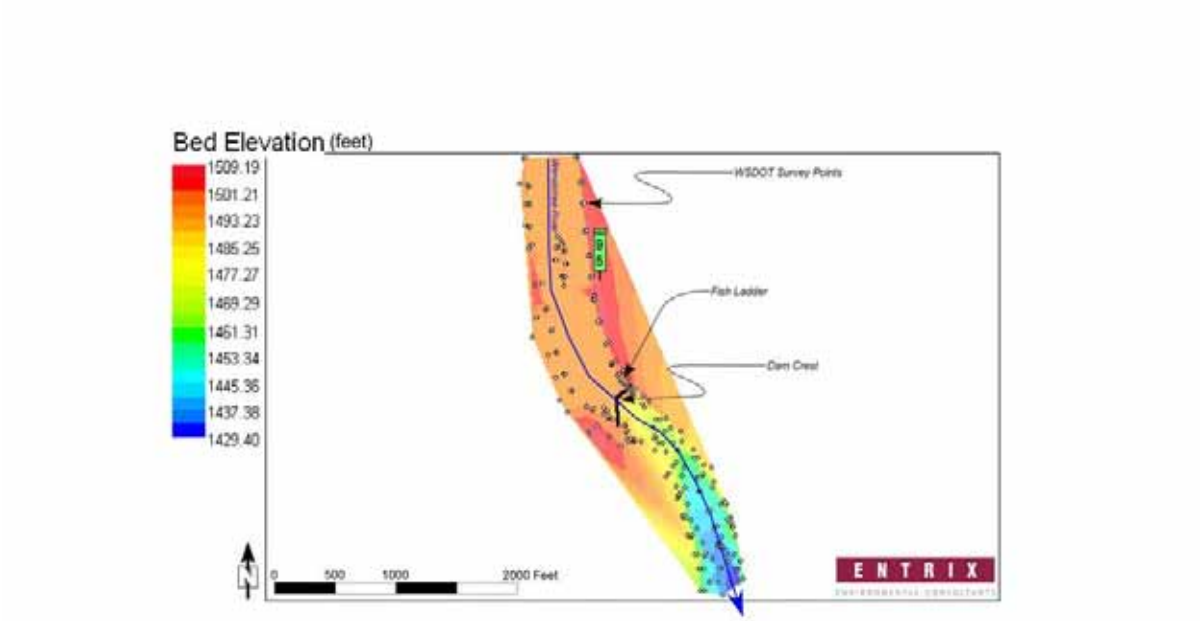


Figure 5-1. WSDOT Survey Points near Tumwater Canyon Dam and Derived Surface

As Figure 5-1 illustrates, the survey data provided to ENTRIX also did not include any points that describe the physical features of the dam such as crest elevation, spillway, or apron. Using the surveyed WSDOT points as a starting condition, additional modeling nodes (points) were added to the topographic database to develop the necessary detailed representation of the dam, stilling basin, and downstream reach. Since no survey points associated with the dam were collected, topographic information for the dam structure was derived from engineer drawings titled "Tumwater Dam General Arrangement" dated June 1997 (Stone & Webster Engineering Corporation, 1997). The drawings provided spot elevations and contours for the dam and areas immediately downstream of the dam.

Points were also added to provide a more defined river channel, dam crest, and plunge pool below the dam (Figure 5-2). The dense concentration of points in the middle of the image is in the location of Tumwater Dam. A comparison of the two point-generated topographic representations reveals a more defined river channel and dam location. To better define the river channel, points were added to represent the bottom of the pond upstream of the dam and the river bottom downstream of the dam. The added river points create a trapezoidal channel with no defined thalweg. At the dam, the additional points were required to better represent the upstream and downstream dam face as well as the concrete apron.

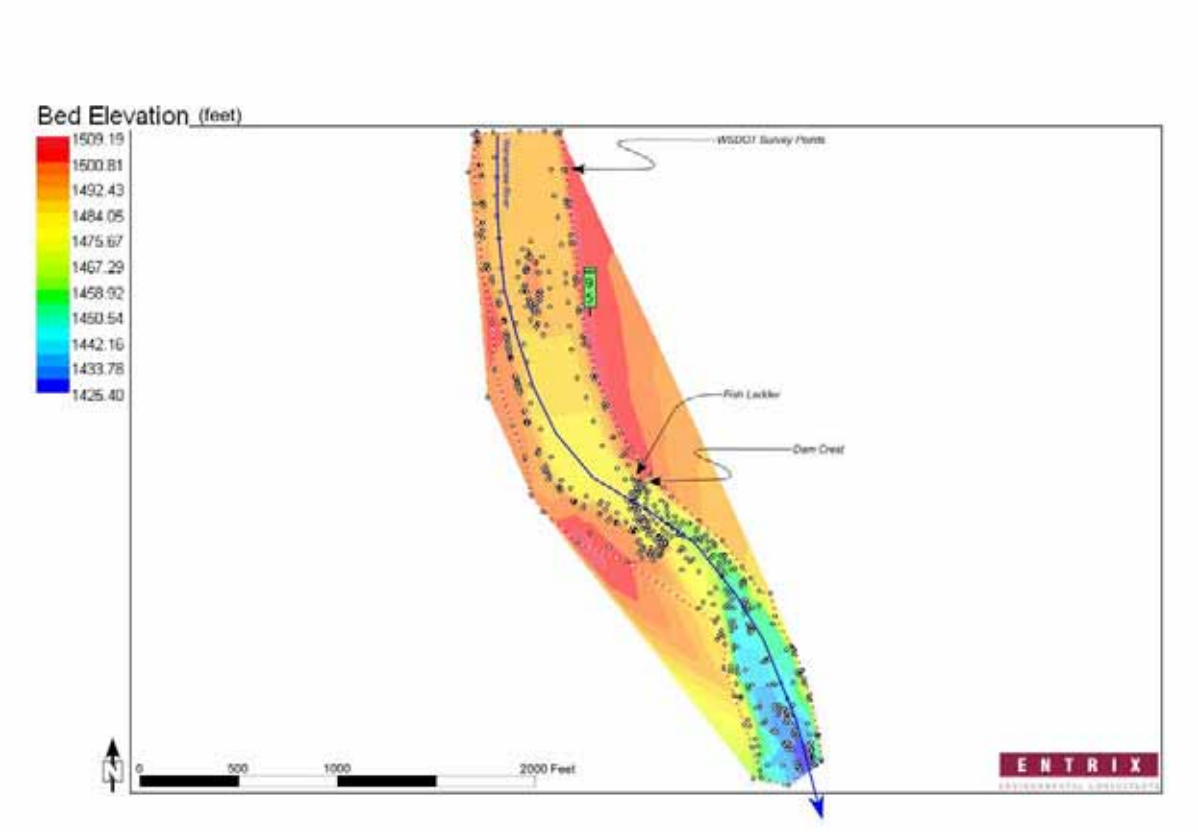


Figure 5-2. Revised Tumwater Canyon Points and Derived Surface

Once all the points were incorporated, "breaklines" were added to the point files to delineate controlling topographic features, such as the crest of the dam, the top of bank, and toe of slope. An example of this process can be found at the dam. The topographic surface development algorithm does not allow adjacent points to interact if a breakline crosses between them. The creation of a breakline along the survey points representing the crest of the dam means that point data that represent the upstream and downstream face of the dam do not recognize each others existence. Therefore, the surface model knows there is a high point located between these two lower elevation points and the results of the model better represent hydrologic reality.

An issue that is reflected in the location and number of points shown in Figure 5-2 is that the banks and floodplains of the modeled reach lack the necessary definition to provide for a smooth running model. Inadequate point coverage causes the model to become unstable and the model is not able to reach a solution within the programs tolerances. The inclusion of additional survey or LiDAR data for the bank and floodplain area would result in a more robust model of the high flow events and better support the development of a more complete picture of how the alignment of Tumwater Dam contributes to the repeated road failures that have occurred immediately below the dam. The computed hydraulic features developed in the modeling effort provide information critical to the subsequent alternative analysis and project design.

5.6. Roughness Factors (Manning's Roughness Coefficient *n*)

The roughness factors for the cross-sections were estimated based on the following factors: vegetation, the irregularity of the channel and the cross section, the degree of meandering of the river, the obstruction in the channel, and the condition of soil within the channel. The information supporting the factors used in the modeling was obtained by consulting the field and aerial photos and field survey records developed by ENTRIX. The photos and field records show rocks with a diameter of more than two feet scattered throughout the channel and the overbank areas. These rocks present a remarkable obstruction to the flow, and consequently increase the roughness in the river channel. Another factor that influences the roughness is the irregularity of the channel in the cross sections observed during the field reconnaissance. This irregularity was primarily caused by the alluvial fan formation along the river and river bank erosion. Figure 3-7 shows the four distinct debris fans on the east valley wall at approximately MP 94.50, 96.00, 96.20, and 97.25 that collectively span approximately 0.90 miles of the east bank of the Wenatchee River within the project reach.

As discussed above, a distinct riparian zone (consisting of a shrub and canopy layer) is not continuous through the project reach. Riparian buffers do exist where there is soil-bearing land between the road and the river at the toe of the east bank debris-fans, and many small bedrock "knobs" supporting small to medium trees that extend into the river channel were observed along the project reach. These knobs also provide some protection for US 2 at points within the project reach. Continuous and persistent riparian buffers have likely never been a feature of the canyon, but trees and low bushes present on the flood plain edge throughout the study reach, especially during the summer and fall seasons. The USGS guideline for the Manning's n selection dictates that such areas would have a roughness of 0.09 to 0.12. In the low-lying area along the overbank, the vegetation is moderate or less than moderate. Therefore, a roughness of 0.060 to 0.075 was determined.

Based on the soil conditions, topographical features, and land use information in the project reach, the roughness in the channel and the overbank areas were estimated following the USGS guidelines of selecting Manning's roughness coefficient, or *n* (USGS, 1984). The estimated Manning's *n* values for the project reach are shown in Table 5-2.

Table 5-2. Roughness Factors (Manning's *n*).

Cross Sections	Channel	Left Overbank	Right Overbank
24725.76 – 20628.43	0.055	0.100	0.100
19213.08 – 16857.77	0.050	0.090	0.080
16085.77 – 11043.98	0.055	0.100	0.100
9946.918 – 7577.187	0.058	0.110	0.085
7205.184 – 5111.223	0.060	0.110	0.110
3499.427 – 2522.208	0.050	0.090	0.085
2011.259 – 569.7745	0.060	0.100	0.100

The River 2D model uses a roughness height that is based on Manning's *n* values and hydraulic radius of the channel. At this preliminary level of assessment, the default value of 0.50 was used for the roughness factor. This roughness factor value corresponds to an approximate Manning's *n* value of 0.04-0.05, depending on the overall hydraulic characteristics of the location.

5.7. Boundary Conditions

The HEC-RAS boundary conditions for the project reach were defined as normal depth for both upstream and downstream ends. The normal depth boundary condition was based on channel slope. The upstream and downstream slope values (0.0175 for upstream and 0.0284 for downstream) were calculated based on the inverts of the last two cross-sections on both ends. Boundary conditions were used within the model as the starting point estimating the successive water surface elevations at each cross section. Typically, HEC-RAS is considered a back-water equation model. This means the model starts at the downstream end of the project reach and estimates the increase in the water surface profile based on channel slope and estimated flow velocities.

The River 2D model also required upstream and downstream boundary conditions. Upstream boundary conditions require a flow rate and initial water surface elevation, while the downstream boundary requires just an initial water surface elevation. Using the boundary conditions as modeling constraints, the model has a more accurate estimation of where the parameter calculations should start. The model equation solver may not be able to converge on a valid answer without setting proper boundary conditions. For the Tumwater Dam model conducted for this project, both of the boundary conditions were based on the one-dimensional HEC-RAS model of the project reach. The HEC-RAS one-dimensional model estimated the water surface profile for the entire Wenatchee River project reach, which includes the 2D model extents. The HEC-RAS results for the cross-sections nearest the upstream and downstream boundary provided the initial boundary conditions.

5.8. Results

As mentioned earlier, the one-dimensional HEC-RAS hydraulic analysis was conducted for both with- and without-dam conditions to assess the influence of the dam. The study results for both assessments are discussed below. The River 2D hydraulic modeling effort only addressed a single flow condition. The HEC-RAS modeling results are discussed first followed by the River 2D results.

5.9. With-Dam Condition

Table 5-1 above shows the computed water surface elevations for the peak flow events listed in Table 2-1. The computed water surface profiles for the selected historical flood events, the selected typical flows, and the 100-year and 500-year flood events are shown in Figure 5-3. Figure 5-3 also shows the road-top elevation of US 2 and surveyed water surface elevations from field surveys. Except for the modeled location at the Tumwater Dam where US 2 has repeatedly been overtopped by 100-year, 500-year, and the November 25, 1990 floods, the results of the model were that the road was not overtopped by any of the simulated flood events.

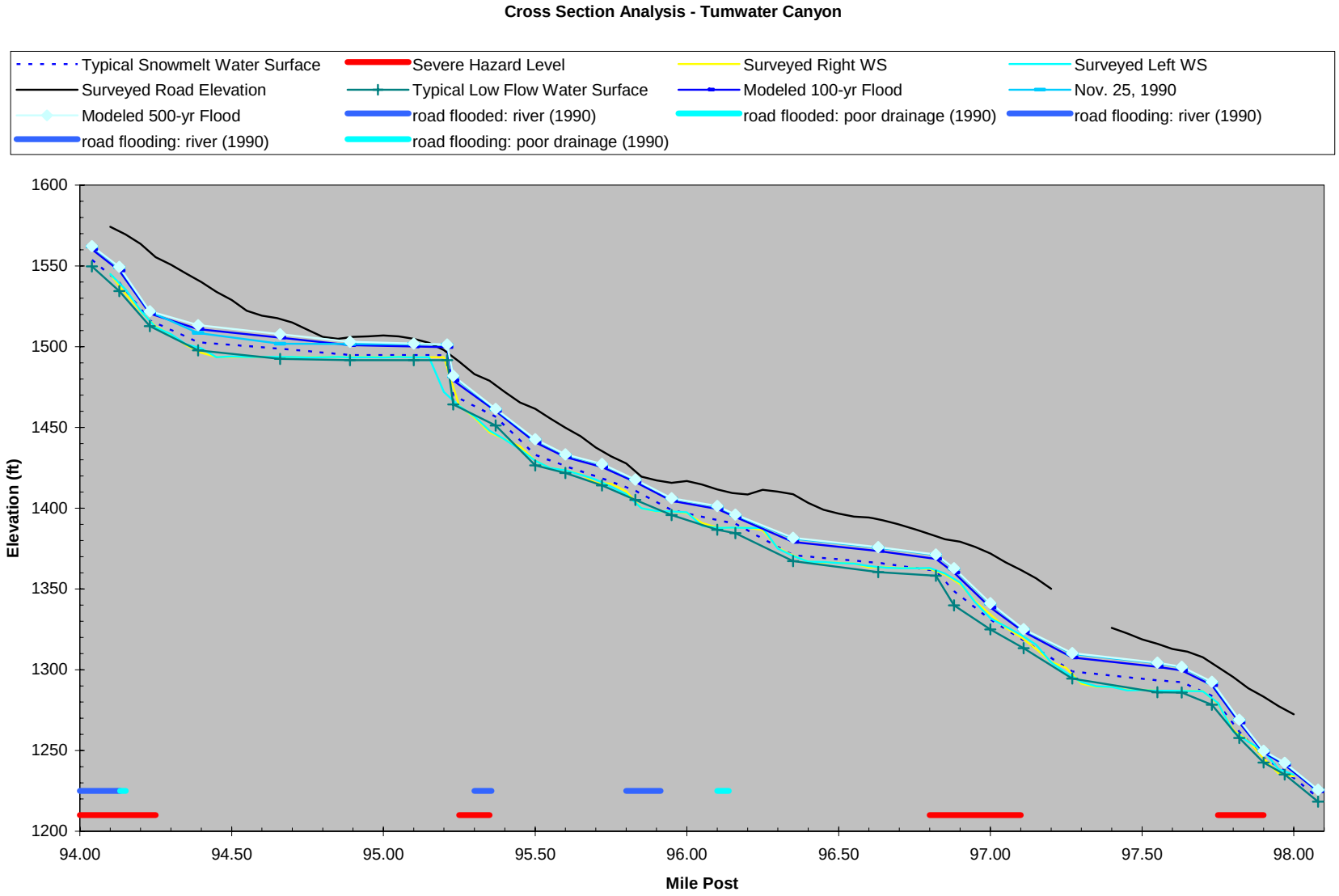


Figure 5-3. Road Top Elevations of US 2 in Project Reach and Surveyed and Computed Water Surface Elevations.

The computed water surface profiles show that US 2 is overtopped at the Tumwater Dam by the Nov. 25, 1990 flood, the 100-year flood, and the 500-year flood. This may not reflect the real situation. The uncertainty of the water surface elevation at this location may be caused by various factors such as inaccurate geometrical data, a higher roughness coefficient than actual conditions, and the simplification of the modeled dam. Of these three factors, the assumption of the dam alignment would have played a major role. In the simulation, the dam was assumed to be a straight line across the river and to be perpendicular to the main flow direction in the channel. This assumption remarkably reduced the dam length and consequently increased the water surface elevation at the dam. The precision of the model results can be improved by using correct dam alignment in the future when accurate data are available.

Figure 5-4 shows the computed channel velocity and shear stress distribution for the 100-year flood. The model results indicate that sections of the road that have experienced road failure are associated with the areas of high flow velocity and shear stress.

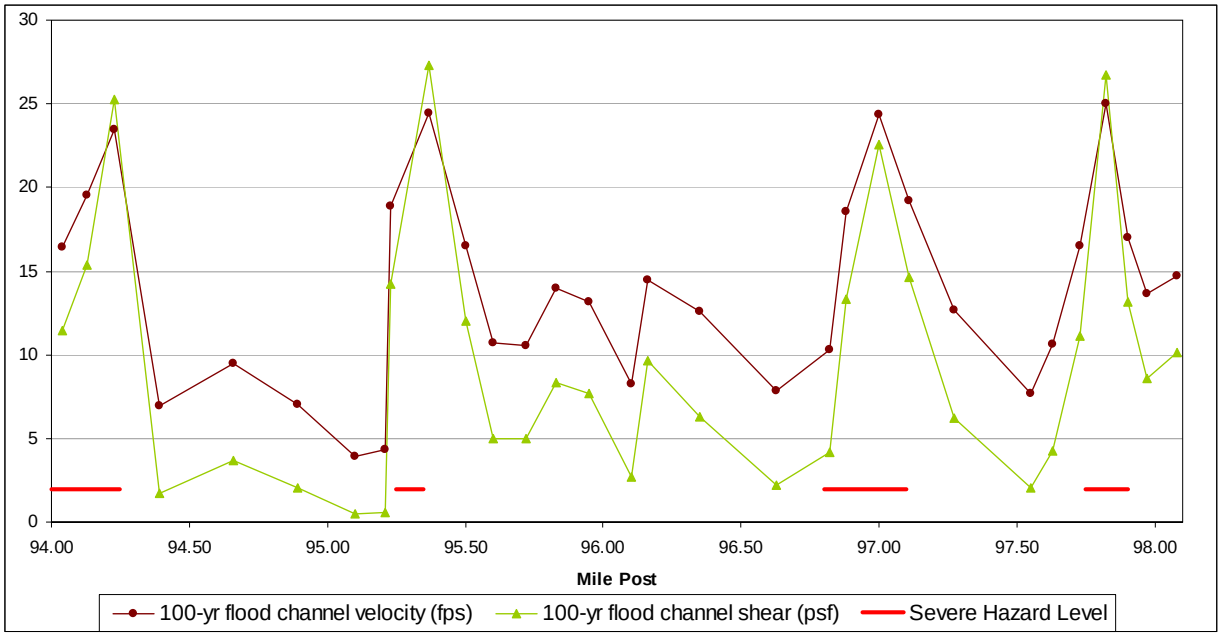


Figure 5-4. Computed Channel Velocity and Shear Stress Distribution for 100-year Flood Event.

5.10. Without-Dam Conditions

Figure 5-5 compares the water surface profiles for the conditions with and without the dam for the 100-year flood. The removal of the Tumwater Dam in the modeling effort only has localized impact on the water surface over approximately one-half mile upstream from the dam. The modeled water surface elevation that could occur without the dam is estimated to be 17.4 ft lower than that would occur with the dam assuming a 100-year flood. The River 2D modeling results use a graphic representation of the flow velocity as shown in Figure 5-6. As Figure 5-6 illustrates, the flow velocity in the reservoir upstream of the dam is relatively low and constant. Flow over the dam and within the plunge pool area is modeled to be very high, exceeding 25 feet per second (fps).

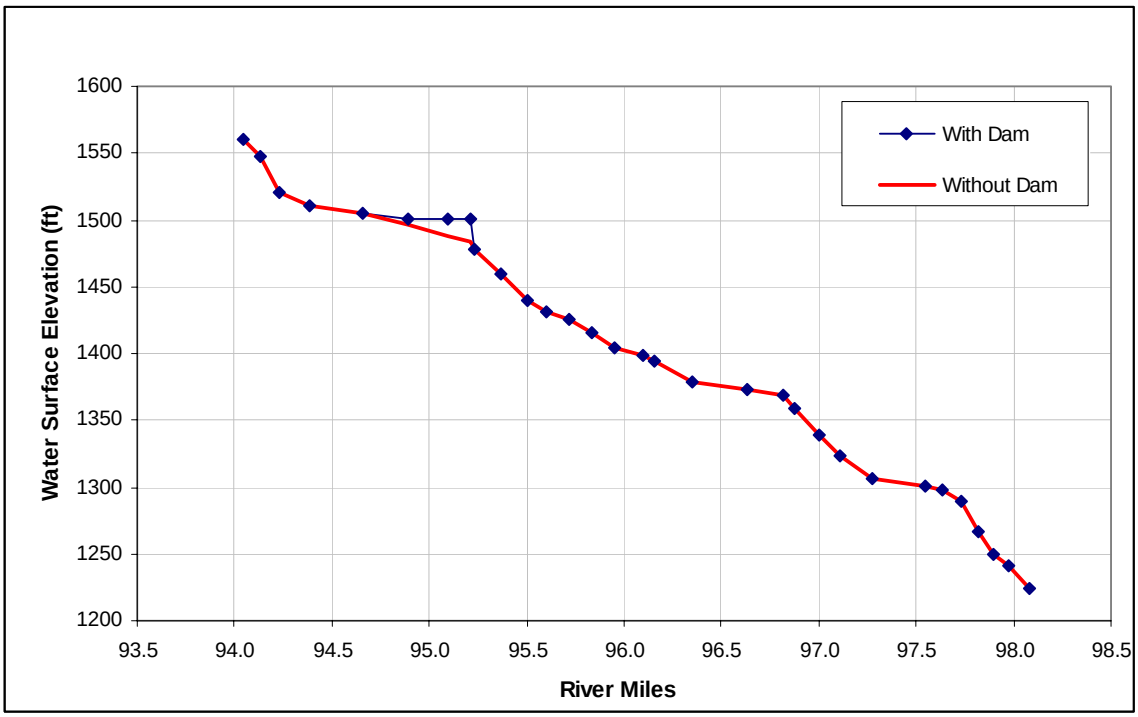


Figure 5-5. Comparison of Computed Water Surface Elevation, With and Without Dam Condition, Assuming a 100-Year Flood Event.

The flow velocity remains high in the reach below the dam, approximately 15 fps, until it gets near the downstream boundary of the model. In the field, this area would be near the calm pool area downstream of the dam (RM 31). At the downstream boundary in the model, the relatively low density of model points in this area has created a relatively unstable condition. To correct the instability issues in modeling of the downstream boundary, inclusion of a more detailed (denser point coverage) would be advisable. If LiDAR and additional survey data are made available, this information can be incorporated into the revision of the 2D modeling surface and the instability in this area will be reduced.

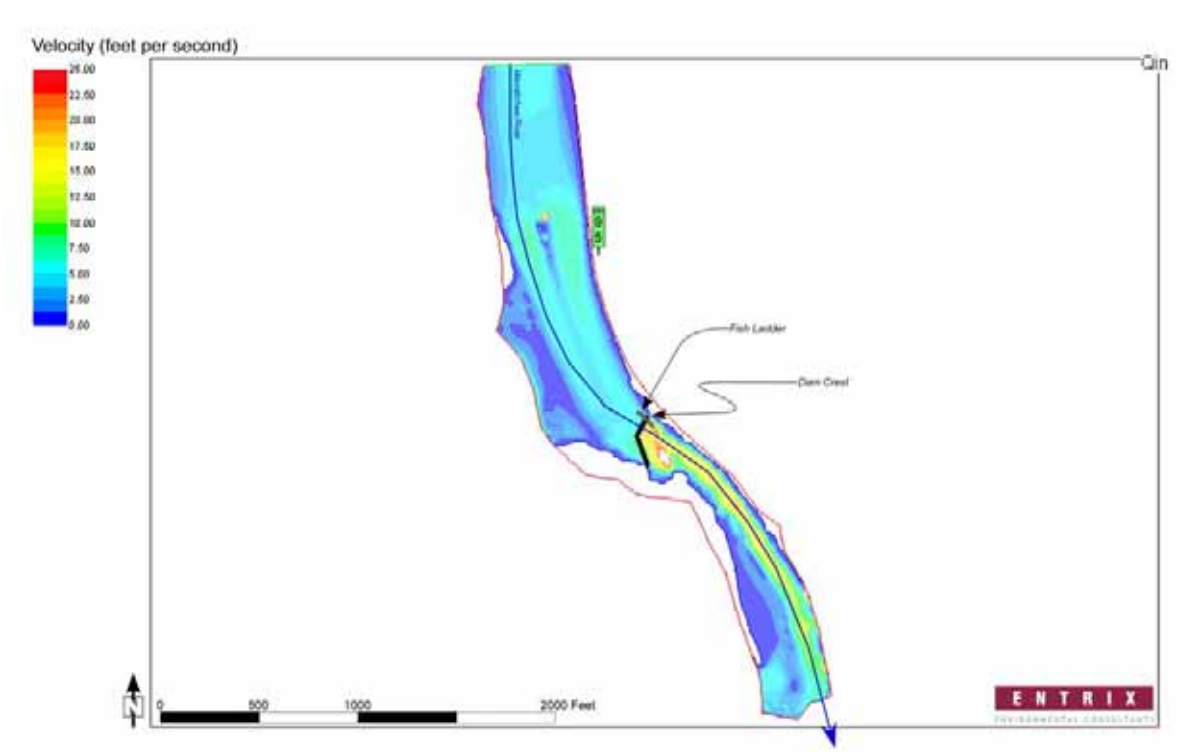


Figure 5-6. Modeled Flow Velocity Results for the Project Reach using the River 2D Model.

Figure 5-7 is a smaller scale depiction of the project reach near Tumwater Dam showing the directional velocity vectors and general flow velocities. As the figure shows, there is an area of localized high flow immediately downstream of the dam. The white area with the largest arrow originating from it indicates that flows are above the shown range (25 fps) and likely indicates the extreme turbulence that is encountered there. Considering the limitations of the model, the modeling results shown may not adequately estimate the magnitudes of the velocities in this location due to the insufficient number of data points, but it does clearly suggest that the directional flow vectors quickly reorient themselves in a downstream direction.

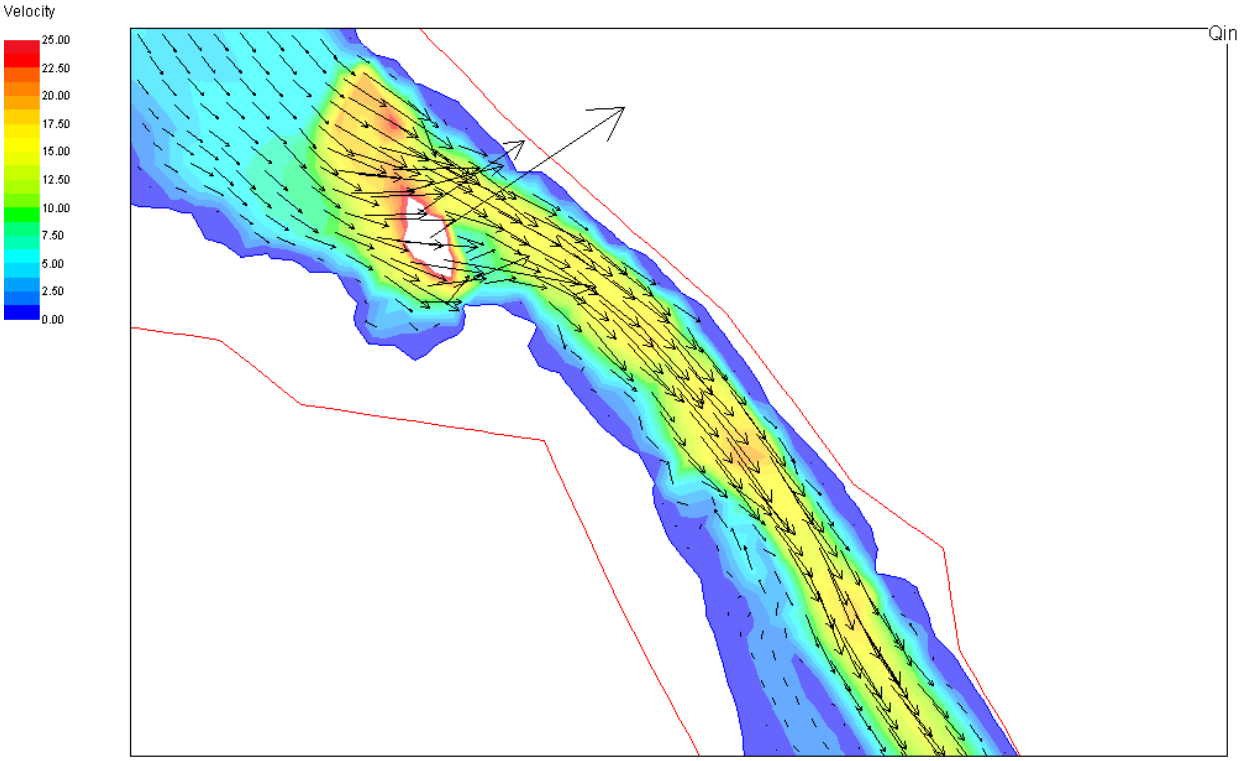


Figure 5-7. River 2D Directional Velocity Flow Vectors near Tumwater Dam.

One of the possible road failure mechanisms being investigated with this study is whether high flows over the dam are directed at the Severe Hazard site, increasing the flow energy occurring on the rock protection. Based on these preliminary modeling results, the directional momentum from flow going over the crest of the dam toward the roadway is rapidly redirected parallel to the channel walls, most likely due to the steep channel slope. This is important because it indicates flow direction at the road failure site below the dam (RM 32) may be parallel to the road and not directed toward the portion of US 2 with chronic maintenance issues.

5.11. Summary of Hydraulic Assessment

The study results from the one-dimensional HEC-RAS model show that the problem areas of US 2 where chronic road maintenance has occurred are the areas where the largest flow velocity, shear stress, and stream power occur. The two-dimensional River 2D model results indicate that the removal of Tumwater Dam will have only a local influence (approximately one-half mile upstream from the dam) on the hydraulic characteristics within the study reach.

5.12. Additional Assessment Needs

To increase our understanding of hydraulic mechanisms responsible for damage of the road prism, to increase confidence in the hydraulic information supporting the alternative design,

and to provide an adequate guide in the subsequent engineering design of protection measures, we recommend additional hydraulic study as follows:

1. There is not enough information to model the entire project reach so the results are limited in scope and utility in assessing conditions throughout the project reach. The hydraulics assessment should be expanded to model conditions throughout the entire project reach.
2. Adequate topographic maps of the study area are essential for hydraulic study that can be used for the subsequent engineering design. The current topographical data used in the study are of coarse resolution (40-ft). These data are not adequate for the calibration of the model in order to establish a robust model. We recommend an accurate, detailed topographic survey of the site be conducted using LiDAR and/or other available survey technology to obtain the topographical features over the floodplain as well as within the channel.
3. The preliminary modeling completed here assumed all water was flowing over the dam when that is likely not the case. Assuming all flow is conveyed over the crest may result in estimated water surface elevations upstream of the dam that are higher than expected. The amount of water flowing through the fish ladder should be calculated and accounted for in the model.
4. More detailed ground surface and channel geometry is required to provide a more reliable two-dimensional analysis for the Tumwater Dam area and improve the quality of the alternatives design. The current River 2D model assumes a trapezoidal channel with no defined thalweg. The location of the actual river thalweg may impact both flow velocities and direction of flow, which in turn could impact the erosive energy at the road failure site below the dam.
5. If greater topographic detail for the project reach is made available, the River 2D model coverage can be expanded to the entire four-mile project reach. This will provide greater analysis detail at all locations under investigation which in turn will provide for a greater understanding of the failure mechanisms at each site where chronic road maintenance issues have been reported.

6. Preliminary Fisheries Assessment

6.1. Purpose

The purpose of this section is to characterize fisheries resources that might be affected by remedial modifications of US 2 in Tumwater Canyon, and to provide relevant information on the distribution and ecology of fish species to be considered in project designs and associated permitting and consultation processes. Significant fisheries management programs and facilities in the project reach are described.

6.2. Methodology

ENTRIX used a rapid assessment method to assess general habitat conditions in the project area that relied on visual estimation of the following four significant habitat features:

- channel stability
- substrate cementation (a measure of how compacted the river bottom is),
- channel complexity (a measure of how complex instream fish habitat is), and
- condition of the riparian zones.

Habitat assessments were conducted at four locations within the project reach noted by the following mile markers on Highway 2: MP 91.7, MP 94, MP 94.5 and MP 97.1. Sites were visited on November 9, 2008 during the winter low-flow period.

The primary source of information on salmon and bull trout distribution, ecology, and status in the Wenatchee River is the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan ([Upper Columbia Salmon Recovery Board], 2007), officially adopted by NOAA Fisheries in 2007 (72 FR 57303). The comprehensive work presented therein is derived from subbasin plans, watershed plans, the Upper Columbia Biological Strategy, the Douglas County PUD and Chelan County PUD Anadromous Fish Agreement and Habitat Conservation Plans (AFAHCPs), and other relicensing agreements.

Other sources of information that contribute to the following synthesis include definitive works on Wenatchee salmon and steelhead ecology by Spaulding et al. (1989) and Hillman et al. (1989), the Wenatchee River Subbasin Salmon and Steelhead Production Plan (WDF, 1990), a final report by the Washington Conservation Commission on factors limiting salmon and bull trout (WSCC, 2001), the U.S. Fish and Wildlife Service draft bull trout recovery plan (USFWS, 2002), and the Wenatchee Subbasin Plan prepared for the Northwest Power and Conservation Council (NPCC, 2004). The descriptions of salmonid species presented below focus on the recent status of salmonid species within the project reach with an emphasis on information of import in the design and permitting of construction activities associated with US 2. The basic biology and ecology of focal species can be found in scholarly and reference publications such as Groot and Margolis (1991), Wydoski and

Whitney (2003), and Quinn (2005). Local and regional information on fish management, facilities and habitat use was obtained by direct contact of agency personnel and review of pertinent websites (NatureServe and StreamNet).

6.3. Project Area

The project area encompasses four miles of the Wenatchee River, from approximately MP 94 to MP 98 on US 2. This section of the Wenatchee River runs through Tumwater Canyon, which lies on the eastern side of the North Cascade Range. Significant aquatic features of this reach include the Tumwater Canyon Dam, the impoundment above Tumwater Dam and the tailwaters of Tumwater Dam. The hydroelectric facilities at Tumwater Dam were dismantled in 1956 and the dam was purchased by the Chelan County PUD in 1957 (Peterka, 2008). In 1987, a fish ladder was installed (Washington State Historical Society). Currently, the dam is used by fishery resource agencies to count fish, capture broodstock for hatchery programs, and for other research. Various modifications have been made to the dam in the last few years to avoid fish passage delays. Resource agencies have worked closely with Chelan PUD to revise and modify tailrace conditions to attract fish to the ladder at all water flows (UCSRB, 2007).

The impoundment behind Tumwater Dam, Lake Jolanda, is a low-gradient shallow reach, which is mostly silted in. The dominant substrate is a mix of fine sediments, sand and gravel, with fine sediments being predominant in the shallows adjacent to the shoreline. There are small patches of emergent wetland and palustrine mud flats along the shoreline of the impoundment, and at least one large bar that supports some wetland vegetation. The tailwaters of Tumwater Dam are a series of rapids and short cascades. The dominant substrate in most areas is mixed cobble and boulders; however, large pockets of gravel tend to settle out immediately upstream of the boulders due to reduced vertical shear velocities. Salmon and steelhead are known to spawn in these gravel pockets (NMFS, 1998; Interior Columbia Technical Recovery Team, 2007).

Reconnaissance habitat surveys by ENTRIX found that except for the unique features and hydraulics proximal to Tumwater Dam, in-stream habitat at all sites was relatively similar. Flow was turbulent and the dominant bed roughness elements were large boulders. Each site contained sufficient holding areas to facilitate movement and holding of adult salmonids through the area, usually in the lee of boulders. Edge habitat at all sites was limited and LWD was sparse as would be expected in a transport reach such as this. Though the canyon reach of the Wenatchee River is gravel poor, it is likely that small patches of spawning substrate would accumulate in the lee of large boulders. In fact, there were markers at MP 94 indicating that a habitat survey team had located redds in the area. Riparian habitat (woody shrub or canopy species) was found to be heavily impacted or nonexistent on the east, or left, ascending bank due to the presence of the road bed. Riparian habitat is also limited by high energy flows and widely fluctuating water surface elevations. On the west ascending bank, the riparian zone appears to have been significantly disturbed by recent wild fire. The east ascending bank was heavily armored, with large stretches of riprap to protect the road bed. At two of the sites, the east ascending bank was heavily eroded, while at the other two sites, the banks were protected by accumulations of large cobble and small boulders.

The Wenatchee subbasin supports three listed salmonid species: spring Chinook, steelhead, and bull trout. Very little habitat restoration or enhancement work has occurred in the Wenatchee River especially considering its importance to resident and anadromous fishes that are the subject of extensive recovery efforts (NPCC, 2004). At the watershed scale, impacts on habitat are primarily related to the state highway, railroad, and private land development and the system suffers from reduced LWD recruitment (UCRTT, 2002). Log drives in the early 20th century removed LWD in the channel and blasted boulders from the channel to facilitate log drives (NPCC, 2005). For much of the mainstem Wenatchee River, habitat diversity, connectivity, water quantity and quality, and riparian function are reduced. However, the subbasin contains headwater areas that are in relatively pristine condition and that currently serve as "strongholds" for listed species. The NPCC (2004) concluded that a series of efforts are required to address the following factors limiting focal fish species and habitats including, but not limited to: identification and protection of key and functional floodplains and riparian areas, evaluation of sediment transport past Tumwater Dam, and investigation of juvenile salmonid passage over and downstream of Tumwater Dam.

6.4. Fisheries Resources

The Wenatchee River subbasin is an important and productive system in the Interior Columbia River Basin (Steel, 2007). The Wenatchee system supports five focal salmonid species that utilize habitats in the project reach for adult and juvenile life history requirements for upstream and downstream passage, winter and summer rearing, and spawning and incubation. A complete description of the fish community can be found in the Wenatchee Subbasin Plan (NPCC, 2004). The following sections describe species that are the subject of complex and long-standing fisheries management programs conducted by a network of State, County, Federal and tribal agencies along with PUDs in the region.

6.4.1. Spring Chinook Salmon

The Upper Columbia River spring Chinook salmon (*Oncorhyncus tshawytscha*) Evolutionarily Significant Unit (ESU) was listed as endangered under the ESA in 1999 (64 FR 14307) and includes Chinook populations in the Wenatchee River. The Chiwawa Riverand White River populations in the upper Wenatchee watershed are integrated with the local population and are included in the ESU. The Chiwawa River is a tributary to the Wenatchee River below Lake Wenatchee; the confluence is north of the city of Plain, upstream of Tumwater Canyon and the project reach. The White River flows into Lake Wenatchee and occupies the basin directly west of the Chiwawa (see Figure 2-1). The Leavenworth National Fish Hatchery (LNFH) spring Chinook program releases an out-of-basin stock (downstream of the project area) that is not included in the ESU because their origin is a mixture of Upper Columbia and Snake River spring Chinook stocks.

Upper Columbia River spring Chinook have limited spawning distribution, low abundance and poor productivity, and are heavily supplemented by hatchery stocks (NMFS, 1999). As a "spring" run-type, these Chinook populations generally exhibit upstream spawning migrations from the ocean in late spring, coincident with spring streamflows from snowmelt, and hold over for some period before spawning in the late summer and early fall. The Upper

Columbia spring Chinook are stream-type, meaning that juveniles generally rear 1-2 years in freshwater before migrating to marine environments, but often utilize habitats well beyond their natal areas. In the past, introductions of spring-run Chinook from outside the watershed and egg transfers within the watershed have altered the genetics of salmon in this population. Habitat degradation, blockages, and entrainment mortality have resulted in significant population declines. Current threats to this population include transmission of bacterial kidney disease from hatchery stock to wild populations and the collection of wild adults to maintain hatchery stocks decimated by kidney disease (NMFS, 1999; Interior Columbia Technical Recovery Team, 2007). A Chinook fishery in the Wenatchee River has not been open since listing in 1999 to protect commingled, naturally produced spring Chinook. Currently, non-listed, hatchery-produced spring Chinook salmon are harvested in Icicle Creek, downstream from LNFH. The Wenatchee spring Chinook population is affected by several artificial propagation programs.

Artificial propagation of Chiwawa River spring Chinook began in 1989 as mitigation for Rock Island Dam. The program was initiated as an integrated supplementation program using locally derived spring Chinook returning to the Chiwawa River. Since the mid-1990s, when adult runs were at record low numbers, some hatchery-produced Chinook returning from this program were collected for broodstock. However, a minimum of 30% of the annual broodstock has remained naturally produced fish. The Chiwawa River is the only source for natural origin broodstock. A weir is used to collect adult broodstock from the Chiwawa River and the Tumwater Dam site is used to collect returning hatchery produced fish for broodstock. Tumwater Dam prevents hatchery fish passage, acting as a sorting site that allows preservation of natural production in the Chiwawa.

Artificial propagation of White River spring Chinook was initiated in 1999 as a captive broodstock program. The program is guided by a committee of co-managers and Grant PUD as the funding entity. Implementation of this program has been on a limited basis and no permanent facilities have been developed in the basin. The first yearling smolt release occurred in the spring of 2004. The White River is the only source for eggs used as brood fish. The White River spring Chinook population is a unique stock relative to other stocks throughout the Columbia River Basin, but was not determined to be an independent population based on the relatively small size of the White River and the short distance to other spawning (ICBTRT, 2004).

Leavenworth National Fish Hatchery has released spring Chinook into Icicle Creek since 1940, except for brood years 1967 and 1968. The program is intended to mitigate for the construction of Grand Coulee Dam by providing salmon for harvest, primarily in the Columbia River and in Icicle Creek. The LNFH is part of a hatchery complex owned and operated by the USFWS that includes the Entiat National Fish Hatchery and the Winthrop National Fish Hatchery. Production at LNFH focuses on spring Chinook salmon, coho salmon, and steelhead. Initially, broodstock trapped at Rock Island Dam; however, now it receives eggs from multiple sources and has several cooperating partners (CPUD, Yakama Tribe, WDFW) (USFWS, 2008). Chinook released from the LNFH are not part of the spring Chinook ESU. Broodstock are collected as volunteers to the hatchery facility, and little natural production occurs in Icicle Creek. Average returns (6,000+ annually) have been

substantial, on average constituting 54% of all spring Chinook passing Rock Island Dam since 1985 (Carrie, 2002). Tagging studies indicate that LNFH stray rates are generally low (<1%) (Pastor, 2004). However, based on expanded carcass recoveries from spawning ground surveys (2001-2004), LNFH and other out-of-basin strays have comprised from 3-27% of the spawner composition upstream of Tumwater Canyon (WDFW, unpublished data, as cited in UCSRB, 2007).

6.4.2. Upper Columbia River Steelhead

The Upper Columbia River Steelhead (*O. mykiss*) Distinct Population Segment (DPS) was listed as endangered under the ESA in 1997 (62 FR 43937) then reclassified as threatened in 2006 (71 FR 834). The 2006 reclassification of the steelhead DPS was invalidated as the result of a legal decision (Trout Unlimited, *et al.* v. Lohn, No. CV–06–1493–ST), restoring the Upper Columbia River Steelhead DPS to endangered status.

Steelhead in the Upper Columbia basin exhibit complex life cycles, including both resident and anadromous forms (Chapman et al., 1994). Adults return to the Columbia River in the late summer and early fall. Most steelhead do not move upstream quickly to tributary spawning streams; their movement into spawning areas occurs over extended periods (UCSRB, 2007). A portion of the returning run overwinters in the mainstem reservoirs, passing over the Upper Columbia River dams in April and May of the following year. Spawning occurs in the late spring of the calendar year following entry into the river. Juvenile steelhead generally spend one to three years rearing in freshwater before migrating to the ocean, but have been documented spending as many as seven years in freshwater before migrating (Peven, 1990; Mullan et al., 1992, as cited in UCSRB, 2007).

Adult steelhead enter the Wenatchee River from August through the following April. Spawning begins in late March and continues through May, peaking in mid to late April (Murdoch and Viola, 2003). In 2002, Murdoch and Viola (2003) found a total of 475 steelhead redds upstream of Tumwater Dam, with most located in the mainstem Wenatchee River. Steelhead currently spawn and rear in the Wenatchee River between Tumwater Canyon and Nason Creek; the Chiwawa River; and in Nason, Icicle, Peshastin, Chumstick, and Mission Creeks (UCSRB, 2007). Steelhead may also spawn and rear in the Little and White Rivers and Chiwaukum Creek.

Steelhead can residualize (lose the ability to smolt) in tributaries and never migrate to sea, thereby becoming resident rainbow trout. Conversely, progeny of resident rainbow trout can migrate to the sea and thereby become steelhead. Despite the apparent reproductive exchange between resident and anadromous *O. mykiss*, the two life forms remain separated physically, physiologically, ecologically, and behaviorally. NMFS has proposed (70 FR 67130) that anadromous steelhead populations are discrete from resident rainbow trout populations.

In the Wenatchee River, Hillman et al. (1989) found most juvenile steelhead rearing in Tumwater Canyon. During daylight, age-0 (less than 1 year) steelhead used slower, shallower water than Chinook, stationed individually over small boulder and cobble substrate

(Hillman et al., 1989a). As they grew, they picked deeper and faster habitat over cobble and boulders. As with Chinook juveniles, in winter, they concealed themselves in interstitial spaces among boulders near the stream bank, but did not cluster together. Hillman and Chapman (1989) found that most steelhead remained in Tumwater Canyon area to rear through all seasons. The amount of habitat diversity and complexity in this reach compared to other reaches was believed to be responsible for this behavior. Further, the NPCC (2005) has identified conservation of high functioning habitat in natal tributaries and Tumwater Canyon, and restoration of riparian and geofluvial processes in or near known and potential parr rearing areas will have the highest likelihood of increasing juvenile survival rates.

The diversity of the Wenatchee steelhead population has been reduced because of past harvest and hatchery practices, hydropower development, and habitat degradation. The Wenatchee steelhead population is currently distributed across several interconnected spawning watersheds (Chiwawa, Nason, Icicle, Peshastin, Chumstick, and Mission), which increases population diversity. Considering all viability parameters, the UCSRB (2007) has determined that the Wenatchee steelhead population is not currently viable and has a moderate to high risk of extinction. The elevated risk is based primarily on the proportion of natural spawners comprised of hatchery-produced fish. The Wenatchee River supported a fairly robust sport fishery (NPCC, 2005) before the listing of steelhead as endangered in 1997. There is currently no harvest of steelhead in the Wenatchee River.

6.4.3. Bull Trout

Bull trout (*Salvelinus confluentus*) in the Upper Columbia Basin, including populations in the Wenatchee River, have been listed as threatened under the ESA since 1998 (63 FR 23 31647). Critical habitat for bull trout has not been designated in the Wenatchee River owing to the extensive federal lands in the watershed and protections afforded those lands under comprehensive conservation strategies (USFWS, 70 FR 56251). For purposes of recovery, the Upper Columbia bull trout Recovery Unit has three core areas, including the Wenatchee, Entiat, and Methow Rivers. A core area represents the closest approximation of a biologically functioning unit for bull trout. Within a core area, many local populations may exist.

Currently, local populations of migratory bull trout in the Wenatchee Core Area include: Chiwaukum Creek, Chiwawa River (including Chikamin, Rock, Phelps, Alpine, Buck, and James Creeks), White River (including Canyon and Panther Creeks), Little Wenatchee (below the falls), Peshastin Creek (including Ingalls Creek), and Nason Creek (including Mill Creek) (USFWS, 2002). The State of Washington (WDFW, 2004) identifies ten bull trout stocks (populations) in the Wenatchee River watershed. They are the Icicle, Ingalls, Chiwaukum, Chikamin, Rock, Phelps, Nason, and Panther creeks stocks and the Little Wenatchee, Chiwawa and White rivers stocks.

Bull trout in the Upper Columbia Basin exhibit both resident and migratory life-history strategies. Resident bull trout complete their entire life cycle in the tributary stream in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear one to four years before migrating to either a lake (adfluvial form) or river (fluvial form)

(UCSRB, 2007). Because of the varying life histories and wide range of habitats used throughout the bull trout life-cycle, this species is often indicative of the degree of habitat fragmentation and geographic restriction within a given watershed (USFWS, 2005). Migrating bull trout have been observed within spawning tributaries as early as the end of June, while spawning occurs in mid-September to late October/early November. Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior. Bull trout at all life stages are associated with complex forms of cover including LWD, undercut banks, boulders, and pools. Tumwater Canyon is a migratory corridor for bull trout and is used by overwintering adults; sub-adults migrate downstream through the project area during September and October (DeLavergne, 2008). Within the Wenatchee and Entiat Core Areas, the migratory life history form is predominant within the existing local populations, and both areas were considered at a diminished risk for extinction (USFWS, 2002).

Abundance and productivity of bull trout in the Wenatchee subbasin is based on redd surveys. Surveys from 2000-2004 were conducted consistently across all populations and redd counts during this period ranged from 309 to 607 in the core area (UCSRB, 2007). For streams with long-term redd counts, numbers of redds have increased over time (e.g., Chiwawa basin). However, there is a fair amount of variability in all the other populations. Number of redds for Little Wenatchee, Nason Creek, Ingalls Creek, and Chiwaukum Creek are very low. Four of ten bull trout stocks in the Wenatchee basin have been classified by WDFW (2004) as Healthy with the six listed as Unknown based on the trend of available abundance data. Nearly all suitable spawning habitat is currently used by bull trout/Dolly Varden and present spawning distribution is thought to be nearly the same as the distribution prior to European settlement.

There has been no fishing for bull trout in the Wenatchee core area since the listing of bull trout in 1998. There is no bull trout hatchery program in the Wenatchee Core Area. However, the stocking of brook trout (*Salvelinus fontinalis)* negatively affects the abundance, productivity, spatial structure, and diversity of bull trout in the core area (USFWS, 2002).

6.4.4. Sockeye Salmon

The status of sockeye salmon (*O. nerka*) was reviewed by NMFS (Gustafson et al., 1997) and no populations in the Upper Columbia River basin were identified for listing under the ESA. Important factors that distinguish the Lake Wenatchee ESU include electrophoretic data that indicate this population is genetically the second most distinctive population (after Redfish Lake, ID) within the contiguous United States, as well as life history and environmental differences with sockeye salmon from the Okanogan River ESU (juvenile outmigration timing, environmental differences in lake-rearing habitat, and age composition). Sockeye salmon in the Upper Columbia River basin exhibit two distinct life histories; an anadromous, lake-rearing form, and a resident lake-rearing form known as kokanee. Lake Wenatchee (upstream of the project area) provides the majority of rearing habitat for sockeye in the Upper Columbia watershed. Run timing is similar to spring Chinook, and spawning occurs from mid-September to mid-October (Wydoski and Whitney 2003). Life history data for Lake Wenatchee sockeye compiled by Gustafson et al. (1997) depict a spring (late March –

May) downstream migration timing for smolts and a mid June through early August upriver migration for adults.

The Upper Columbia population of sockeye is likely the most robust population in the Columbia River system (NatureServe, 2008). However, this Upper Columbia population is dependent on relatively small reaches in the White River, Little Wenatchee River and the upper end of Wenatchee Lake for spawning habitat. Consequently, Lake Wenatchee sockeye are vulnerable to development along these streams and are currently the focus of hatchery supplementation programs at the Lake Wenatchee/Chiwawa Hatchery (NMFS, 1998).

6.4.5. Coho Salmon

Historically, coho salmon populations were more abundant in the lower Columbia River and small groups of coho salmon descendant from the lower river were found in upper Columbia River tributaries. Currently, the population in the Upper Columbia River is a relict population that is dependent on hatchery supplementation. The Yakama Nation, as the lead agency, has implemented a substantial reintroduction program designed to restore naturally reproducing coho salmon through the development of locally adapted stock, while releasing acclimated smolts in natural production areas. Since the reintroduction of coho to the Wenatchee River in 1999, the abundance of adult returns has been estimated to range from 350 to 4,000 (Murdoch et. al., 2004).

Coho salmon enter the Wenatchee River in early September through late November, with adults ascending tributaries in the fall and spawning between mid-October and late December. Coho entering in September and October hold in larger pools prior to spawning, later entering fish may migrate quickly upstream to suitable spawning locations. Coho salmon currently spawn in the main stem Wenatchee River (Cashmere to Lake Wenatchee), Nason Creek, Beaver Creek, Icicle Creek, Peshastin Creek, Mission Creek, and possibly Chiwakum Creek (NPCC, 2004). The availability and number of deep pools and cover is important to off-set potential pre-spawning mortality. Coho salmon prefer slower velocity rearing areas than Chinook salmon or steelhead, and recent work completed by the Yakama Nation in the Wenatchee system supports this general assumption (Murdoch et. al., 2004). Juvenile coho tend to overwinter in riverine ponds and other off channel habitats. Some juvenile coho likely migrate downstream during the fall, presumably seeking overwinter habitats. Overwinter survival is strongly correlated to the quantity of woody debris and habitat complexity (Quinn and Peterson, 1996). Naturally-produced coho smolts in the Wenatchee Basin emigrate between March and May.

The Wenatchee coho population is not protected under any state or federal authority (NatureServe, 2008) having long been considered extinct along with all natural coho populations above Bonneville Dam (Nehlsen et al., 1991) and never having been identified as a separate ESU (Weitkamp et al., 1995). Conservation of and restoration of high functioning habitat in natal tributaries along, and restoration of riparian and geofluvial processes in or near, known and potential rearing areas will have the highest likelihood of increasing juvenile survival (NPCC, 2004).

6.5. Management Facilities

Two fish management facilities could be indirectly affected by construction activities in the project area. The Wenatchee/Chiwawa Hatchery, which is owned and operated by WDFW, and the fish collection and fish handling facilities at Tumwater Canyon Dam, which are owned by Chelan County PUD and operated jointly with WDFW.

The Lake Wenatchee/Chiwawa River Hatchery is a part of the Rock Island Hatchery Complex, a group of five cooperating hatcheries that supplement salmon production in the Upper Columbia River watershed through captive breeding programs. Participating agencies include Chelan County CPUD, NMFS, WDFW, Yakama Nation and USFWS. The Lake Wenatchee/Chiwawa River hatchery is primarily focused on production of sockeye salmon, although the hatchery also produces coho salmon, spring Chinook and steelhead. Eggs are collected from fish moving upstream to spawn and hatched at the Chiwawa River facilities where they are raised to fingerling size. Some stocks are moved to net pens at the Lake Wenatchee facility and held until they reach the smolt stage, after which they are released to the wild (Northwest Power Planning Council, 2000).

The Tumwater Dam site is primarily used by the WDFW's Lake Wenatchee/Chiwawa River hatchery to count, sort and tag outmigrating smolts and to separate and collect spawning adults. The Yakama Tribe also uses the facility to collect adult coho that are transferred to the Entiat National Fish Hatchery and the Leavenworth National Fish Hatchery to supplement production in the Upper Columbia River Basin. The Chelan County PUD is a cooperating partner in the operation and maintenance of the fish ladder and the fish sorting, collection and tagging facilities as mitigation for operations at Rock Island Dam (NPCC, 2004).

6.6. Conclusions

The diversity and status of salmonids in the project area likely presents a need for careful consideration in the design of potential remedies and the permitting of construction activities. Reports of bull trout and unspecified salmon spawning in the project reach area suggests that the area and distribution of habitats with the project reach that may be affected will need to be quantified and better understood through project-specific biological surveys and/or analyses of past and on-going records of efforts by fish management agencies routinely conducting such work. Design considerations may need to be directed toward preservation of hydraulic conditions that allow for spawning and deposition of spawning substrates for salmonids. If such conditions cannot be maintained or are quantified and likely to be reduced, it may be necessary to expand the scope of future investigations to identify proximal areas where mitigating treatments of in-channel conditions can be applied. Of lesser consideration, from a design perspective, is maintaining upstream and downstream passage of juvenile and adult salmonids through the project reach. Reasonably foreseeable treatments of the road prism in the project are reach not expected to create vertical limitations or flow velocities exceeding salmonid swimming abilities.

Monitoring of salmonid utilization of the project reach area, including proximal mitigation areas, should be included in any project scope in order to document expected results from

design and mitigation elements and to provide assurances to permitting agencies and stakeholders about project effects. Ideally, the scope of monitoring should include pre-treatment (pre-construction) documentation of salmonid utilization by species and life-stage and the distribution of habitats, monitoring of construction activities at intervals or in response to unanticipated events, and replication of pre-treatment monitoring for at least one year following project completion to allow a basic comparison of effects. The scope of monitoring efforts should include development of partnerships and cost-sharing options with the many fisheries management entities operating in the project vicinity.

The focal species for permitting construction activities will be bull trout, Upper Columbia River Chinook and Upper Columbia River steelhead. Formal consultation under the Endangered Species Act with the USFWS (for bull trout) and NOAA Fisheries (salmon) can be expected and it is highly advisable for the scope of the conduct for these consultations to include a period of "pre-consultation" wherein the WSDOT and its contractors can identify key issues, mitigation needs and in-stream/near-stream work periods. The project area supports resources and fish management activities that are important to both public and agency stakeholders. Public awareness is high due to recreation activities, tourism, salmon recovery efforts and angling. Any construction activities proposed for the project area should be scoped to include a comprehensive decision analysis process, including a communications plan, to facilitate interactions with both public and private stakeholders that are not otherwise a part of formal permitting processes.

7. Cultural and Historical Assessment

7.1. Importance

This section addresses the prehistoric and historic context of Tumwater Canyon, specifically relating to the project reach, to identify historical known and unknown issues and important cultural resources that may be a consideration in project permitting so that informed decisions concerning project permitting and design alternatives to mitigate the chronic road failures of sections of US 2 in the project reach can be made.

7.2. Methodology

Both primary and secondary research sources were investigated to collect information relevant to the cultural and historical importance of the project reach. Information was summarized and the relevance of this information to designing alternatives to address the chronic road maintenance problems, and the subsequent permitting of the preferred alternative, is identified to ensure regulatory compliance.

7.2.1. Primary Research

A field survey of the Tumwater Canyon project area was conducted by an architectural historian on January 21, 2008. The project area was photographed, including US 2, Tumwater Dam, Penstock Bridge, the Wenatchee River, and other general canyon features. The Tumwater Dam and Penstock Bridge were specifically assessed for historic engineering significance and physical integrity.

7.2.2. Secondary Research

The following information was reviewed to assess the historical and archaeological resources:

- project area maps;
- historical data, photographs and maintenance records provided by WSDOT;
- archaeological site forms;
- historic property inventory forms, and previous cultural resources reports from within one-quarter mile of the project area at the Department of Archaeology and Historic Preservation in Olympia.

Additional historical records and photographs were reviewed at the Wenatchee-Okanogan National Forest Supervisor's Office and Wenatchee Valley Museum. Historical road failure research included a review of Wenatchee World/Wenatchee Daily World newspaper articles that were at the Wenatchee Public Library.

Figure 7-1. Penstock Bridge in the Project Reach

7.3. Prehistoric and Historic Context of the Tumwater Canyon Area

7.3.1. Prehistoric Setting

The Wenatchi and other regional tribes first settled the Leavenworth/Tumwater Canyon area, attracted by its plentiful deer and elk, as well as salmon in Icicle Creek and the Wenatchee River in Tumwater Canyon. Ethnographic sources indicate that Tumwater Canyon is within the traditional territory of the Interior Salish-speaking Wenatchi tribe (Ray, 1936). Tumwater is a Chinook jargon term for "rough water" (Majors, 1975).

Tumwater Canyon was undoubtedly the setting of considerable procurement of salmon by the Wenatchi during the summer and fall runs (Willis, 2006). However, the canyon's physical terrain, characterized by steep, V-shaped canyon walls, deterred the establishment of permanent settlements. Wenatchi villages were established below the mouth of Tumwater Canyon at Icicle Creek and upstream at the confluence of the Wenatchee and Chiawawa Rivers (Ray,1936). Smaller, seasonal encampments, including fish drying camps and

platforms, were scattered throughout the canyon in sheltered, easily accessible localities, such as rock shelters.

The mouth of Tumwater Canyon included two important fishing settlements at the confluence of the Wenatchee River and Icicle Creek. Reportedly 400-600 Wenatchi, Chinook and Yakama tribal members annually fished in this area (Hollenbeck and Carter, 1986), although upwards to 3,000 Indians sometimes populated the area at the height of salmon season (Majors, 1975). In 1870, railroad surveyor D.C. Lindsey (Northwest Press, 1981) noted 200-300 Indians camped at the mouth of Tumwater Canyon collecting salmon in great numbers.

7.3.2. Historic Setting

Early Exploration and Settlement

The earliest recorded Euro-American contact with the Wenatchi peoples in the Tumwater Canyon area was most likely associated with the fur trade (Willis, 2006). The first non-Native Americans trapped area streams for fur animals and farmed the fertile lands of the Icicle Creek valley. There was also a gold rush in nearby Peshastin Creek, attracting additional settlers to the region (Holstine ed., 1994).

The early history of the Tumwater Canyon area is centered on the railway and lumber industries. E. T. Cady and E. C. Ferguson were the first non-Native Americans to explore Tumwater Canyon in 1860 (Majors, 1975). A decade later, D. C. Lindsey of the Northern Pacific Railroad conducted a railroad survey across Stevens Pass. He noted that a "road can be constructed" through Tumwater Canyon (Northwest Press, 1981). In 1888, the Great Northern Railway engineer, John F. Stevens, surveyed a northern transcontinental rail line from St. Paul, Minnesota to Everett, Washington, crossing the 4,055 foot Cascade Mountain pass that currently bears his name (Stevens Pass Greenway, 1999). Under time constraints to compete with the recently-constructed Northern Pacific Railroad, Stevens developed a series of lengthy switchbacks over Stevens Pass as a temporary alternative to more costly and time-consuming tunnels. The Great Northern line was completed in 1893. By 1900, the railroad simplified travel over the Pass by replacing the switchbacks with the 2.6-mile Cascade Tunnel (Stevens Pass Greenway, 1999).

7.4. Construction of the Great Northern Railroad

The railroad was constructed through the Wenatchee River valley and up the deep Tumwater Canyon parallel to the Wenatchee River and north and west to Stevens Pass. A railroad stop was established at Drury Falls in Tumwater Canyon and at Chiwaukum at the head of the canyon. A series of five snow sheds was built in Tumwater Canyon over the tracks to protect the rail line from snow during the winter months and from rock slides in the spring and summer (Wood, no date). Landslides and falling boulders threatened work crews during their construction of the railroad grade through Tumwater Canyon. High water required riprapping the bank of the Wenatchee River to prevent the washing away of the railroad grade.

With the announcement in 1892 that the Great Northern Railroad would be constructed through the Wenatchee River valley, a group of local businessmen headed by Captain Charles F. Leavenworth of the Okanogan Investment Company, founded and platted the new town site of Leavenworth along the railroad's right-of-way in 1893. The region began to prosper when the Great Northern Railway located its divisional headquarters and roundhouse and switchyard in Leavenworth. The abundance of timber and access to a transcontinental railroad persuaded the Lamb-Davis Lumber Company to build a large saw mill in the new town. The lumber company established logging camps at Lake Wenatchee and drove logs downstream through Tumwater Canyon to their mill in Leavenworth (Kirk and Alexander, 1990). The town was incorporated in 1906, fruit trees were planted, and irrigation canals were constructed that developed Leavenworth's agricultural base.

7.5. Construction of Tumwater Canyon Dam

The Great Northern Railway constructed the Tumwater Canyon Diversion Dam and related hydroelectric facilities between 1907 and 1909 to power locomotives through the Cascade Tunnel. Electrification of the railroad through the 2.6-mile tunnel was urgently needed to eliminate the dangerous smoke and fumes in the tunnel caused by coal-burning locomotives. Electrical power was generated and delivered by transmission lines to four 100-ton electric locomotives to pull passenger and freight trains through the tunnel. Trolley wire was hung in the tunnel, on the approach tracks and in the yard at both ends, to give power to the locomotives (Peterka, 2008).

The Tumwater Canyon hydroelectric facility included the dam, a powerhouse, penstock, steel tower, steel bridge, and a residence. At the time of construction the hydroelectric project was the largest west of Niagara Falls.

Ground was broken for the dam when the Wenatchee River was at its lowest stage. To withstand the force of the river at flood stage, the dam was constructed at an angle, allowing the water to spill over a wide area and spend its force. Twenty railroad cars of sand a day were delivered to the dam site while it was constructed. Twelve thousand barrels of cement were employed in erecting the river barrier. To prevent possible leakage or destruction of the dam, the workman dug down to a depth of 38 feet below the dam (Morris, no date).

The dam, measuring 400 feet long by 23 feet high, delivered water through an 11,654-foot long wood stave and steel banded penstock to the power house. The power house was a 3 story, 76-foot by 117-foot, concrete and brick structure that housed three water wheels and three 2,000-kilowatt generators, used to provide power to the locomotives (Roe, 1995). A large diameter pipeline (penstock) carried the water from the dam to the power plant. The 8.5-foot diameter penstock was constructed of wood staves, which were wrapped with a continuous length of heavy steel wire to hold the staves in place and resist water pressure. The penstock ran along the west bank of the Wenatchee River, across the river from the railroad tracks due to lack of space trackside. The rail company constructed a bridge over the

Wenatchee River that carried the penstock from the opposite bank of the river to the power plant. This bridge is one of the early examples of a riveted steel Baltimore Petit truss within the state of Washington. A steel water tank on a 100-foot tower was constructed next to the power house to protect the pipeline and the generators from surges in the water pressure, and a house for plant operators was constructed near the power plant (Peterka, 2008).

7.6. Relocation of the Great Northern Railway

The railroad route through Tumwater Canyon was historically prone to snow and rock slides that frequently damaged track and interrupted service. While the steep-roofed, wooden snow sheds provided some protection, they proved to be expensive to maintain and subject to fires. As early as 1914 the Great Northern began surveys to relocate the route away from the canyon. The labor shortages and other demands caused by World War I temporarily delayed relocation efforts. The Great Northern was also seeking a safer and faster route through Stevens Pass due to numerous switchbacks and frequent avalanche-related accidents, highlighted by the catastrophic 1910 avalanche at Wellington that swept a passenger train off the tracks causing over 100 deaths.

The construction of a new Stevens Pass tunnel and the relocation of the rail line around Tumwater Canyon began in the mid-1920s and was completed in 1928-1929. The new 7.8-mile Cascade Tunnel, completed between the towns of Scenic and Berne, eliminated the need for numerous snow sheds and unnecessary curves through Stevens Pass. The new route bypassed slide-prone Tumwater Canyon through Chumstick Valley north of Leavenworth (Kirk and Alexander, 1990). The Chumstick Valley route was shorter, straighter, and had fewer grades for the trains to traverse than Tumwater Canyon.

The new route also bypassed Leavenworth. Anticipating the change, the Great Northern transferred its round house and divisional headquarters from Leavenworth to Wenatchee. With no easy access to the rail line, the Leavenworth saw mill closed and the lumber company moved.

7.7. Construction of the Tumwater Canyon Highway

After the abandonment of the Tumwater Canyon line in 1928, the grade reverted to government ownership. The State constructed a road along the former railway grade that was completed in 1929. The Tumwater Canyon highway provided a direct link between Leavenworth and Stevens Pass. While the first road over the Pass was completed several years earlier in 1925, the official dedication of the Stevens Pass Highway was in 1937-38 as part of State Highway 15. In 1948, the highway became a section of US 2.

7.8. Closure of the Tumwater Canyon Power Plant

After construction of the new Cascade Tunnel, the Great Northern electrified the line from Skykomish to Wenatchee to avoid multiple changes from steam to electricity and vice versa.

The Tumwater Canyon hydroelectric facility could not provide enough power to meet the Great Northern's electrification needs. The Great Northern sold the power plant to Puget Sound Power and Light in 1926. This allowed the railway access to the utility giant's large electrical power grid to power their expanded rail line electrification (Roe, 1995). The Tumwater Canyon Dam and hydroelectric facilities were closed in 1956, at the time the Great Northern replaced their electric locomotives with diesel engines and began operating their tunnel ventilation system in the second Cascade Tunnel. The Chelan County PUD purchased the Tumwater Canyon complex in 1957. The power plant and related generating facilities were subsequently removed.

Table 7-1. Timeline of Historic Events in the Project Area.

1860	Euro-American exploration of Tumwater Canyon
1870	Northern Pacific Railroad survey of Stevens Pass
1888	Great Northern Railway survey of Stevens Pass
1893	Great Northern Railway completed
1900	Construction of Great Northern Railway's 2.6-mile Cascade Tunnel
1907-09	Construction of Tumwater Canyon Dam, Penstock Bridge and power plant
1910	Avalanche at Wellington on Great Northern line
1928	Construction of Steven's Pass 7.8-mile tunnel and abandonment of Tumwater Canyon line
1929	Construction of Stevens Pass Highway (U. S. Highway 2) on Great Northern Railway grade
1956	Closure of Tumwater Canyon Dam facility
1957	Chelan County PUD purchased Tumwater Canyon Dam

7.9. Description of Cultural Resources in the Project Area

7.9.1. Prehistoric Resources

Prehistoric resources are located throughout the length of the canyon, mainly in areas above the Wenatchee River and canyon highway. The resources consist of rock shelters, petroglyphs and pictographs, and short-term habitation sites/camps and fishing stations. Identified artifacts consist mainly of flakes, bone fragments, projectile points and shell middens. The rock shelters consist of a number of large granite boulders clustered in shelters with several chambers.

7.10. Historical Resources

7.10.1. Great Northern Railroad Grade

The grade was the route of the Tumwater Canyon Railroad from its construction in 1893 until it was abandoned in 1928. The grade was converted to a section of the Stevens Pass Highway in 1929 that provided the first automobile link between Stevens Pass and

Leavenworth. The current highway consists of an asphalt road parallel to the Wenatchee River constructed on top of the former railroad grade through Tumwater Canyon.

7.10.2. US 2

The asphalt highway through the Tumwater Canyon, currently a section of US 2, was constructed in 1929 on top of the former Great Northern Railroad grade and provided automobile access to Stevens Pass. The project reach spans MP 94 and 98, which includes the location of the Tumwater Canyon Diversion Dam adjacent to the highway.

7.10.3. Tumwater Dam

Constructed between 1907 and 1909, the Tumwater Dam is near MP 95 on US 2 at a wide place in the river called Big Lake, or Jolanda Lake (Roe, 1995).

Figure 7-2. Tumwater Dam Pre-Highway or before 1929.

The dam, which is currently owned and operated by Chelan County PUD, no longer diverts water through a penstock to a downstream power plant for the purpose of generating electricity for locomotives on the former Great Northern rail line. While the low concrete dam remains, all related hydroelectric facilities have been removed.

Figure 7-3. Tumwater Dam 2008.

The Tumwater Dam is now equipped with modern fish passage facilities to provide upstream and downstream passage for resident and migratory fish species. The fish ladder and appurtenant structures also serve as a site for trapping and sorting anadromous fishes by agencies conducting management programs in the Wenatchee River basin (see section 7 for additional information).

7.10.4. Penstock Bridge

The riveted steel Baltimore petit truss bridge (shown in Figure 7-1) is still extant across the Wenatchee River near MP 97, two miles downstream from the diversion dam. The bridge was built during 1907-09 and carried the penstock across the river to the former power plant. The penstock has been cut in half to allow use of the bridge as a pedestrian walkway.

7.10.5. Power Plant Foundation and Penstock

The 11,654 foot wooden stave and steel banded penstock delivered water from the concrete dam downstream to the former power plant near the Penstock Bridge. The penstock is abandoned and most of it is no longer intact, (half of a section of the pipe is intact over the Penstock Bridge). The concrete and brick power plant, constructed during 1907-1909, has been removed as well. The only remains of the power plant are the foundations near the Penstock Bridge.

7.10.6. Railroad, Dam and Highway Construction Camps

The remains of these camps are located throughout the length of the canyon, in close vicinity to the former railroad grade, US 2, and the dam and former power plant site. Identified artifacts consist mainly of scattered domestic debris, cans, glass/bottles, coffee containers, engineering equipment, and miscellaneous metal, wood debris, and rock cooking ovens.

7.10.7. Mining Audits

These horizontal entrances to underground mines are located above the adjacent valley floor on both sides of the river.

The research that was undertaken regarding cultural resources revealed a depth of historical and archaeological content, indicating that further fieldwork and research would likely be required for any proposed changes to US 2 to mitigate the chronic maintenance problems. Therefore, useful information on regulations that must be considered when assessing the proposed alternatives to address the chronic road maintenance issues to ensure actions are in compliance with regulations is provided below.

7.11. Regulatory Compliance

The prehistoric and historic setting in this assessment provides the cultural context for future assessment investigations to comply with the National Environmental Policy Act (NEPA) and Section 106 of the National Historic Preservation Act (NHPA). Impacts to cultural resources must be evaluated under NEPA. The impacts on historic properties listed in or eligible for the National Register of Historic Places (NRHP) must be considered under section 106 of NHPA. Under 36 CFR Part 800, the NEPA and Section 106 studies may be combined.

Under the NEPA, federal agencies must evaluate impacts to all cultural resources and those prehistoric and historical resources that are eligible for or listed in the NRHP before a project is approved. The regulations that govern the implementation of the NHPA (36 CFR Part 800) allows for combining NEPA and Section 106 studies in an effort to streamline the environmental compliance process. The FHWA is the lead Federal Agency for the project under NEPA and NHPA.

Section 106 of the NHPA of 1966, as amended, requires that any federal or federally-assisted project or any project requiring federal licensing or permitting take into account the effect of the undertaking on historic properties listed in or eligible for the NRHP.

The NRHP, created under the NHPA, is the federal list of historical, archaeological, and cultural resources worthy of preservation. Resources listed in the NHRP include districts, sites, buildings, structures, and objects that are significant in American history, prehistory, architecture, archaeology, engineering, and culture. The NRHP is maintained by the National Park Service on behalf of the Secretary of the Interior. The Department of Archaeology and Historic Preservation in Olympia, Washington administers the statewide NRHP program under the direction of the State Historic Preservation Officer (SHPO). The National Park Service has developed the NRHP Criteria for Evaluation to guide the selection of properties for listing in or a determination of eligibility for the NRHP. The following criteria are standards by which every property that is considered for listing in the NRHP is evaluated:

- The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, material, workmanship, feeling, and association, and:

- Criterion A: Associated with events that have made a significant contribution to the broad patterns of our history; or

- Criterion B: Are associated with the lives of persons significant in our past; or

- Criterion C: Embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

- Criterion D: Has yielded, or may be likely to yield, information important in prehistory or history (36 CFR Part 60).

Archaeological sites are primarily assessed under Criterion D. Buildings less than 50 years old do not meet the NRHP criteria unless they are of exceptional importance, as described in Criteria Consideration G (36 CFR Part 60) and the National Park Service Bulletin No. 22, "How to Evaluate and Nominate Potential National Register Properties That Have Achieved Significance Within the Last 50 Years."

Section 4(f) of the Department of Transportation Act of 1966 requires that federally-funded transportation projects must avoid historic properties unless there is "no feasible and prudent alternatives" and requires all federal agencies to consider "all possible planning to minimize harm" to historic places (49 U.S.C. §303).

7.12. Summary of Historical and Archaeological Resources

This reconnaissance level investigation provides background information on known cultural resources within the project reach. Prehistoric resources (rock shelters, petroglyphs/pictographs, and short-term habitation sites/camps and fishing stations) are present throughout the length of the canyon, mainly in areas above the Wenatchee River and canyon highway. Historical resources in the project reach consist of the Great Northern railroad grade; Tumwater Dam, Penstock Bridge, and foundation remains of the power house; and historical artifacts scattered throughout the canyon associated with the railroad, dam and highway construction camps. The depth of historical and archaeological content in the project reach indicate that a number of regulations discussed above will likely need to be considered before implementing any proposed changes to US 2 to mitigate the chronic maintenance problems.

7.13. Additional Assessment Needs

If major alterations to the road embankment, dam, Penstock Bridge or Wenatchee River are proposed, an in-depth archaeological and historical resources investigation and a Cultural Resources Section 106 Technical Report will be required by both federal and state laws and regulations.

Additional survey and inventory fieldwork and archival and records research would likely be required to evaluate the cultural resources described in this report for NRHP eligibility. Once recommended determinations of eligibility of identified cultural resources are completed, impacts related to proposed changes to US 2 can be evaluated.

Along with the NEPA and Section 106 of the NHPA of 1966, the Washington State Environmental Policy Act (SEPA, RCW 43.21C), and implementing rules contained in the Washington Administrative Code (WAC 197-11), also apply. These rules require the identification of historic, archaeological, and cultural resources listed on or eligible for the national, state, or local registers. Measures must be considered to reduce or control impacts to identified historic properties affected by a proposed project. To ensure compliance with applicable regulations, the following bulleted list identifies actions WSDOT will likely need to complete in the permitting of any alternatives within the project reach. These items represent specific elements of supplemental work WSDOT should consider to support permitting, design and implementation of alternatives to address the chronic road maintenance issues on US 2 in the project reach.

- Consultation with agencies and tribes
- Background historic research
- Survey and inventory of archaeological and historical resources

- Evaluation of project area cultural resources for eligibility for listing in the National Register of Historic Places
- Evaluation of project effects
- Development of mitigation measures for historic properties
- Development of agreements such as a Programmatic Agreement or Memorandum of Agreement
- Development of a Cultural Resources Section 106 Technical Report.

8. Recommended Alternatives and Cost Estimates

8.1. Importance

The purpose of this section is to present the two recommended alternatives that were arrived at by ENTRIX to address the chronic road maintenance issues on US 2 in the project reach. It also identifies the process for arriving at the recommended alternatives, describes the prior alternatives considered, and provides a preliminary planning level estimate of construction costs.

8.2. Methodology

ENTRIX arrived at the two recommended alternatives through consideration of the following:

(1) The reconnaissance level assessment of road repair history, geology, geomorphology, hydrology, hydraulics, fisheries, and cultural resources all detailed in previous sections of this reach analysis

(2) An examination of alternatives provided by WSDOT CED as well as combinations of the alternatives

(3) A statistical analysis with probabilistic modeling based on assumptions of stakeholder criteria (i.e. goals) and inputs measuring impacts of those criteria (the Multi-Criteria Decision Analysis or MCDA). Planning level cost estimates are based on engineering analysis and estimates

8.3. Analysis of Two Recommended Alternatives

Based on the prevailing geomorphic and geologic conditions along US 2 in the project reach, and with the help of ENTRIX's MCDA (details provided in Appendix C), ENTRIX believes that the two recommended solutions, one long term and the other interim, to prevent chronic road failure of US 2 are as follows:

1) Long Term Solution -Concrete Wall with Reinforced Toe
2) Interim Solution - Reinforced Toe with Rock Upslope

Table 8-1. Planning Level Cost Estimate for Two Recommended Alternatives.

Alternative	Construction Costs
Alternative One: Long Term Solution – Concrete Wall with Reinforced Toe	$ 70,044,000
Alternative Two: Interim Solution - Reinforced Toe with Rock Upslope	$ 15,474,000

A summary of the components of the two recommended alternatives is provided in Appendix D. Detailed construction cost estimates are provided in Appendix E.

8.4. Synopsis of Alternative One: Long Term Solution

Concrete Wall with Reinforced Toe (Alternative One) represents a long term solution. This alternative consists of the construction of a rock toe protection to the existing retaining wall. This alternative involves installing boulders from 8 feet to 10 feet in diameter down to 2 feet in diameter, raising the roadway in specific areas, and installing a retaining wall system on the creek side of US 2 in areas along the project reach.

Projected Lifetime for Alternative One: One hundred plus years
Alternative One Issues:

- Hazards:
  - Land slide: Does not address
  - Debris Flow: Does not address
  - River Scour: addresses
  - Avalanche: Does not address
- Smaller foot print: less constriction.
- More stable embankment
- Less risk of undercutting
- Potentially more aesthetically pleasing
- Less environmental impact

8.5. Synopsis of Alternative Two: Interim Solution - Reinforced Toe with Rock Upslope

Alternative two represents a shorter term solution. This alternative consists of constructing rock toe protection to the existing retaining wall with riprap/grouting extending half of the wall height. Boulders will be installed and riprap/grouting will be grouted together, extending up the wall height. The roadway would be raised four feet in areas along the project reach, with ramps on either side of US 2.

Projected Lifetime for Alternative Two: Twenty to thirty years, expected to eventually wash out.
Alternative Two Issues:

- Hazards
  - Land slide: Does not address
  - Debris Flow: Does not address
  - River Scour: Addresses
  - Avalanche: Does not address
- Larger foot print, thus more environmental impacts
- Further constriction on the river

- Provides improved stability over existing conditions by providing cohesion to rock embankment and larger rock will also provide more hydraulic roughness thereby reducing risk of scouring

8.6. Description of the Two Recommended Alternatives

Given the hydraulic conditions within Wenatchee River flowing through Tumwater Canyon, it is not surprising that the existing embankment of US 2 is undermined. During peak flows with a five-year recurrence or greater, the river is potentially capable of dislodging riprap protecting the highway at four sites within the project reach. Each of the four sites is characterized by significant channel confinement imposed by debris fans originating on the west side of the valley (right bank of river) opposite the highway. Highway protection is complicated by localized flooding of the highway associated with river flows and upland drainage. Preventing flood inundation will necessitate raising the road. The most important action to preserve US 2 will be to prevent future undermining of its embankment by the river. Any alternatives to meet these goals that include encroachment on the existing river channel will further compound hydraulic conditions resulting from channel confinement. Therefore, the optimal alternative will minimize the highway footprint.

The most cost-effective means of minimizing encroachment into the river would be a reinforced concrete wall protected along its toe by placement of clasts large enough to form stable roughness elements. Based on the preliminary reach analysis these “mega-clasts” would have a median diameter of 10 feet or greater. The mega-clasts would reduce effective shear stresses along the embankment, stabilizing smaller grouted rock (four to six feet) that would prevent scour and damage induced by mobile clasts. If mega-clasts are not available or if transportation and placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel.

Potential impacts requiring mitigation could include:

- Chronic failures of highway embankment into Wenatchee River
- Reconstruction of US 2 after failure
- Fill encroachment into Wenatchee River floodway
- Reduction in quality of fish habitat
- Adverse impacts to recreational boating
- Aesthetic and cultural resource impacts

The preferred alternative provides the most cost-effective approach with the least potential for significant adverse impacts. A short-term or interim alternative (Figure 8-1) was also considered if funding for the preferred alternative can not be secured. The short-term alternative (Figure 8-2) involves reinforcing the existing rock embankment with additional large grouted rock, therefore preventing considerable encroachment into the river and the associated impacts. However, this alternative will also be more susceptible to periodic

damages. The interim alternative of a reinforced rock revetment using more and larger grouted rock may be expected to last 10-20 years and potentially incur more environmental impacts than the preferred alternative. Thus, the lower cost of the interim solution may not be the most economical solution for the long-term.

Placement of large "mega-clasts" and backfill of large riprap at toe of embankment is critical to design. Mega-clasts (median diameter of 10 feet or larger) provide stable roughness elements that lower effective shear stresses to hold large riprap (3 to 6 feet median diameter) and protect toe of concrete wall. If mega-clasts are not available or if transportation and placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel. Rock riprap would be grouted to provide cohesion and additional resistance. Given the high aesthetic value of US 2 through Tumwater Canyon, ENTRIX recommends creating a textured inclined concrete facing to primary wall that would simulate dip-slope of adjacent bedrock (not shown in figure).

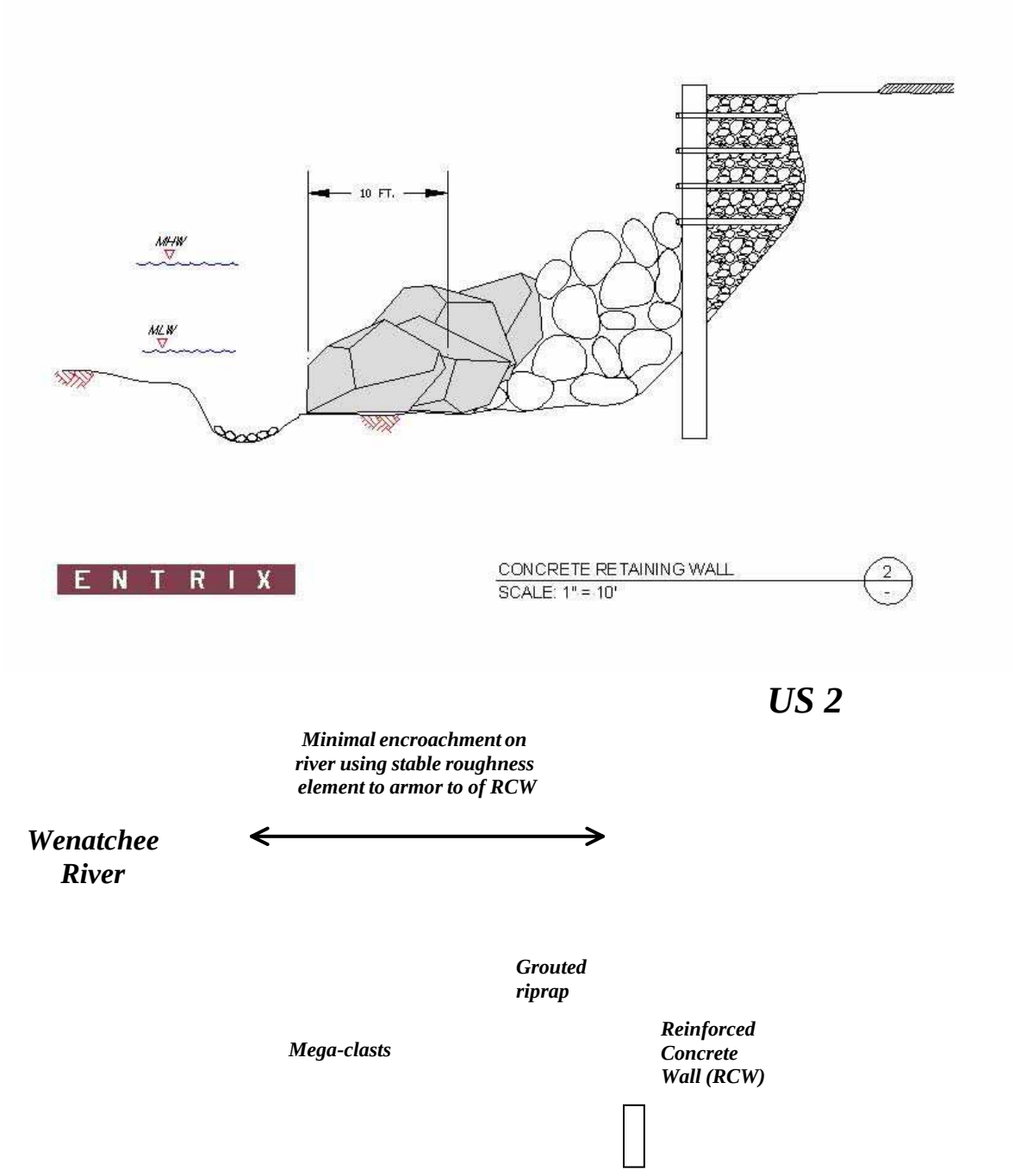


Figure 8-1. Basic elements of preferred concept alternative for long-term erosion protection that minimizes encroachment of road prism into Wenatchee River.

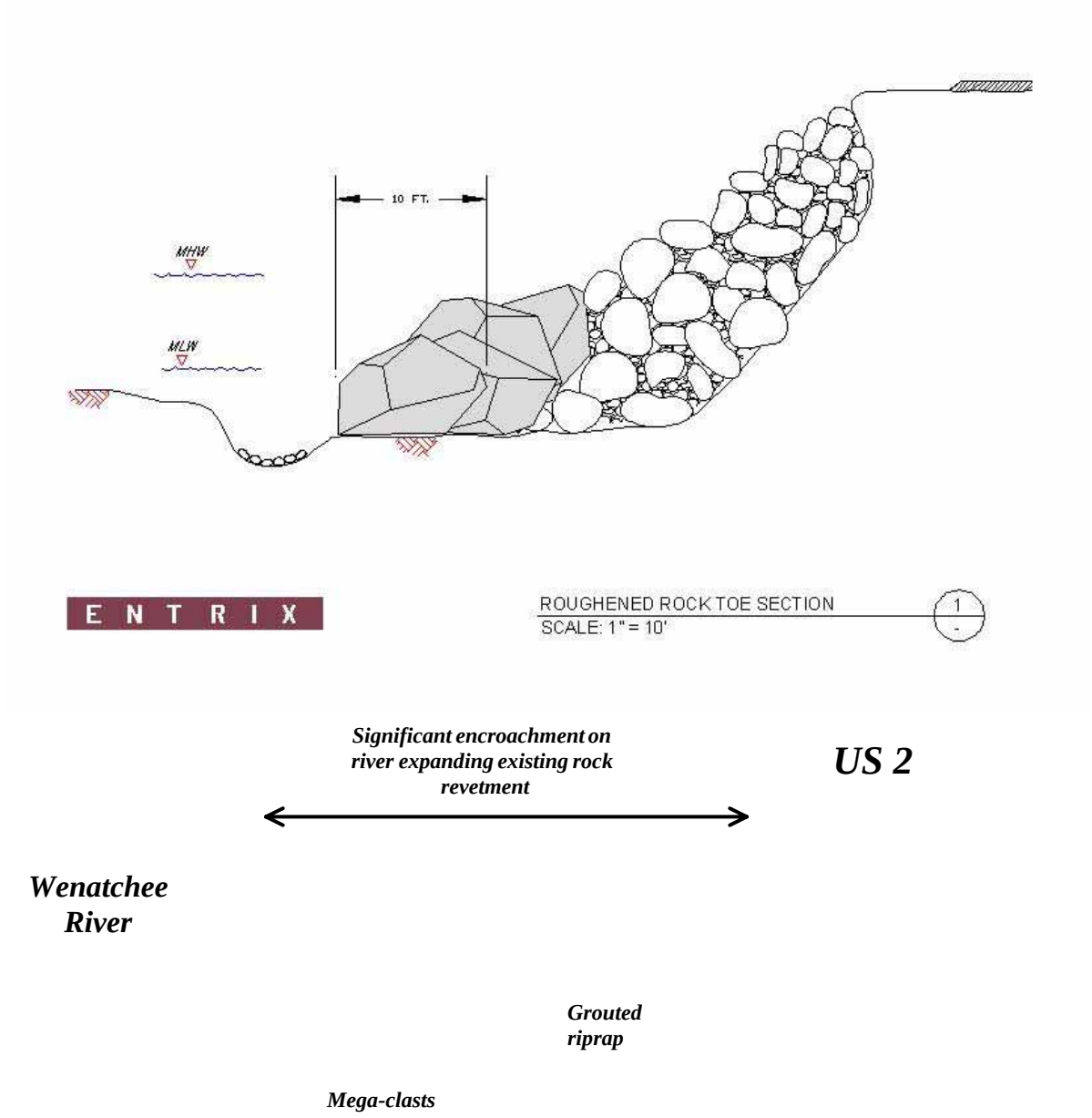


Figure 8-2. Interim (short-term) alternative of reinforced rock revetment. Build out existing rock revetment by constructing a "mega-clast" toe backfilled with grouted riprap.

8.7. Preliminary Alternatives Considered

The recommended alternatives were selected after consideration of the 14 alternatives under consideration by WSDOT CED prior to ENTRIX involvement. A third potential recommended option considered between analyzing the 24 total possible alternatives and arriving at the two recommended alternatives is to construct a viaduct. Appendix F provides a description and cost estimates of this alternative. The cost of this option is higher than the long term recommended solution ($139,000,000 for 500 feet of viaduct). Moreover, because the viaduct would likely need to extend further than 500 feet to provide a long term solution, the cost of $139,000,000 significantly underestimates the total cost. Due to cost implications, ENTRIX does not recommend constructing a viaduct at this point.

In addition to the assessment completed in Sections One through Eight of this reach analysis, the following additional information was considered: (1) construction costs, (2) project start date, (3) maintenance costs, (4) permitting costs, (5) mitigation costs, (6) recreational impacts, (7) traffic convenience and potential safety impacts, and (8) tourism impacts. The MCDA tool was used as a mechanism to include the criteria listed within the decision. An explanation of the MCDA is provided in Appendix C.

These criteria were derived from assumptions about stakeholders and their interests. A refined approach to identifying stakeholders and their interests would be necessary to determine the final set of criteria for deciding upon an alternative. Thus, the list above is not conclusive. Cost estimates will vary depending on construction starting dates, length of construction period, miscellaneous costs (including permitting) and rising expenses associated with inflation. Appendix G presents photographs relevant to the reach analysis. Stakeholder concerns need to be included in the selection of a final best preferred alternative for US 2. A preliminary outline of potential stakeholders is provided in Appendix H.

8.8. Summary of Recommended Alternatives and Cost Estimates

Based on the current understanding of road repair history, geologic and geomorphologic factors, hydrologic assessment, hydraulic assessment, fisheries, cultural resources conditions, assumed stakeholder criteria (goals or interests) and inputs to measure the criteria, two recommended alternatives were presented. These are installing an angled concrete wall with reinforced toe (a permanent solution) or completing a temporary or short-term solution consisting of reinforced toe with rock upslope. Constructing a viaduct over the problem reach was not considered a viable alternative due to the very high costs associated with implementation of this alternative. Further analysis of the road geology and geomorphology, hydrology, hydraulics, fisheries, cultural resources, as well as refinement of stakeholder engagement, is necessary before determining a solution. The planning level cost estimates are based on engineering analysis and estimates, and would require refinement as more information is known.

9. Diagnosis and Planning Level Cost Estimates

9.1. Importance

This section provides a summary of all the assessments completed as part of the reach analysis and presents the planning level cost estimates for the two viable alternatives for addressing the chronic road maintenance issues on US 2 in the project reach.

9.2. Summary

Problem Description: ENRIX was contracted by WSDOT to prepare a reach analysis for the four-mile stretch from of US 2 from MP 94 to 98 (Wenatchee River RM 32 to 28) to determine the causal mechanisms underlying the chronic road failures. Specifically, this reach analysis:

- Identifies those specific areas of US 2 where chronic maintenance issues have been reported and are likely to occur in the future
- Assesses the geomorphic and hydraulic conditions in the project reach to understand how these conditions may be contributing to the chronic road maintenance problems on US 2
- Based on the pertinent information analyzed and presented, develops alternatives for stabilizing the bank of the Wenatchee River along the US2 road prism in the project reach in order to prevent or reduce the future need for road maintenance associated with impacts resulting from the Wenatchee River
- Provides planning level cost estimates for the identified preferred alternatives

Chronic Road Maintenance Issues: US 2 in the project reach is subject to chronic damage, primarily associated with flood events, as evidenced by the record of minor and major damage and washouts during high flow events in the Wenatchee River. Review of historical records indicates that not all sections of US 2 are likely to be damaged but specific sections are likely to be adversely affected during high flow events. Recurring road washouts have been focused in the following two distinct locations on US 2: MP 95.2 directly below the Tumwater Dam and MP 97.0. The washout damage in these two areas has ranged from minor bank undercutting to complete washouts of the road prism and has been proportional to the magnitude of the flood event.

G**eologic and Geomorphic Assessment**: Bedrock is generally strong throughout the project reach; however, at all but the most upstream of the chronic maintenance locations, the slopes adjacent to US2 are characterized by soil-filled fractures and raveling slopes. Bedrock foliation dips sub-parallel to east canyon wall slopes, except at severe hazard road sections where slopes are roughly parallel to foliation dip, indicating that slope stability may be a

contributing factor in road failures. Canyon walls are steep (≈ 35° slopes), except where the west wall is broken by tributary drainages that form debris-flow fed alluvial fans, constricting the river and delivering large sediment across from the severe hazard road sections. River gradient varies from < 1% to >8%, with the steepest gradients located at the west bank alluvial fans and severe hazard road sections. Channel width varies between 50 and 400 feet, with the most confined sections located at the west bank alluvial fans and severe hazard road sections. Tumwater Dam is at the upstream end of the largest, most constricting alluvial fan with the steepest river gradient. The dam exacerbates the constriction and steepness, but without the dam, the site would still be at least as steep and constricted as the other severe hazard road sections. The size of clasts that are apparently stable within the channel varies through the project reach, and the largest clasts are found at the severe hazard road sections. All of the available data indicate that conditions contributing to road failure and road washouts are acting in concert at several areas of US 2 where road failure has occurred.

Hydrologic Assessment: The reconstruction of the hydrologic regime in the project reach (using the two existing USGS gages, upstream at Plain [Gage number 12457000] and downstream at Peshastin [Gage number 12459000]), indicates it is reasonable to assume that flows within the project reach - which is between the two USGS gages - would fall between the flow rates recorded at the two gaged sites. Therefore, a reasonable estimate of the resulting estimated peak flows could be developed for the project reach and these data used to support the hydraulic modeling.

Hydraulic Assessment: The results from the one-dimensional HEC-RAS model indicate that the problem areas of US 2 where chronic road maintenance issues have occurred are the areas where the highest flow velocity, shear stress, and stream power occur. The two-dimensional River 2D model results indicate that the removal of Tumwater Dam would have only a local influence (approximately half mile upstream from the dam) on the hydraulic characteristics within the study reach.

Fisheries: The diversity and status of salmonids in the project area likely presents a need for careful consideration in the design of potential remedies and the permitting of construction activities. Reports of bull trout and unspecified salmon spawning in the project reach indicate that further study is required. The area and distribution of habitat that may be affected will need to be quantified and better understood through project-specific biological surveys and/or analyses of past and on-going records of efforts by fish management agencies routinely conducting such work. Design considerations may need to be directed toward preservation of hydraulic conditions that allow for spawning and deposition of spawning substrates for salmonids. If such conditions cannot be maintained or are quantified and likely to be reduced, it may be necessary to expand the scope of future investigations to identify proximal areas where mitigating treatments of in-channel conditions can be applied. Of lesser consideration from a design perspective is maintaining upstream and downstream passage of juvenile and adult salmonids through the project reach. Reasonably foreseeable treatments of the road prism in the project reach not expected to create vertical limitations or flow velocities exceeding salmonid swimming abilities.

Cultural and Historic Assessment: Prehistoric resources (rock shelters, petroglyphs/pictographs, and short-term habitation sites/camps and fishing stations) are present throughout the length of the canyon, mainly in areas above the Wenatchee River and canyon highway. Historical resources in the project reach consist of the Great Northern railroad grade; Tumwater Canyon Diversion Dam, Penstock, and foundation remains of the power house; and historical artifacts scattered throughout the canyon associated with the railroad, dam and highway construction camps. The depth of historical and archaeological content in the project reach indicate that a number of regulations will likely need to be considered before implementing any proposed changes to US 2 to mitigate the chronic maintenance problems.

Preliminary Alternatives: Based on the current understanding of road repair history, geologic and geomorphologic factors, hydrologic assessment, hydraulic assessment, fisheries, and cultural resources conditions, assumed stakeholder criteria (goals, or interests) and inputs to measure the criteria, the two recommended alternatives are:

- Installing an angled concrete wall with reinforced toe (a permanent solution)
- Completing a reinforced toe with rock upslope (an interim or short-term solution)

Constructing a viaduct over the problem reach was not considered a viable alternative due to the very high costs associated with implementation of this alternative. Further analysis of the road repair history, geology and geomorphology, hydrology, hydraulics, fisheries, cultural resources, as well as refinement of stakeholder engagement, is necessary before determining a solution.

Cost Estimates: Cost estimates are based on planning-level engineering analysis and estimates, and would require refinement as more information is known. The following costs were developed:

- **Alternative One**: construction of an addition of a rock toe protection to an existing retaining wall. This alternative involves installing boulders from 8 feet to 10 feet in diameter down to 2 feet in diameter, raising the roadway in specific areas, and installing a retaining wall system on the creek side of US 2 in areas along the project reach. Cost is approximately $70 million.

- **Alternative Two**: This alternative consists of constructing rock toe protection to the existing retaining wall with riprap/grouting extending half of the wall height. Boulders will be installed and riprap/grouting will be grouted together, extending up the wall height. The roadway would be raised four feet in areas along the project reach, with ramps on either side of US 2. Cost is approximately $16 million.

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APPENDICES

APPENDIX A: Computed Hydraulic Data

Table A-1. Computed Water Surface Elevation

RIVER STATION	RIVER INVERT EL. (FT)						FLOOD EVENT						
		28-May-48 26,464 cfs	25-Nov-90 38,705 cfs	30-Nov-95 42,086 cfs	19-May-06 18,420 cfs	7-Nov-06 23,783 cfs	20-Mar-07 5,643 cfs	25-Mar-07 9,501 cfs	05-Jun-07 13,873 cfs	Low Flow 350 cfs	Snowmelt 8,161 cfs	100-yr 29,422 cfs	500-yr 37,096 cfs
24725.76	1580.97	1588.76	1590.99	1591.56	1587.11	1588.23	1583.80	1584.91	1586.02	1581.51	1584.55	1589.32	1590.71
23910.23	1566.97	1579.34	1581.95	1582.59	1577.26	1578.70	1572.48	1574.28	1575.88	1568.20	1573.71	1580.03	1581.64
22538.06	1548.93	1559.20	1561.52	1562.10	1557.28	1558.58	1553.32	1554.69	1556.04	1549.82	1554.24	1559.81	1561.23
22035.23	1532.97	1546.47	1549.41	1550.12	1544.15	1545.73	1539.10	1541.01	1542.70	1534.58	1540.40	1547.24	1549.06
21425.26	1511.04	1519.47	1521.03	1521.43	1518.35	1519.11	1515.89	1516.73	1517.56	1512.79	1516.45	1519.86	1520.83
20628.42	1496.53	1508.64	1511.59	1512.29	1506.20	1507.88	1500.65	1502.69	1504.55	1495.37	1502.03	1509.42	1511.24
19213.08	1484.11	1503.77	1506.20	1506.80	1501.86	1503.16	1497.45	1499.13	1500.59	1493.29	1498.60	1504.40	1505.90
18026.45	1475.79	1500.54	1502.75	1503.31	1498.86	1500.00	1495.50	1496.66	1497.79	1493.20	1496.27	1501.10	1502.48
16857.77	1456.47	1500.16	1502.18	1502.69	1498.62	1499.67	1495.48	1496.58	1497.64	1493.20	1496.22	1500.68	1501.94
16085.77	1463.87	1499.91	1501.77	1502.23	1498.47	1499.46	1495.45	1496.52	1497.55	1493.20	1496.17	1500.39	1501.54
15990	**Tumwater Dam**												
15988.42	1461.54	1477.59	1480.72	1481.57	1474.99	1476.78	1469.09	1471.25	1473.24	1463.91	1470.58	1478.42	1480.32
15537.85	1449.88	1453.30	1455.34	1455.92	1451.62	1452.78	1448.13	1449.38	1450.53	1445.25	1448.96	1453.83	1455.10
14599.46	1423.69	1439.57	1441.99	1442.58	1437.73	1439.02	1432.11	1434.56	1436.54	1426.62	1433.62	1440.23	1441.70
14046.43	1419.84	1430.62	1432.57	1433.03	1429.09	1430.16	1425.49	1426.78	1428.02	1421.93	1426.37	1431.11	1432.35
13419.7	1412.56	1424.31	1426.56	1427.13	1422.48	1423.77	1417.77	1419.43	1421.19	1414.11	1418.90	1424.89	1426.29
12829.16	1403.28	1415.31	1417.18	1417.62	1413.71	1414.82	1410.16	1411.47	1412.61	1405.25	1411.08	1415.80	1416.95
12135.39	1395.06	1403.53	1405.59	1406.11	1401.96	1403.02	1398.34	1399.66	1400.94	1395.86	1399.21	1404.07	1405.34
11339.14	1385.04	1398.44	1400.69	1401.24	1396.60	1397.87	1391.96	1393.75	1395.33	1386.82	1393.18	1399.04	1400.43
11043.98	1382.28	1393.61	1395.43	1395.91	1392.33	1393.20	1389.82	1390.70	1391.53	1384.63	1390.42	1394.05	1395.19
9946.918	1366.15	1378.29	1381.31	1382.06	1375.91	1377.55	1370.36	1372.46	1374.30	1367.27	1371.80	1379.08	1380.94
8558.12	1358.25	1372.58	1375.53	1376.27	1370.39	1371.88	1365.68	1367.42	1368.98	1360.63	1366.88	1373.32	1375.16
7577.187	1356.90	1367.63	1370.86	1371.67	1365.25	1366.88	1360.75	1362.26	1363.79	1358.27	1361.77	1368.43	1370.44
7205.184	1335.30	1358.55	1361.85	1362.64	1355.19	1357.69	1348.26	1350.75	1352.95	1340.34	1349.99	1359.49	1361.54
6583.357	1322.58	1338.40	1341.64	1342.50	1335.90	1337.65	1330.63	1332.81	1334.56	1325.23	1332.17	1339.20	1341.23
6033.149	1311.74	1322.85	1324.90	1325.32	1322.42	1322.97	1317.91	1319.62	1321.19	1313.59	1319.07	1323.43	1324.68
5111.223	1293.7	1305.77	1309.11	1309.87	1302.70	1304.89	1298.33	1299.90	1301.30	1294.65	1299.40	1306.67	1308.73
3499.427	1281.65	1300.01	1302.97	1303.70	1297.68	1299.28	1291.95	1294.40	1296.14	1286.13	1293.76	1300.78	1302.62
3107.834	1284.5	1297.75	1300.34	1301.00	1295.74	1297.11	1290.68	1293.02	1294.45	1285.91	1292.47	1298.42	1300.03
2522.208	1276.25	1289.40	1291.73	1292.32	1287.61	1288.83	1283.08	1285.19	1286.43	1278.48	1284.36	1290.00	1291.44
2011.259	1256.24	1266.25	1268.28	1268.81	1264.67	1265.75	1261.16	1262.51	1263.64	1257.81	1261.93	1266.77	1268.06
1521.443	1241.48	1249.21	1250.22	1250.54	1248.01	1248.83	1245.29	1246.28	1247.20	1242.66	1245.96	1249.59	1250.05
1164.436	1234.61	1240.69	1242.13	1242.48	1239.59	1240.34	1237.26	1238.09	1238.87	1235.28	1237.82	1241.07	1241.96
569.4475	1217.6	1224.41	1225.90	1226.27	1223.24	1224.04	1220.65	1221.64	1222.48	1218.42	1221.31	1224.79	1225.72

Table A-2. Computed Channel Mean Velocity

RIVER STATION	RIVER INVERT EL. (FT)	CHANNEL VELOCITY (FPS)											
		28-May-48 26,464 cfs	**25-Nov-90 38,705 cfs**	**30-Nov-95 42,086 cfs**	**19-May-06 18,420 cfs**	**7-Nov-06 23,783 cfs**	**20-Mar-07 5,643 cfs**	**25-Mar-07 9,501 cfs**	**05-Jun-07 13,873 cfs**	**Low Flow 350 cfs**	**Snowmelt 8,161 cfs**	**100-yr 29,422 cfs**	**500-yr 37,096 cfs**
24725.76	1580.97	12.84	13.82	14.05	11.96	12.58	9.07	10.50	11.41	3.74	10.07	13.12	13.71
23910.23	1566.97	11.31	12.95	13.35	9.93	10.87	6.57	7.83	8.95	2.34	7.44	11.74	12.76
22538.06	1548.93	15.67	17.37	17.76	14.35	15.33	10.01	11.98	13.33	4.11	11.40	16.11	17.17
22035.23	1532.97	18.42	20.01	20.36	16.85	17.98	12.15	13.91	15.48	5.07	13.36	18.84	19.82
21425.26	1511.04	22.82	26.22	26.99	19.71	21.88	11.86	15.16	17.75	5.36	14.15	23.76	25.84
20628.42	1496.53	5.92	7.05	7.34	5.05	5.65	3.07	3.81	4.48	1.02	3.58	6.21	6.91
19213.08	1484.11	9.99	11.18	11.43	8.72	9.63	5.27	6.56	7.74	1.84	6.15	10.33	11.06
18026.45	1475.79	6.10	7.22	7.49	5.17	5.82	2.73	3.69	4.50	0.32	3.40	6.40	7.09
16857.77	1456.47	3.27	4.29	4.55	2.48	3.02	0.93	1.45	1.98	0.07	1.28	3.53	4.17
16085.77	1463.87	3.66	4.90	5.21	2.75	3.37	0.99	1.57	2.17	0.07	1.38	3.98	4.75
15990	**Tumwater Dam**												
15988.42	1461.54	18.06	19.99	20.33	16.63	17.62	12.55	14.27	15.58	6.26	13.69	18.54	19.80
15537.85	1449.88	27.91	31.57	32.10	25.06	27.01	16.48	19.98	22.92	4.65	18.98	28.89	31.14
14599.46	1423.69	15.82	17.40	17.78	14.37	15.31	12.46	13.22	13.24	4.52	13.47	16.18	17.21
14046.43	1419.84	10.06	11.74	12.17	8.63	9.59	5.37	6.65	7.70	2.19	6.25	10.54	11.53
13419.7	1412.56	10.21	11.16	11.38	9.57	9.96	8.40	9.12	9.18	3.97	8.87	10.47	11.05
12829.16	1403.28	12.98	15.08	15.58	11.39	12.48	6.82	8.67	10.26	3.08	8.05	13.54	14.83
12135.39	1395.06	12.58	13.85	14.14	11.39	12.24	9.05	9.85	10.52	3.15	9.65	12.91	13.71
11339.14	1385.04	7.65	8.89	9.21	6.71	7.35	4.65	5.48	6.10	2.44	5.24	7.97	8.74
11043.98	1382.28	13.85	15.36	15.65	12.16	13.34	6.61	8.93	10.78	3.03	8.20	14.31	15.23
9946.918	1366.15	11.35	12.46	12.71	10.44	11.06	9.82	9.46	9.90	4.44	9.41	11.65	12.33
8558.12	1358.25	7.01	8.25	8.55	5.91	6.68	3.24	4.24	5.14	0.89	3.91	7.35	8.11
7577.187	1356.90	9.51	10.03	10.16	9.08	9.36	8.49	8.57	8.80	4.53	8.50	9.67	9.99
7205.184	1335.30	18.02	19.30	19.61	17.85	17.68	12.76	15.17	17.01	5.11	14.39	18.27	19.02
6583.357	1322.58	20.41	22.66	23.08	18.41	19.72	12.61	14.35	16.32	6.54	13.71	21.09	22.43
6033.149	1311.74	17.28	20.19	21.02	12.67	15.32	7.88	9.67	11.17	2.81	9.11	17.99	19.80
5111.223	1293.7	12.92	13.38	13.61	13.81	12.96	10.63	12.04	13.23	4.95	11.61	12.94	13.27
3499.427	1281.65	7.30	8.65	8.96	6.12	6.94	3.34	4.27	5.27	0.63	3.92	7.66	8.49
3107.834	1284.5	10.52	12.02	12.37	9.23	10.13	6.79	7.21	8.31	2.54	6.89	10.92	11.84
2522.208	1276.25	15.72	17.43	17.83	14.19	15.25	11.34	11.72	13.13	5.77	12.19	16.18	17.24
2011.259	1256.24	24.09	26.66	27.15	21.70	23.38	14.97	17.42	19.88	5.77	17.35	24.84	26.29
1521.443	1241.48	13.16	16.58	17.28	11.27	12.56	6.90	8.57	10.03	2.45	8.05	13.79	16.27
1164.436	1234.61	12.07	13.91	14.38	10.55	11.60	6.75	8.22	9.48	2.52	7.76	12.55	13.67
569.4475	1217.6	12.77	14.50	14.93	11.27	12.31	7.56	8.91	10.20	2.68	8.55	13.24	14.30

Table A-3: Computed Channel Shear Stress

RIVER STATION	RIVER INVERT EL. (FT)						CHANNEL SHEAR STRESS (LB/SQ FT)						
		28-May-48 26,464 cfs	**25-Nov-90 38,705 cfs**	**30-Nov-95 42,086 cfs**	**19-May-06 18,420 cfs**	**7-Nov-06 23,783 cfs**	**20-Mar-07 5,643 cfs**	**25-Mar-07 9,501 cfs**	**05-Jun-07 13,873 cfs**	**Low Flow 350 cfs**	**Snowmelt 8,161 cfs**	**100-yr 29,422 cfs**	**500-yr 37,096 cfs**
24725.76	1580.97	7.61	8.11	8.23	7.15	7.49	5.17	6.28	6.91	1.58	5.93	7.76	8.05
23910.23	1566.97	5.13	6.36	6.67	4.20	4.83	2.24	2.90	3.56	0.46	2.69	5.44	6.21
22538.06	1548.93	10.73	12.34	12.71	9.52	10.42	5.64	7.44	8.65	1.58	6.91	11.15	12.15
22035.23	1532.97	13.83	15.53	15.91	12.22	13.36	7.76	9.26	10.78	2.07	8.77	14.27	15.32
21425.26	1511.04	24.98	30.69	32.01	19.84	23.43	8.66	13.10	16.89	2.57	11.68	26.56	30.05
20628.42	1496.53	1.28	1.71	1.83	0.99	1.18	0.45	0.63	0.81	0.08	0.57	1.38	1.66
19213.08	1484.11	3.32	4.00	4.14	2.64	3.12	1.17	1.65	2.16	0.23	1.49	3.52	3.93
18026.45	1475.79	1.25	1.64	1.74	0.95	1.16	0.31	0.54	0.75	0.01	0.46	1.35	1.59
16857.77	1456.47	0.29	0.49	0.54	0.17	0.25	0.02	0.06	0.11	0.00	0.05	0.33	0.46
16085.77	1463.87	0.41	0.71	0.80	0.23	0.35	0.03	0.08	0.15	0.00	0.06	0.48	0.67
15990	**Tumwater Dam**												
15988.42	1461.54	13.02	14.67	14.87	11.68	12.63	8.03	9.54	10.69	3.18	8.99	13.42	14.55
15537.85	1449.88	34.69	41.91	43.66	29.70	33.05	15.60	21.04	26.05	1.92	19.51	36.58	41.01
14599.46	1423.69	10.93	12.37	12.74	9.61	10.42	7.92	8.58	8.60	1.43	8.80	11.21	12.18
14046.43	1419.84	4.34	5.60	5.93	3.38	4.01	1.60	2.25	2.81	0.41	2.03	4.68	5.44
13419.7	1412.56	4.71	5.20	5.31	4.40	4.58	4.07	4.33	4.22	1.46	4.23	4.84	5.14
12829.16	1403.28	7.41	9.50	10.04	5.98	6.95	2.46	3.73	5.03	0.74	3.28	7.95	9.24
12135.39	1395.06	7.25	8.20	8.42	6.33	6.99	5.16	5.41	5.68	0.95	5.38	7.49	8.10
11339.14	1385.04	2.44	3.07	3.25	2.00	2.29	1.12	1.46	1.74	0.50	1.36	2.59	2.99
11043.98	1382.28	9.07	10.47	10.73	7.36	8.57	2.41	4.25	5.98	0.69	3.62	9.52	10.37
9946.918	1366.15	5.81	6.53	6.70	5.29	5.64	6.38	5.07	5.05	2.23	5.24	6.00	6.45
8558.12	1358.25	2.04	2.66	2.81	1.53	1.88	0.55	0.87	1.21	0.06	0.76	2.20	2.58
7577.187	1356.90	4.21	4.32	4.36	4.22	4.19	5.11	4.54	4.29	2.30	4.68	4.25	4.33
7205.184	1335.30	15.91	17.50	17.87	15.56	15.48	9.21	12.27	14.74	2.01	11.23	16.16	17.07
6583.357	1322.58	19.66	22.76	23.29	17.02	18.67	9.60	11.47	13.92	3.99	10.78	20.66	22.47
6033.149	1311.74	14.94	19.66	21.17	8.13	11.71	3.78	5.23	6.57	0.75	4.76	15.98	18.97
5111.223	1293.7	8.39	8.19	8.33	10.57	8.71	7.61	8.95	10.19	2.74	8.52	8.19	8.14
3499.427	1281.65	1.60	2.16	2.30	1.17	1.46	0.40	0.60	0.89	0.02	0.52	1.75	2.09
3107.834	1284.5	3.72	4.55	4.75	3.06	3.51	1.89	2.10	2.60	0.44	1.98	3.94	4.44
2522.208	1276.25	8.92	10.24	10.56	7.78	8.56	5.78	6.04	7.04	2.25	6.31	9.27	10.10
2011.259	1256.24	31.59	36.58	37.43	27.10	30.26	15.51	19.26	23.73	3.37	19.79	33.08	35.77
1521.443	1241.48	9.54	14.45	15.48	7.46	8.86	3.43	4.83	6.19	0.69	4.37	10.28	14.02
1164.436	1234.61	8.47	10.47	11.02	6.93	7.98	3.59	4.80	5.92	0.83	4.40	8.97	10.19
569.4475	1217.6	9.49	11.48	11.96	7.87	8.98	4.32	5.53	6.78	0.91	5.20	10.01	11.25

APPENDIX B: Communications Log

COMMUNICATIONS LOG: TUMWATER CANYON

Date: 15 April 2008

Brian Adair

Contact: Cathy Lynn – Leavenworth Chamber of Commerce (509-548-5807)

RE: Recreational boating in Tumwater Canyon.

Notes:
I contacted Cathy to ask about recreational boating in Tumwater Canyon, specifically within the project area.

Cathy informed me that the reach from Tumwater Canyon Dam to a point about ½ a mile upstream of Leavenworth was not used by commercial rafting services or people in rented boats. She suggested I contact the Wenatchee River Ranger District at 509-548-6977 to ask about use of the area by experienced kayakers. She also recommended that I contact local river guide services and boat rental companies.

Date: 15 April 2008

Brian Adair

Contact: Receptionist – Wenatchee River Ranger District

RE: Recreational boating in Tumwater Canyon.

Notes:
At the Suggestion of Cathy Lynn, I called the office of the Wenatchee River Ranger District. The receptionist confirmed that Tumwater Canyon was not used by commercial rafting guides or boat rental services. I asked if she had any idea of how many kayakers floated this reach each season and she transferred me to the district recreation manager; however, he was out of the office. I left a message asking him to contact me.

COMMUNICATIONS LOG: TUMWATER CANYON

Date: 15 April 2008

Brian Adair

Contact: Don (No last name given) - River Recreation Raft Rental Service (1-800-464-5899)

RE: Recreational boating in Tumwater Canyon.

Notes:
I called River Recreation to inquire about use of Tumwater Canyon by kayakers and rafters. Don confirmed what both Cathy Lynn and the receptionist at the Wenatchee Ranger District office told me. Tumwater Canyon is used only by experienced Kayakers, and no commercial guide or rental services use the area. According to Don, the rapids in the canyon are to challenging for the casual recreational boater. However, Don also indicated that the rapids in the canyon are popular with experienced kayakers who are looking for a challenge and the area sees regular use during the months of May, June and July, when flows are high.

According to Don, the canyon sees the heaviest amount of boat traffic during the last half of May through June. Don estimated that heaviest boat traffic occurs on weekends beginning mid-afternoon on Friday and lasting through Sunday evening. I asked Don if he could estimate the average number of boaters that used the area each spring, but he said that he had no way to give an accurate estimate.

Don was very curious about what we planned to do along the banks. I was discrete about the project scope and stated that we were still in the planning phase; however, Don started asking about ELJs. According to him, other projects involving ELJs had been proposed for the area. Don stated that rafters and kayakers would not be in favor of such measures, because they considered ELJs to be safety hazards.

At the conclusion of the call, Don thanked me for the call and asked if we could e-mail more information to him. I indicated that any information about the project would be disseminated by WSDOT, whereupon he asked me to send his contact information to the appropriate person. He gave me the River Recreation e-mail address (office@riverrecreation.com).

COMMUNICATIONS LOG: TUMWATER CANYON

Date: 16 April 2008

Brian Adair

Contact: Char (no last name given) – Osprey Rafting Co. (509-548-6800)

RE: Recreational boating in Tumwater Canyon.

Notes:
Char confirmed that peak season for Kayakers was May through July, and that the canyon was not used commercially. I asked her about the number of users each season, but she could not give me a good estimate. However, she promised to confer with one of the guides who frequently kayaks the canyon (Jeff) and have him call me the following day. Char thought that Jeff might be able to give me a good estimate.

Appendix C: Multi-Criteria Decision Analysis

Appendix C: Multi Criteria Decision Analysis

This appendix is composed of the following two parts:

(1) a description of ENTRIX's Multi-Criteria Decision Analysis (MCDA) tool, and
(2) an explanation of the use of MCDA as a stakeholder engagement and management tools future use.

Importance

ENTRIX's MCDA tool was applied to the Tumwater preliminary alternatives set forth in Appendix D.

PART ONE: APPLICATION OF MULTI CRITERIA DECISION ANALYSIS

The MCDA is a transparent, objective, well established process for analyzing alternatives that is used for stakeholder engagement and management. MCDA is used for complex projects involving numerous potential alternatives; multiple stakeholders with competing objectives and holding different definitions of success; significant uncertainties; potential risks to human health and safety, the environment and reputation; and significant project costs. All of these factors exist on the Tumwater reach analysis project.

The following sections describe the:

- Methodology for the demonstration model;
- Construction of the demonstration model;
- Results obtained from the model; and
- Recommended next steps for refining the model.

The ensuing section describes the MCDA as a stakeholder engagement and management process.

METHODOLOGY

ENTRIX has developed a preliminary demonstration MCDA model for this project but used costing information that has since been revised following discussion with WSDOT. Therefore, the information used is outdated but the use of the MCDA is still considered advisable once more reliable information is obtained. The information on MCDA provided here is only an example of how this tool can be used. The demonstration model required making assumptions about potential criteria (desired objectives), input ranges for each criteria (measurements whether a criterion has been met), and weights for the criteria (measurement of how much importance is placed on a particular criterion). Criteria are defined based on stakeholder interests and, thus, requires identification of stakeholders and their interests. ENTRIX used its expertise to assume

criteria, input ranges, and weights for the criteria. Financial costs were based information provided by WSDOT, as described in Appendix D.

All of the assumptions used here will require reevaluation, and be revised and refined in order to develop an actual or finalized model for the Tumwater reach analysis project.

ANALYSIS

ENTRIX undertook the following steps to construct the preliminary demonstrative MCDA model, using the project alternatives designated in Appendix D.

1. Identify criteria
2. Develop input range for each criteria for each project alternative considered
3. Identify weights for criteria
4. Construct a probabilistic model for each of the identified alternatives
5. Structure and run the MCDA model and analyze the results.

ENTRIX utilized a technique called Monte Carlo simulation in order to develop input ranges that accounts for such uncertainties for input ranges that could be directly calculated. For the Monte Carlo simulation, ENTRIX developed a range of estimates (rather than single point estimates) for all uncertain input parameters (e.g., construction costs, operating & maintenance costs, activity dates, etc.). For input ranges that cannot be directly calculated such as aesthetics, ENTRIX developed a subjective scale using a range from 1 to 10, where 10 represents very good aesthetics and 1 represents poor aesthetics.

During a simulation run, values were sampled from each of the input parameter ranges and used to calculate the output ranges, or statistics, for each alternative. This process is repeated many times (often 1,000 times or more) which results in a range of output statistics for each alternative. Output statistics such as the mean cost, standard deviation and 90% confidence interval are then reported and compared for each alternative.

ENTRIX assumed weights for the criteria to evaluate the various project alternatives. The criteria weights are simply numerical representation of the degree of importance that project stakeholders place on each of the individual criterions when evaluating the characteristics of the various alternatives.

The criteria and weights used in the demonstration model are presented in Table C-1.

Table C-1: Assumed Criteria for MCDA.

Criterion Name	Weight
Aesthetics	5%
Habitat/Env Cost	7.5%
Habitat/Env Bene	7.5%
Inconvenience to public	15%
Longevity	20%
Public Safety	25%
Cost	20%
Sum	**100%**

Once the criteria, input ranges and weights were developed, ENTRIX estimated the values associated for each criterion within each alternative. Value associated with a criterion represents the magnitude of the criteria associated with a particular alternative. For example, the weight of the cost criterion as indicated in Table C-1 is 20%. The actual net present value (NPV) cost, i.e., the value associated with a criterion for an alternative such of the "Rock Toe and Concrete Retaining Wall" is $6.5 million dollars. As mentioned previously, ENTRIX developed a subjective scale for criterion values that cannot be directly calculated, such as aesthetics. ENTRIX assumed different stakeholders rate individual alternatives differently and assumed a range of values were used for a particular alternative.

The criterion score for any particular criterion is simply its weight multiplied by its value. ENTRIX normalized the criterion values so that they are on a similar scale, as criterion values were in different units (e.g., dollars for the cost criterion scale of 1 to 10 for aesthetics). For example, normalization results in the highest cost alternative have a normalized score of 0 and the lowest cost alternative has a normalized score of 10.

ENTRIX structured the MCDA model by programming a spreadsheet to complete the following:

- Carry out the criterion normalization calculations;
- Calculate the individual criterion scores by multiplying the criterion weights by their normalized values; and
- Determine the multi-criteria score for each alternative by summing the individual criteria.

Monte Carlo simulation was used to estimate the multi-criteria score for each alternative.

Demonstration Model Results

Output statistics and risk profiles are used to present financial modeling results. Figure C-1 provides a summary of MCDA profiles produced by the demonstration model. Figure C-2 provides a summary of financial profiles produced by the demonstration model.

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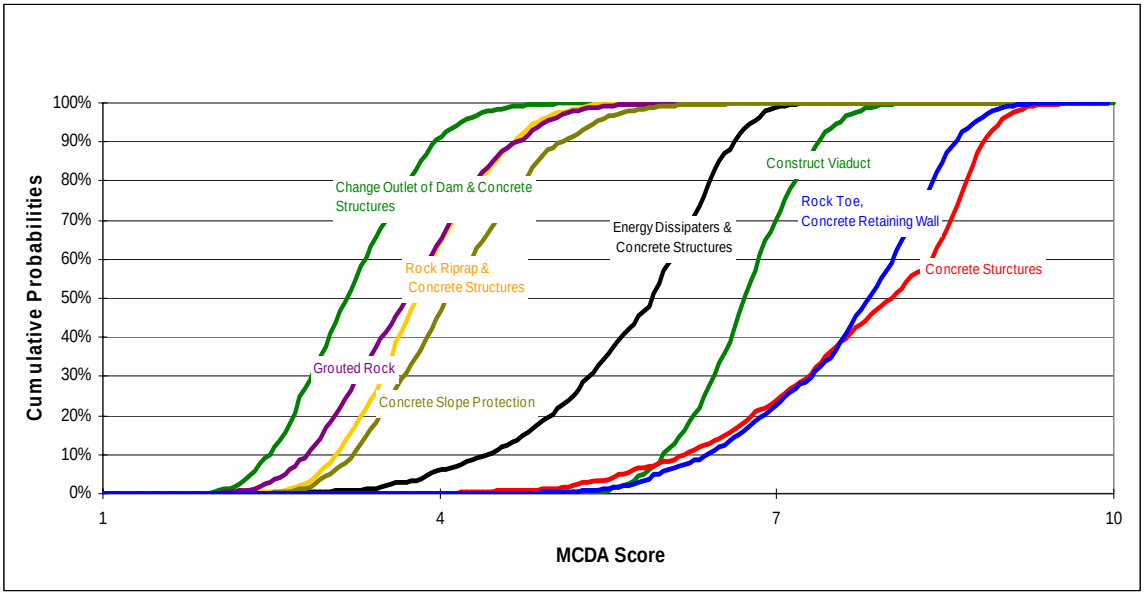

Figure C-1. MCDA Score for the Profiles.

To determine the best alternative based on multiple criteria, ENTRIX produced the MCDA score for each criteria, and produced a graph of the scores for the top ranking eight alternatives (Figure C-1). The alternative farthest to the right in Figure C-1 best meets the criteria based on the weights assigned. The alternative most vertical has the least variability. The ideal curve would be vertical (no risk) and furthest to the right (meets all the criteria).

Additional information, such as the probability that the alternative will meet the criteria, can be obtained from the model. The model indicates that the rock toe and concrete retaining wall alternative would be a better choice 40% of the time. This is determined by starting at the 40% probability value on the y-axis and moving vertically until it reaches where the rock toe and concrete structures alternative curve (in blue) intercepts with the concrete structures alternative curve (in red), then moving vertically downward to the x-axis to read approximately 7.6 as the MCDA score. The multi-criteria score for any alternative is simply the sum of its criteria scores.

Under the model, concrete structures is the preferred alternative from a perspective of cost and risk.

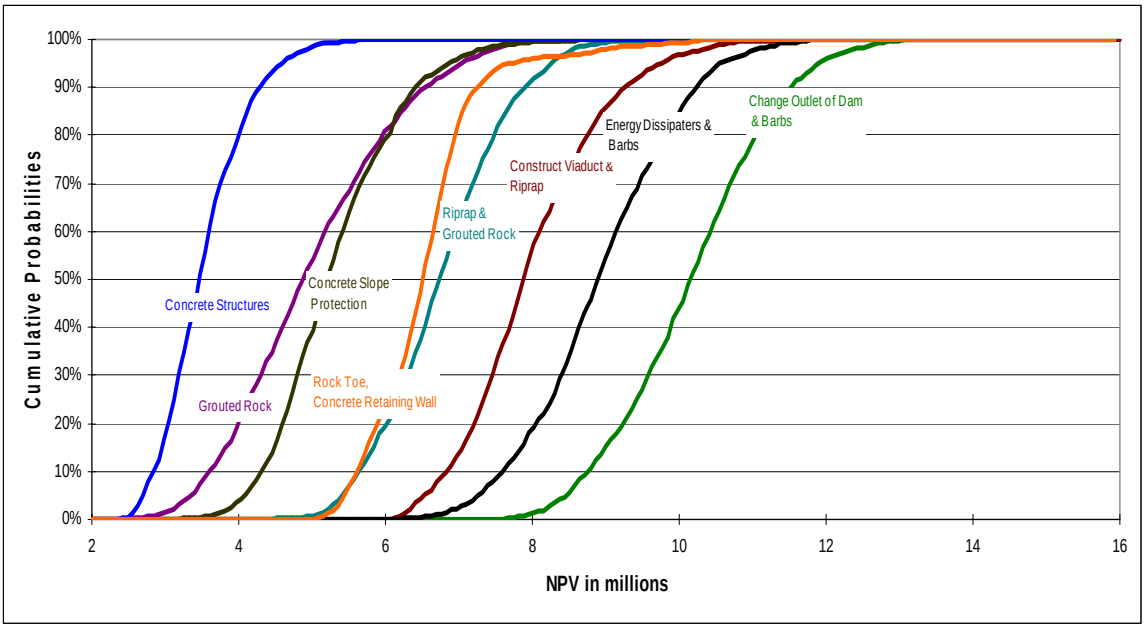

Figure C-2. Summary of Financial Profiles.

The alternative located furthest to the left is the least costly. The most vertical alternative has the least variability. The ideal alternative for the financial model would be furthest to the left and vertical; the "least cost – lowest risk" alternative. Under the model, concrete structures is the preferred alternative from a perspective of cost and risk.

Additional information, such as the probability that the alternative will be completed at or below a given cost can be obtained from the financial model. The model indicates that there is an 80% chance that the Concrete Structures alternative can be implemented for a net present value cost of less than or equal to $3.8 million dollars. This is determined by starting at the 80% probability value on the y-axis and moving vertically until it reaches the Concrete Structures curve, then moving vertically downward to the x-axis to read 3.8 million dollars.

CONCLUSION TO APPLICATION OF THE MCDA APPLIED TO REACH ANALYSIS AND COST ESTIMATES

Based on the assumptions about criteria, input ranges and weights, concrete structures or rock toe and retaining wall best meet stakeholder interests. Concrete structures or retaining wall are the least costly and least risk alternatives. However, these results are based on assumptions that require additional consideration and refinement.

More important than the results of the model is the development of a model and process for future stakeholder engagement and management; transparent decision making and a means to objectively and transparently determine which alternative best meets stakeholder objectives and overall preferences. A fuller explanation of the MCDA model and stakeholder engagement is provided in Section Two (below) of this appendix. The model can also provide a means to develop future probabilistic cost estimates for implementing the preferred alternatives.

In order to fully implement the MCDA process on the Tumwater reach analysis, the following next steps are strongly advised:

1. Identify stakeholders
2. Conduct framing session with stakeholders to determine gaps in criteria, refine criteria and weights
3. Conduct on-line surveys
4. Refine model inputs
5. Conduct sensitivity analysis to identify drivers and decision break points
6. Rerun model using various stakeholder weights.

SECTION TWO: THE MCDA MODEL AND STAKEHOLDER ENGAGEMENT FOR FUTURE APPLICATION

The first step in the stakeholder engagement process is a framing session that brings together key stakeholders. The framing session develops a shared understanding of the program objectives, uncertainties, key decisions, and policies.

Figure C-3: MCDA Framing Session

A series of exercises are used to develop a model that will help evaluate project alternatives. These exercises allow participants to:

- Clarify program goals and objectives,
- Identify key evaluation criteria and their relative importance (weight), and
- Establish consensus about the process for evaluating policy options and engaging additional stakeholders

One of the exercises used during the framing session involves the use of Trade-off analysis. Trade-off analysis is a powerful tool for helping stakeholders express the weight they place on decision criteria. Other techniques often ask stakeholders to consider each criterion in isolation using an arbitrary scale, such as "Very Important" to "Unimportant". This often does not help stakeholders carefully consider their priorities and often results in all the criteria being labeled "Very Important." Trade-off analysis requires stakeholders to consider each policy option as a package, which includes both good and bad outcomes. This helps stakeholders understand and evaluate the trade-offs that are inherent in environmental and natural resource decision making and provides policy makers with better information about stakeholder preferences.

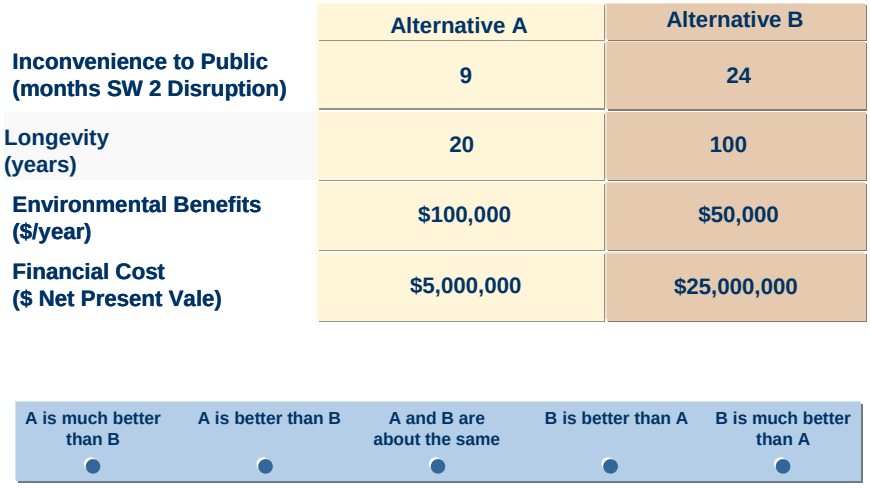

Figure C-4. Example of Trade-Off Questions

Figure C-4 provides an example trade-off question that could be used for the Tumwater reach analysis project. Each participant answers about eight to ten questions with varying attribute combinations.

A statistical model determines the weights that the participants place on the individual criteria. Figure C-5 provides an example of how these weights are typically displayed.

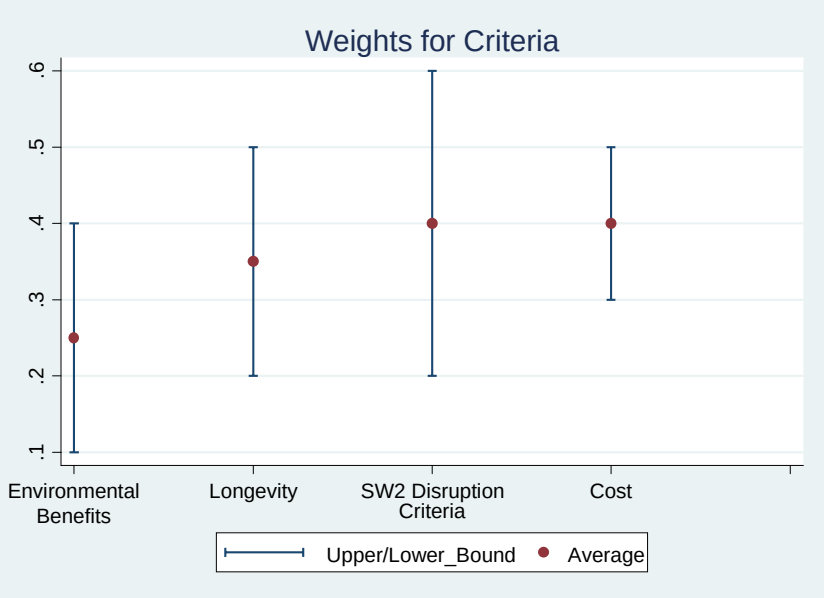

Figure C-5. Example of Criteria Weights

Stakeholder meetings are an important component of the stakeholder engagement process. MCDA can help make sure the meetings provide actionable results and minimize the potential for unfocused, unproductive discussions. This is a powerful method for achieving results and identifying policy options that reflect public values. The attendees participate in a series of exercises that create a shared understanding of the project issues. Traditional survey questions and trade-off analyses are conducted, which allows participants to indicate their preferences using hand-held voting devices. The results are presented in real time, allowing the participants to see the group preferences. Any misunderstandings in the questions can be discussed, changes can be made, and re-votes can be taken. The process can be continued until a consensus is achieved, allowing for a mutually agreeable decision in complex issues with multiple stakeholders.

Once the stakeholder engagement process is complete, the next step in the MCDA process, modeling, is performed. This includes developing a probabilistic financial component that accounts for the uncertainties and risks associated with alternative project strategies. The financial results identify the least-cost, most profitable, high value, lowest-risk strategy for addressing issues at an individual site or portfolio of sites. These results help decision makers understand the probability of completing a project at or below a given cost and of achieving profit targets.

Moreover, MCDA extends beyond financial analysis to consider other objectives and criteria important to the project stakeholders. The results identify the alternative that best satisfies all objectives. Combining the financial and MCDA results makes it possible to evaluate the cost of meeting objectives, perform trade-off analysis, and maximize value. The alternatives analysis step involves running the model, reviewing the results, and

conducting a sensitivity analysis to determine the effect that changes in input parameters have on output results.

Lastly, the alternative selection step involves reviewing the model results with project stakeholders and obtaining agreement on the alternatives.

APPENDIX D: Recommended Alternatives

Description of Alternative One:
Long Term Solution - Concrete Wall with Reinforced Toe

Roadway Stabilization – US 2
MP 94.00-98.10
By: ENTRIX, Inc. Date 4/17/2008

PROJECT SYNOPSIS:

DESCRIPTION OF EXISTING CONDITIONS:

Currently US 2 runs along the Wenatchee River in the north central region of Washington State. Two historical high water events (November 25, 1990 and November 30, 1995) caused significant embankment erosion and roadway failure. Pre-emptive repairs were also made during the 2006 fall/winter season to prevent complete roadway failure. High water levels in the river undercut staged riprap that holds the toe of the roadway embankments. The State has spent a little more than $4 million dollars since 1990 on repairs and maintenance in this troublesome area.

PURPOSE OF PROJECT:

The purpose of this project is to increase roadway durability/reliability along US 2 in this area associated with river washout. Additionally, the existing roadway will be raised in two locations to prevent sheet flow flooding across the roadway. All sites are shown on Figure D-1.

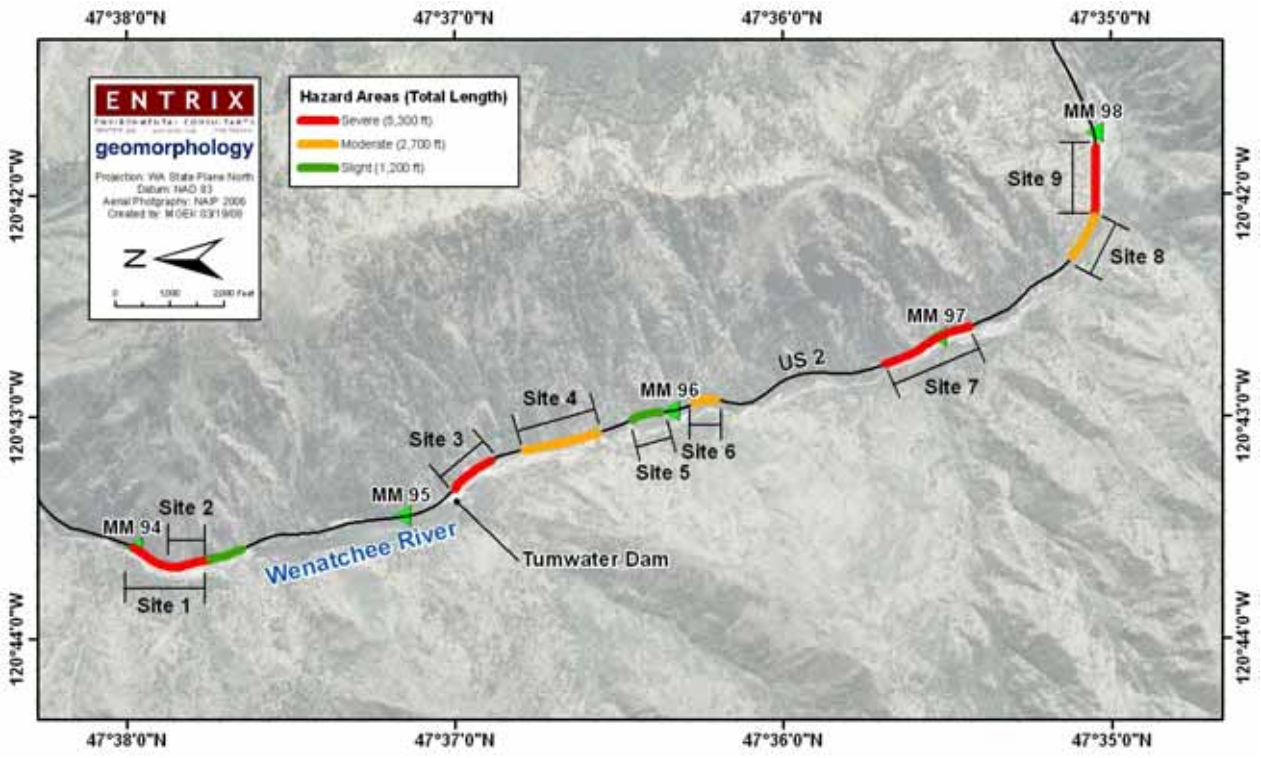

Figure D-1: Project Sites and Road Hazard Areas.

DESCRIPTION OF PROPOSED PROJECT:

Site 1 – MP 94.00 to 94.29 (1,500 Linear Feet)

Construct the addition of a rock toe protection to an existing retaining wall. Boulder (8'-10' diameter) toe protection will be installed to protect the toe of the wall in the river channel. Each boulder will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the wall height. If mega-clasts are not available or if transportation and placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel.

Site 2 - MP 94.29 to MP 94.13 (700 Linear Feet, and 1,100 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be raised four feet above the existing elevation. This elevation gain is needed to preventing further flooding and to provide an adequate amount of free board in the event of future

high water events. The area to be raised is estimated at 700 feet, with an additional 1 foot of freeboard provided. It is anticipated that road curves will encroach into each side of the 700' to provide the minimum design standard for sight distance. A 200 linear feet (LF) ramp will be required leading up to the section in question as well as an additional ramp back down to meet the existing roadway. A retaining wall system will be required along the creek side of the roadway to obtain this elevation gain. It is assumed that the wall will be buried 8 feet underground, and be 6 feet above ground for a total wall height of 14 feet. The ramp up section will have a retaining wall that begins at grade ramping up to a height of 14 feet (vice versa for the ramping down section). The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 3 - MP 95.16 to MP 95.35 (1,000 Linear Feet)

From the existing roadway, a retaining wall sloped at 1:15 (Horizontal: Vertical) will extend down below the river keying into the bedrock layer. The proposed wall height (above ground) will be 27 ft (typical) in this section. Boulder (8 foot to 10 foot diameter) toe protection will be installed to protect the toe of the wall in the river channel. Each boulder will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. If mega-clasts are not available or if transportation and placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel. Varying sized smaller boulders (2 feet diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the wall height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 4 – MP 95.50 to 95.75 (1400 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 5 - MP 95.80 to MP 95.91 (600 Linear Feet, and 1,000 Linear Feet Total Including Ramps)

The existing roadway would be raised four feet above the existing elevation to prevent roadway flooding. This elevation gain is needed to preventing further flooding and to provide an adequate amount of free board. The area to be raised is estimated at 700 feet, with an additional 1 foot of freeboard provided. It is anticipated that road curves will encroach into each side of the 700' to provide the minimum design standard for sight distance. A 200 LF ramp will be required

leading up to the section in question as well as an additional ramp back down to meet the existing roadway. A retaining wall system will be required along the creek side of the roadway to obtain this elevation gain. It is assumed that the wall will be buried 8 feet underground, and be 6 feet above ground for a total wall height of 14 feet. The ramp up section will have a retaining wall that begins at grade ramping up to a height of 14 feet (vice versa for the ramping down section). The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 6 – MP 96.10 to 96.15 (400 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 7 - MP 96.79 to MP 97.11 (1,500 Linear Feet)

From the existing roadway, a retaining wall sloped at 1:15 (Horizontal: Vertical) will extend down below the river keying into the bedrock layer. For this section the proposed wall height (above ground) will be 40 feet (typical). Boulder (8 foot to10 foot diameter) toe protection will be installed to protect the toe of the wall in the river channel. If mega-clasts are not available or if transportation and placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel. Each boulder will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the wall height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 8 – MP 97.55 to 97.70 (870 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 9 - MP 97.70 to MP 97.95 (1,000 Linear Feet)

From the existing roadway, a retaining wall sloped at 1:15 (Horizontal: Vertical) will extend down below the river keying into the bedrock layer. For this section the proposed wall height (above ground) will be 27 feet (typical). Boulder (8 foot to10 foot diameter) toe protection will be installed to protect the toe of the wall in the river channel. If mega-clasts are not available or if transportation and

placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel. Each boulder will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the wall height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

COST ESTIMATING INFORMATION:

All cost estimating information can be found with the provided worksheets. Unit costs associated with this proposed alternative can be found in Appendix E.

PROJECT SCHEDULE AND COSTS:

CN = 2012
CPMS AD Date = TBD
Scheduled AD Date = TBD

Scoping Estimate:

CN = $56.4 million
RW = $0
PE = $13.6 million
TOTAL (uninflated April 2008) = $70.0 million
TOTAL (Inflated for April 2012 CN [1]) = $80.1 million

[1] Inflation Factor of 14.4% was used based on WSDOT Spreadsheet (from April 2008 to April 2012).

UNIT COST INFORMATION
For Scoping Estimate US-2 Alt. 1.xls

Notes:
All averages below are dated from 2004 to 2008.

Item #	Historical Amount / Code
1	Mobilization 0001- (Given as 10% of pre-total).
2	Clearing and Grubbing 0025- From historical database (DB).

- NCR- (North Central Region) Ave. $631.36/acre.
- State average = $3,341.74/acre.
- More information given for statewide average.

- Use $3,300/acre x 2 = $6,600, due to accessibility issues.

3 Removing Guardrail 0170- From historical database.
- NCR Ave.- low bid = $1.70
- 3/12/07 Similar length- low bid = $7.00
- Use~ $5.00 / LF to remove.

4 Remove Guardrail Anchor 0182- From historical DB.
- NCR Ave. - low bid = $5.77.
- State Ave. - $194.13.
- Double to $360, due to the minimal value/effort required for remote access.

5 Remove Guideposts 0185- From historical DB.
- NCR Ave. - low bid = $5.77.
- Sate Ave. - $3.98.
- Assume ~ $6.00.

6 Roadway Excavation Incl. Haul 0310- From historical DB.
- NCR Ave. - low bid = $5.18.
- State Ave. - $6.33.
- Assume $6.00.

7 Common Borrow Incl. Haul 0405- State historical DB.
- NCR Ave. – low bid = $6.27.
- State Ave. - $3.25.
- Assume $7.00, for location and region.

8 Embankment Compaction 0470 – State historical DB.
- NCR Ave. – low bid = $0.77.
- State Ave. - $1.29
- Small quantity price increases / and remote accessibility
- Assume $4.00

9 Streambed Boulder 1097 – State historical DB – No Record of bid amount.
- Call contractor previous work – estimator
- Selland Construction – Jerry (estimator)
- Assume the use of DOT quarry site (cost savings)
- Assume the need of 2 cranes, one on each end (source and delivery site).
- For the requested size, need to shoot and blast rock.
- Excess waste, could be used for riprap.
- Low boys needed for transportation (cables and flagging required).

- Construction site crane would probably need to be larger of the two cranes (boom and hydraulics for placement).
- 8’-10’ diameter boulders
- Approximately $3000.00 per boulder.

10 Channel Excavation 1035 – State historical DB.
- Statewide (2 bids that included haul) Ave. $30.37.
- Assume $30.00, difficult terrain w/o hauling.

11 Heavy Loose Riprap 1076 – State historical DB.
- NCR Ave. – low bid $76.86.
- State Ave. - $55.03.
- Difficult location to deliver / access.
- Assume $100.00.

12 Anti-Stripping Additive 5334 – Calculated.
- 0.5 x (HMA [tons]) = $3650.00 (total)
- Unit price $3650.00, quantity = 1.

13 Planing Bituminous Pavement 5711 – State historical DB.
- NCR Ave. – low bid = $1.03.
- State Ave. – bid = $1.68.
- Assume $1.25.

14 HMA CL. ½'' PG 5767 – Historical State DB.
- NCR Ave. – low bid = $42.84.
- State Ave. – bid = $51.55.
- Small quantity drives up the price along with remote location.
- Assume $65.00/ton.

15 Job Mix Compliance Price Adjustment 5830 – Calculated, given in spreadsheet.
- 0.03 x ($HMA)
- 0.03 x ($HMA) = $14,235.
- Unit price $14,235, quantity = 1.

16 Compaction Price Adjustment 5835 – Calculated, given in spreadsheet.
- 0.02 x ($HMA)
- 0.02 x ($HMA) = $9,490.
- Unit price $9,490, quantity = 1.

17 ESC Lead 6403 – State historical DB.
- NCR Ave. – low bid = $152.39
- State Ave. – low bid = $115.79
- Remote location and relatively small number of hours.
- Assume $200.

18 Silt Fence 6373 – Historical State DB.
- NCR Ave. – low bid = $3.87.
- State Ave. - $3.62
- Small quantity, higher price.
- Assume $4.00.

19 Water Pollution / Erosion Control - 6490 – Estimated (water filled berm calculations and dewatering).
- See spreadsheet scoping estimate for calculated values.
- Unit Price $191,400.00, quantity = 6.

20 Raising Existing Beam Guardrail 6783 – Historical state DB.
- NCR Ave. – low bid $3.48.
- State Ave. - $4.50.
- Smaller quantity.
- Assume $4.00.

21 Truck Mounted Impact Attenuator 7447 – Historical State DB.
- NCR Ave. – low bid = $7,316.67.
- State Ave. - $7,372.60.
- Recent 12/17/07 Data ~ $5,250.00.
- Remote location.
- Use $7,500.

22 Operation of Truck Mounted Impact Attenuator 7449 – Historical State DB.
- NCR Ave. – Low bid = $26.00.
- State Ave. – Low bid = $28.16.
- Assume $30.00.

23 Repair T.M. Impact Attenuator 7450 – Historical State DB.
- ~ Similar number - $1,000 - $2,000.
- Assume $2,500.

24 Flexible Guide Post 6832 – Historical State DB.
- NCR Ave. – Low bid $26.84.
- State Ave. - $26.16.
- Location
- Assume $28.00.

25 Paint Line 6806 – Historical State DB.
- NCR Ave. - $0.14.
- State Ave. - $0.11.
- Small Quantity (less than one mile total)
- Remote location for paint truck.
- Assume $2.00.

26 Recessed Pavement Marker 6889 – Historical State DB.
- NCR Ave. - $780.41.
- State Ave. - $833.76.
- Assume $10,000 total/38 = minimum cost for man power and equipment.
- Use $265.00 for unit cost.

27 Temporary Pavement Marking 6888 – Historical State DB.
- NCR Ave. - $0.13.
- State Ave. - $0.16.
- Small Quantity (less than a mile total)
- Assume $0.50.

28 Portable Changeable Message Sign 6994 – Historical State DB.
- NCR Ave. - $5,111.81.
- State Ave. - $4,650.39.
- Due to location and region.
- Use piece $5,500.

29 Operation of Portable Changeable Message Sign 6995 – Historical State DB.
- NCR Ave. - $2.49.
- State Ave. - $2.81.
- Assume similar numbers - $2.50.

30 Project Temporary Traffic Control - 6971
- Calculated at 5% of the total construction cost
- Value based on detours and extensive Traffic Control issues.
- Calculated value (for all sites) = $1,781,834.

31 Flaggers and Spotters 6980 – Historical State DB.
- NCR Ave. - $39.62.
- State Ave. - $31.82.
- Newer numbers, 11/13/2007 = $54.00.
- Increased latest value by 5%.
- Assume $57.00.

32 Traffic Control Vehicle 6968 – Historical State DB.
- NCR Ave. – None.
- State Ave. - $64.33 (only values are in 2004).
- Assume $100 per day.

33 Traffic Control Supervisor 6972 – Historical State DB.
- NCR Ave. – None.
- State Ave. - $31.17 (newest entry 2005).

- Assume $50.00.

34 Construction Signs Class A 6982 – Historical State DB.
- NCR Ave. – low bid $8.43.
- State Ave. - $13.21.
- Small Quantity.
- Assume $12.00.

35 Roadside Cleanup 7480 – Estimate.
- Assume $1,000.
- Given in spreadsheet, no unit cost.

36 SPCC Plan 7736 – SPCC Plan
- Lump Sum = $2,000.
- Given in spreadsheet, no unit cost.

37 Structure Surveying 7037 – Lump Sum.
- Estimate, based on Eng. judgment.
- Assume $30,000.

38 Roadway Surveying 7038 – Lump Sum.
- Estimate based on Eng. judgment.
- Assume $30,000.

39 Shoring 7007 – Historical Site DB.
- NCR Ave. – None.
- State Ave. - $1.07
- Location drives price up.
- Assume $2.00.

40 Backfill for rock wall 7167 – Historical Site DB.
- NCR Ave. – None.
- State Ave. - $33.85.
- Location and accessibility drive costs up.
- Assume $35.00.

41 Shotcrete Facing (Grouting Riprap) 7561 – Historical Site DB.
- NCR Ave. – None.
- State Ave. - $12.08.
- Location drives price up, and older values given in database.
- Assume $20.00.

42 St. Rein. Bar for Retaining Wall 4150 – Historical State DB.
- NCR Ave. – $1.25 (only one value).
- State Ave. - $1.13.

- Assume $2.00.

43 Conc. Class 4000 for Retaining Wall 4139 – Historical State DB.

- NCR Ave. – low bid = $1,000 (only one value).
- State Ave. - $566.07.
- Based on location and access.
- Assume $1,000.

Description of Alternative Two:
Interim Solution - Reinforced Toe with Rock Upslope

Roadway Stabilization – US 2
MP 94.00-98.10
By: ENTRIX, Inc. Date: 4/17/2008

PROJECT SYNOPSIS:

DESCRIPTION OF EXISTING CONDITIONS:

Currently US 2 runs along the Wenatchee River in the north central region of Washington State. Two historical high water events (November 25, 1990 and November 30, 1995) caused significant embankment erosion and roadway failure. Pre-emptive repairs were also made during the 2006 fall/winter season to prevent complete roadway failure. High water levels in the river undercut staged riprap that holds the toe of the roadway embankments. The State has spent a little more than $4 million dollars since 1990 on repairs and maintenance in this troublesome area.

PURPOSE OF PROJECT:

The purpose of this project is to increase roadway durability/reliability along US 2 in this area associated with river washout. Additionally two locations will raise the existing roadway to prevent future sheet flow flooding across the roadway.

DESCRIPTION OF PROPOSED PROJECT:

Site 1 – MP 94.00 to 94.29 (1,500 Linear Feet)

Construct the addition of a rock toe protection to an existing retaining wall. Boulder (8 foot to10 foot diameter) toe protection will be installed to protect the toe of the wall in the river channel. If mega-clasts are not available or if transportation and placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel. Each boulder will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (riprap) will be grouted together preventing scour and undercutting along the retaining wall. This riprap/grouting protection will extend up to half of the wall height.

Site 2 - MP 94.13 TO MP 94.29 (700 Linear Feet, and 1,100 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be raised four feet above the existing elevation. This elevation gain is needed to preventing further flooding and to provide an adequate amount of free board. The area to be raised is estimated at 700 feet, with an additional 1 foot of freeboard provided. It is anticipated that road curves will encroach into each side of the 700' to provide the minimum design standard for sight distance. A 200 LF ramp will be required leading up to the section in question as well as an additional ramp back down to meet the existing roadway. A retaining wall system will be required along the creek side of the roadway to obtain this elevation gain. It is assumed that the wall will be buried 8 feet underground, and be 6 feet above ground for a total wall height of 14' feet. The ramp up section will have a retaining wall that begins at grade ramping up to a height of 14 feet (vice versa for the ramping down section). The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 3 - MP 95.16 TO MP 95.35 (1,000 Linear Feet)

From the existing roadway, a boulder and riprap protected toe will be placed along the existing slope. Each boulder (8 foot to10 foot diameter) will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. If mega-clasts are not available or if transportation and placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the slope height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 4 – MP 95.50 to 95.75 (1400 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 5 - MP 95.80 TO MP 95.91 (600 Linear Feet, and 1,000 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be raised four feet above the existing elevation. This elevation gain is needed to preventing further flooding and to provide an adequate amount of free board. The area to be raised is estimated at 700 feet, with an additional 1 foot of freeboard provided. It is anticipated that road curves will encroach into each side of the 700' to provide the minimum design standard for sight distance. A 200 LF ramp will be required leading up to the section in question as well as an additional ramp back down to

meet the existing roadway. A retaining wall system will be required along the creek side of the roadway to obtain this elevation gain. It is assumed that the wall will be buried 8 feet underground, and be 6 feet above ground for a total wall height of 14 feet. The ramp up section will have a retaining wall that begins at grade ramping up to a height of 14' (vice versa for the ramping down section). The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 6 – MP 96.10 to 96.15 (400 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 7 - MP 97.11 TO MP 96.79 (1,500 Linear Feet)

From the existing roadway, a boulder and riprap protected toe will be placed along the existing slope. Each boulder (8 foot to 10 foot diameter) will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. If mega-clasts are not available or if transportation and placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the slope height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 8 – MP 97.55 to 97.70 (870 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 9 - MP 97.70 TO MP 97.75 (1,000 Linear Feet)

From the existing roadway, a boulder and riprap protected toe will be placed along the existing slope. Each boulder (8 foot to 10 foot diameter) will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. If mega-clasts are not available or if transportation and placement are not feasible, a value engineering study will be conducted to determine the best alternative to meet the roughness required in the channel. Varying sized smaller

boulders (2 foot diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the slope height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

COST ESTIMATING INFORMATION:

All cost estimating information for this alternative can be found with the provided worksheets. Unit costs associated with this proposed alternative can be found in Appendix E.

CN = 2012
CPMS AD Date = TBD
Scheduled AD Date = TBD

Scoping Estimate:

CN = $12.5 million
RW = $0
PE = $2.9 million
TOTAL (uninflated April 2008) = $15.4 million
TOTAL (Inflated for April 2012 CN [1]) = $17.6 million

[1] Inflation Factor of 14.4% was used based on WSDOT Spreadsheet (from April 2008 to April 2012).

UNIT COST INFORMATION
For Scoping Estimate US-2 Alt. 2.xls

Notes:
All averages below are dated from 2004 to 2008.

Item #	Historical Amount / Code
44	Mobilization 0001- (Given as 10% of pre-total).
45	Clearing and Grubbing 0025- From historical database (DB). ▪ NCR- (North Central Region) Ave. $631.36/acre. ▪ State average = $3,341.74/acre. ▪ More information given for statewide average. ▪ Use $3,300/acre x 2 = $6,600, due to accessibility issues.
46	Removing Guardrail 0170- From historical database. ▪ NCR Ave.- low bid = $1.70 ▪ 3/12/07 Similar length- low bid = $7.00 ▪ Use~ $5.00 / LF to remove.
47	Remove Guardrail Anchor 0182- From historical DB. ▪ NCR Ave. - low bid = $5.77. ▪ State Ave. - $194.13. ▪ Double to $360, due to the minimal value/effort required for remote access.

48 Remove Guideposts 0185- From historical DB.
- NCR Ave. - low bid = $5.77.
- Sate Ave. - $3.98.
- Assume ~ $6.00.

49 Roadway Excavation Incl. Haul 0310- From historical DB.
- NCR Ave. - low bid = $5.18.
- State Ave. - $6.33.
- Assume $6.00.

50 Common Borrow Incl. Haul 0405- State historical DB.
- NCR Ave. – low bid = $6.27.
- State Ave. - $3.25.
- Assume $7.00, for location and region.

51 Embankment Compaction 0470 – State historical DB.
- NCR Ave. – low bid = $0.77.
- State Ave. - $1.29
- Small quantity price increases / and remote accessibility
- Assume $4.00

52 Streambed Boulder 1097 – State historical DB – No Record of bid amount.
- Call contractor previous work – estimator
- Selland Construction – Jerry (estimator)
- Assume the use of DOT quarry site (cost savings)
- Assume the need of 2 cranes, one on each end (source and delivery site).
- For the requested size, need to shoot and blast rock.
- Excess waste, could be used for riprap.
- Low boys needed for transportation (cables and flagging required).
- Construction site crane would probably need to be larger of the two cranes (boom and hydraulics for placement).
- 8’-10’ diameter boulders or equivalent
- Approximately $3000.00 per boulder.

53 Channel Excavation 1035 – State historical DB.
- Statewide (2 bids that included haul) Ave. $30.37.
- Assume $30.00, difficult terrain w/o hauling.

54 Heavy Loose Riprap 1076 – State historical DB.
- NCR Ave. – low bid $76.86.
- State Ave. - $55.03.
- Difficult location to deliver / access.
- Assume $100.00.

55 Anti-Stripping Additive 5334 – Calculated.
- 0.5 x (HMA [tons]) = $3650.00 (total)
- Unit price $3650.00, quantity = 1.

56 Planing Bituminous Pavement 5711 – State historical DB.
- NCR Ave. – low bid = $1.03.
- State Ave. – bid = $1.68.
- Assume $1.25.

57 HMA CL. ½'' PG 5767 – Historical State DB.
- NCR Ave. – low bid = $42.84.
- State Ave. – bid = $51.55.
- Small quantity drives up the price along with remote location.
- Assume $65.00/ton.

58 Job Mix Compliance Price Adjustment 5830 – Calculated, given in spreadsheet.
- 0.03 x ($HMA)
- 0.03 x ($HMA) = $14,235.
- Unit price $14,235, quantity = 1.

59 Compaction Price Adjustment 5835 – Calculated, given in spreadsheet.
- 0.02 x ($HMA)
- 0.02 x ($HMA) = $9,490.
- Unit price $9,490, quantity = 1.

60 ESC Lead 6403 – State historical DB.
- NCR Ave. – low bid = $152.39
- State Ave. – low bid = $115.79
- Remote location and relatively small number of hours.
- Assume $200.

61 Silt Fence 6373 – Historical State DB.
- NCR Ave. – low bid = $3.87.
- State Ave. - $3.62
- Small quantity, higher price.
- Assume $4.00.

62 Water Pollution / Erosion Control - 6490 – Estimated (water filled berm calculations and dewatering).
- See spreadsheet scoping estimate for calculated values.
- Unit Price $191,400.00, quantity = 6.

63 Raising Existing Beam Guardrail 6783 – Historical state DB.
- NCR Ave. – low bid $3.48.
- State Ave. - $4.50.

- Smaller quantity.
- Assume $4.00.

64 Truck Mounted Impact Attenuator 7447 – Historical State DB.
- NCR Ave. – low bid = $7,316.67.
- State Ave. - $7,372.60.
- Recent 12/17/07 Data ~ $5,250.00.
- Remote location.
- Use $7,500.

65 Operation of Truck Mounted Impact Attenuator 7449 – Historical State DB.
- NCR Ave. – Low bid = $26.00.
- State Ave. – Low bid = $28.16.
- Assume $30.00.

66 Repair T.M. Impact Attenuator 7450 – Historical State DB.
- ~ Similar number - $1,000 - $2,000.
- Assume $2,500.

67 Flexible Guide Post 6832 – Historical State DB.
- NCR Ave. – Low bid $26.84.
- State Ave. - $26.16.
- Location
- Assume $28.00.

68 Paint Line 6806 – Historical State DB.
- NCR Ave. - $0.14.
- State Ave. - $0.11.
- Small Quantity (less than one mile total)
- Remote location for paint truck.
- Assume $2.00.

69 Recessed Pavement Marker 6889 – Historical State DB.
- NCR Ave. - $780.41.
- State Ave. - $833.76.
- Assume $10,000 total/38 = minimum cost for man power and equipment.
- Use $265.00 for unit cost.

70 Temporary Pavement Marking 6888 – Historical State DB.
- NCR Ave. - $0.13.
- State Ave. - $0.16.
- Small Quantity (less than a mile total)
- Assume $0.50.

71 Portable Changeable Message Sign 6994 – Historical State DB.
- NCR Ave. - $5,111.81.
- State Ave. - $4,650.39.
- Due to location and region.
- Use piece $5,500.

72 Operation of Portable Changeable Message Sign 6995 – Historical State DB.
- NCR Ave. - $2.49.
- State Ave. - $2.81.
- Assume similar numbers - $2.50.

73 Project Temporary Traffic Control - 6971
- Calculated at 5% of the total construction cost
- Value based on detours and extensive Traffic Control issues.
- Calculated value (for all sites) = $1,781,834.

74 Flaggers and Spotters 6980 – Historical State DB.
- NCR Ave. - $39.62.
- State Ave. - $31.82.
- Newer numbers, 11/13/2007 = $54.00.
- Increased latest value by 5%.
- Assume $57.00.

75 Traffic Control Vehicle 6968 – Historical State DB.
- NCR Ave. – None.
- State Ave. - $64.33 (only values are in 2004).
- Assume $100 per day.

76 Traffic Control Supervisor 6972 – Historical State DB.
- NCR Ave. – None.
- State Ave. - $31.17 (newest entry 2005).
- Assume $50.00.

77 Construction Signs Class A 6982 – Historical State DB.
- NCR Ave. – low bid $8.43.
- State Ave. - $13.21.
- Small Quantity.
- Assume $12.00.

78 Roadside Cleanup 7480 – Estimate.
- Assume $1,000.
- Given in spreadsheet, no unit cost.

79 SPCC Plan 7736 – SPCC Plan
- Lump Sum = $2,000.
- Given in spreadsheet, no unit cost.

80 Structure Surveying 7037 – Lump Sum.
- Estimate, based on Eng. judgment.
- Assume $30,000.

81 Roadway Surveying 7038 – Lump Sum.
- Estimate based on Eng. judgment.
- Assume $10,000.

82 Shoring 7007 – Historical Site DB.
- NCR Ave. – None.
- State Ave. - $1.07
- Location drives price up.
- Assume $2.00.

83 Backfill for rock wall 7167 – Historical Site DB.
- NCR Ave. – None.
- State Ave. - $33.85.
- Location and accessibility drive costs up.
- Assume $35.00.

84 Shotcrete Facing (Grouting Riprap) 7561 – Historical Site DB.
- NCR Ave. – None.
- State Ave. - $12.08.
- Location drives price up, and older values given in database.
- Assume $20.00.

85 St. Rein. Bar for Retaining Wall 4150 – Historical State DB.
- NCR Ave. – $1.25 (only one value).
- State Ave. - $1.13.
- Assume $2.00.

86 Conc. Class 4000 for Retaining Wall 4139 – Historical State DB.
- NCR Ave. – low bid = $1,000 (only one value).
- State Ave. - $566.07.
- Based on location and access.
- Assume $1,000.

APPENDIX E: Cost Estimates

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 2**

Four areas along the roadway would be ripraped with boulders and smaller diameter boulders halfway up the slope ba
Riprapped toe protection would be grouted (shotcreted) together.
Two additional roadway areas would be raised (w/ retaining walls) to prevent flooding.
Three moderate hazardous lengths would be riprapped and grouted the slope banks. (No boulder placement).

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.

AS OF DATE: 4/17/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
PREPARATION						
1	MOBILIZATION	0001	L.S.	10.00%	1.00	$873,995.75
2	CLEARING AND GRUBBING	0025	ACRE	$6,600.00	4.80	$31,680.00
3	REMOVING GUARDRAIL	0170	L.F.	$5.00	7,100.00	$35,500.00
4	REMOVE GUARDRAIL ANCHOR	0182	EACH	$360.00	12.00	$4,320.00
5	REMOVE GUIDEPOSTS	0185	EACH	$6.00	1,143.00	$6,858.00
GRADING						
6	ROADWAY EXCAVATION INLC. HAUL	0310	C.Y.	$6.00	5,300.00	$31,800.00
7	COMMON BORROW INCL. HAUL	0405	C.Y.	$7.00	8,600	$60,200.00
8	EMBANKMENT COMPACTION	0470	C.Y.	$4.00	17,200	$68,800.00
DRAINAGE						
9	STREAMBED BOULDER	1097	EACH	$3,000.00	630.00	$1,890,000.00
10	CHANNEL EXCAVATION	1035	C.Y.	$30.00	9,400.00	$282,000.00
11	HEAVY LOOSE RIPRAP	1076	C.Y.	$100.00	8,000.00	$800,000.00
LIQUID ASPHALT						
12	ANTI-STRIPPING ADDITIVE (0.5*(HMA Tons+ ATB Tons)	5334	EST.	$1,350.00	1.00	$1,350.00
HOT MIX ASPHALT						
13	PLANING BITUMINOUS PAVEMENT	5711	S.Y.	$1.25	8,000.00	$10,000.00
14	HMA CL.1/2" PG 64-28 Depth: 0.50'	5767	TON	$65.00	2,700.00	$175,500.00
15	JOB MIX COMPLIANCE PRICE ADJUSTMENT (0.03*$HMA Total)	5830	EST.	$5,265.00	1.00	$5,265.00
16	COMPACTION PRICE ADJUSTMENT (0.02*($HMA)	5835	EST.	$3,510.00	1.00	$3,510.00
EROSION CONTROL AND PLANTING						
17	ESC LEAD	6403	DAY	$200.00	16.00	$3,200.00
18	SILT FENCE	6373	L.F.	$4.00	14,670	$58,680.00
19	WATER POLLUTION/EROSION CONTROL	6490	EST.	$191,400.00	6.00	$1,148,400.00
TRAFFIC						
20	RAISING EXISTING BEAM GUARDRAIL	6783	L.F.	$4.00	7,105.00	$28,420.00
21	TRUCK MOUNTED IMPACT ATTENUATOR	7447	EACH	$7,500.00	1.00	$7,500.00
22	OPERATION OF TRUCK MOUNTED IMPACT ATTENUATO	7449	HR	$30.00	40.00	$1,200.00
23	REPAIR T.M. IMPACT ATTENUATOR	7450	EACH	$2,500.00	1.00	$2,500.00
24	FLEXIBLE GUIDE POST	6832	EACH	$28.00	1,143.00	$32,004.00
25	PAINT LINE	6806	L.F.	$2.00	6,300.00	$12,600.00
26	RECESSED PAVEMENT MARKER	6889	HUND.	$265.00	38.00	$10,070.00
27	TEMPORARY PAVEMENT MARKING	6888	L.F.	$0.50	4,200.00	$2,100.00
28	PORTABLE CHANGEABLE MESSAGE SIGN	6994	EACH	$5,500.00	2.00	$11,000.00
29	OPERATION OF PORTABLE CHANGEABLE MESSAGE SIG	6995	HR	$2.50	4,800.00	$12,000.00
30	PROJECT TEMPORARY TRAFFIC CONTROL	6971	L.S.	5.00%	1.00	$416,188.45
31	FLAGGERS AND SPOTTERS	6980	HR	$57.00	300.00	$17,100.00
32	TRAFFIC CONTROL VEHICLE	6968	DAY	$100.00	60.00	$6,000.00
33	TRAFFIC CONTROL SUPERVISOR	6974	HOUR	$50.00	650.00	$32,500.00
34	CONSTRUCTION SIGNS CLASS A	6982	S.F.	$12.00	276.00	$3,312.00
OTHER ITEMS						
35	ROADSIDE CLEANUP	7480	L.S.	$2,000.00	1.00	$2,000.00
36	SPCC PLAN	7736	L.S.	$1,000.00	1.00	$1,000.00
37	STRUCTURE SURVEYING	7037	L.S.	$30,000.00	1.00	$30,000.00
38	ROADWAY SURVEYING	7038	L.S.	$10,000.00	1.00	$10,000.00
39	SHORING	7007	S.F.	$2.00	55,600.00	$111,200.00
40	BACKFILL FOR ROCK WALL	7167	TON	$35.00	12,080.00	$422,800.00
41	SHOTCRETE FACING (GROUTING RIPRAP)	7561	S.F.	$20.00	50,000.00	$1,000,000.00
STRUCTURE						
42	ST. REIN. BAR FOR RETAINING WALL	4150	LB	$2.00	100,700.00	$201,400.00
43	CONC. CLASS 4000 FOR RETAINING WALL	4139	C.Y.	$1,000.00	1,750.00	$1,750,000.00

MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR	1.00%	$96,139.53
CONSTRUCTION TOTAL		$9,710,092.73
SALES TAX	8.00%	$776,807.42
SUB TOTAL		$10,486,900.15
CONSTRUCTION ENGINEERING (CE)	15%	$1,573,035.02
CONTINGENCIES	4%	$419,476.01
CN		**$12,479,411.17**
RW		$0.00
Mitigation Costs		$0.00
PE	24%	$2,995,058.68
PROJECT TOTAL		**$15,474,469.85**

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

SCOPING ESTIMATE - SUMMARY

PROJECT: **US 2, Wenatchee River - Alternative 2**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/18/2008

PREPARATION

1 MOBILIZATION - 0001

Note: Mobilization is a percentage of the pre-total. (See Estimate Tab)

2 CLEARING AND GRUBBING - 0025

Site 1		
Length (LF)	0	Existing Retaining wall in place
Slope Length (LF)	40	
Total (Acres)	0	
Site 3		
Length (LF)	1005	
Slope Length (LF)	40	
Total (Acres)	0.92286501	
Site 7		
Length (LF)	1500	
Slope Length (LF)	40	
Total (Acres)	1.37741047	
Site 9		
Length (LF)	1000	
Slope Length (LF)	40	
Total (Acres)	0.91827365	
Mod. Hazardous Area Site 4		
Length (LF)	1400	
Slope Length (LF)	27	
Total (Acres)	0.8677686	
Mod. Hazardous Area Site 6		
Length (LF)	400	
Slope Length (LF)	23	
Total (Acres)	0.21120294	
Mod. Hazardous Area Site 8		
Length (LF)	870	
Slope Length (LF)	25	
Total (Acres)	0.49931129	
Total	4.7968	

TOTAL (ACRE) 4.80

3 REMOVING GUARDRAIL - 0170

Note: Flooding Areas include 200' (LF) transitions on both ends

	Length (LF)	
Site 1	1500	Removal needed inorder to construct/place Boulders and Riprap
Site 3	1005	Removal needed inorder to construct/place Boulders and Riprap
Site 7	1500	Removal needed inorder to construct/place Boulders and Riprap
Site 9	1000	Removal needed inorder to construct/place Boulders and Riprap
Flooding Area Site 2	1100	Removal needed inorder to construct/place Riprap
Flooding Area Site 5	1000	Removal needed inorder to construct/place Riprap
Total	7105	

TOTAL (LF) 7100.00

4 **REMOVE GUARDRAIL ANCHOR - 0182**

Mp	Lt/Rt	Qty.

Note: Assume the each length has one on each end (6x2 = 12)

TOTAL (EA)	12.00

5 **REMOVE GUIDEPOSTS - 0185**

Note: Assume that the number of Guideposts to be removed equals the number to install
(See RPM-Guidepost Tab for Quantity)

TOTAL (EA)	1143.00

GRADING

6 **ROADWAY EXCAVATION INCL. HAUL - 0310**

	Length(LF)	Width (LF)	Roadway Depth(LF)	Sum (C.Y.)	
Site 1	0	34	2	0	(No Roadway Excavation at thi
Site 3	0	34	2	0	(Keep existing Roadway as is)
Site 7	0	34	2	0	(Keep existing Roadway as is)
Site 9	0	34	2	0	(Keep existing Roadway as is)
Flooding Area Site 2	1100	34	2	2770.37037	
Flooding Area Site 5	1000	34	2	2518.518519	
			Total (C.Y.)	5288.888889	

TOTAL (CY)	5300.00

7 **COMMON BORROW INCL. HAUL - 0405**

Note: Ten feet added to wall heights to meet bed rock

	Length of Wall (LF)	Width (LF)	Height (LF)	Sum (C.Y.)	
Site 1	0	8	42	0	(Existing Wall)
Site 3	0	8	37	0	(Only Rock Toe, No Reinforced Wall)
Site 7	0	8	50	0	(Only Rock Toe, No Reinforced Wall)
Site 9	0	8	37	0	(Only Rock Toe, No Reinforced Wall)
			Total (C.Y.)	0	

Note: Assume Triangular Distribution

Flooding Roadway:
Note: Assume 200' approach lengths, and 4 feet of height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard
Assume triangular approach and descent

	Approach	Flood	Road Width	Fill Needed (CF)
Flood Area Site 2 approach	200	4	34	13600
Flood Area Site 2 decent	200	4	34	13600
			Total (CY)	1007.41

	Approach	Flood	Road Width	Fill Needed (CF)
Flood Area Site 5 approach	200	4	34	13600
Flood Area Site 5 decent	200	4	34	13600
			Total (CY)	1007.41

Note: Four feet height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard

	Roadway	Flood	Road Width	Fill Needed (CF)
Flood Area Site 2	700	4	34	95200
Flood Area Site 5	600	4	34	81600
			Total (CY)	6548.15

Total of Both Sections (CY)	8562.96

TOTAL (CY)	8600.00

8 **EMBANKMENT COMPACTION - 0470**

Note: Compact base of wall and stockpile file
Total = 2 X Common Borrow Value

TOTAL (CY)	17200.00

DRAINAGE

9 **STREAMBED BOULDER - 1097**

Note: Equals the LF of channel divided by the Average Diameter

	Length (LF)	Average Boulder Diameter (LF)	
Site 1	1500	8	187.5
Site 3	1005	8	125.625
Site 7	1500	8	187.5
Site 9	1000	8	125
		Total Boulders Needed (Each)	625.625

TOTAL (EACH) 630.00

10 **CHANNEL EXCAVATION - 1035**

Note: Recontouring Channel and the Toe of the River Bank

	Length of Channel(LF)	Width of Channel (LF)	Excavation Depth (LF)	Sum (C.Y.)	
Site 1	1500	10	4	2222.22	
Site 3	1005	10	4	1488.89	
Site 7	1,500	10	4	2222.22	
Site 9	1,000	10	4	1481.48	
Mod. Hazardous Area Site 4	1400	10	2	1037.04	(Boulder Placement is not prop
Mod. Hazardous Area Site 6	870	10	2	644.44	(Boulder Placement is not prop
Mod. Hazardous Area Site 8	400	10	2	296.30	(Boulder Placement is not prop
			Total (C.Y.)	9392.59	

TOTAL (C.Y.) 9400.00

11 **HEAVY LOOSE RIPRAP - 1076**

Note: Assume that boulders (#9) are buried up to half of the diameter (4') at the toe of the reinforced wall
Assume Riprap height will be half the height of the exposed wall minus the above mentioned boulder.
Assume Riprap is a 2' diameter boulder

	Wall Height Exposed (LF)	Height (LF) - Half of Wall Ht. Out of Ground minus 1/2 Boulder Dia.	Height (LF)	Length (LF)	Sum (C.Y.)
Site 1	32	12	12	1500	1333.333333
Site 3	27	9.5	9.5	1005	707.2222222
Site 7	40	16	16	1,500	1777.777778
Site 9	27	9.5	9.5	1,000	703.7037037
				Total (C.Y.)	4522.037037

	Height (LF) - From the Roadway to the River	Height (LF) - Half of the slope height	Length (LF)	Sum (C.Y.)	
Mod. Hazardous Area Site 4	26.6	13.3	1400	1379.259259	(The average slope height is ass
Mod. Hazardous Area Site 6	22.55	11.275	400	334.0740741	(The average slope height is ass
Mod. Hazardous Area Site 8	25.15	12.575	870	810.3888889	(The average slope height is ass
			Total (C.Y.)	2523.722222	

TOTAL (C.Y.) 8,000.00

LIQUID ASPHALT

12 **ANTI-STRIPPING ADDITIVE - 5334**

(0.5*(HMA))

TOTAL (EST.) 1350.00

HOT MIX ASPHALT

13 **PLANING BITUMINOUS PAVEMENT - 5711**

See the HMA section of this excel file for quantity calculations.

TOTAL (SY) 8,000.00

14 **HMA CL. 1/2" PG 64-28 - 5767**

See the HMA section of this excel file for quantity calculations.

TOTAL (TON)	2,700.00

15 **JOB MIX COMPLIANCE PRICE ADJUSTMENT - 5830**

(0.03*$HMA)

TOTAL (EST.)	See Estimate

16 **COMPACTION PRICE ADJUSTMENT - 5835**

(0.02*$HMA)

TOTAL (EST.)	See Estimate

EROSION CONTROL AND PLANTING

17 **ESC LEAD - 6403**

Referring to Std. Spec 8-01.3(1)B

ESC inspects at least once every 5 working days and each working day there is a runoff event.

60 working days/5 ESC days =	12	days for ESC Lead	Working Days	60
Assumed 4 rainy days	4	days for runoff event		
Total	16	days for ESC lead		

TOTAL (DAY)	16.00

18 **SILT FENCE - 6373**

Note: Equals the entire length of the project times 1.5

	Length (LF)	
Site 1	1500	
Site 3	1005	
Site 7	1500	
Site 9	1000	
Flooding Area Site 2	1100	(includes ramp up and down lengths)
Flooding Area Site 5	1000	(includes ramp up and down lengths)
Mod. Hazardous Area Site 4	1400	
Mod. Hazardous Area Site 6	870	
Mod. Hazardous Area Site 8	400	
Total (LF)	9775	
Total (1.5 Increase)	14662.5	

TOTAL (L.F.)	14670.00

19 **TEMP. WATER POLLUTION/EROSION CONTROL**

Note: Water filled berms can be reused, only priced out one section

Assume all set-up and installation costs are covered in the total price

One Water filled berm - stream diversion	
Length of Diversion Needed (LF)	1500
Width of Diversion Needed (2x -LF) ~20'	40
Losses for connections (2x - LF) ~12'	24
Cost for Aqua-Berm per LF	100
Total Cost for Berm $	$ 156,400.00

Dewatering Activities - (Pumping, etc.)	
Total Cost associated with Dewatering	$ 35,000.00

Total (EST. for One Setup)	$ 191,400.00
One Setup for Each Area	4
Moderate Hazardous Areas[1]	2
Total Setups	6

TOTAL (EST.)	6.00

[1] Since the lengths for the moderate hazardous areas are short, assume that 2 setups will cover all three areas.

TRAFFIC

Working Days = 60.00 Working Hours (10-hr days) = 600

20 **RAISING EXISTING BEAM GUARDRAIL - 6783**

	Length of Road (LF)	
Site 1	1500	(Replace Existing)
Site 3	1005	(Replace Existing)
Site 7	1500	(Replace Existing)
Site 9	1000	(Replace Existing)
Flooding Area Site 2	1100	(includes ramp up and down lengths)

Flooding Area Site 5	1000	(includes ramp up and down lengths)
Total (LF)	7105	

TOTAL (L.F.) 7,105.00

21 **TRUCK-MOUNTED IMPACT ATTENUATOR - 7447** — **TOTAL (EACH)** 1.00

22 **OPERATION OF TRUCK-MOUNTED IMPACT ATTENUATOR - 7449**

Note: Assume four ten hour days — **TOTAL (HR)** 40.00

23 **REPAIR TRUCK-MOUNTED IMPACT ATTENUATOR - 7450**

Note: assume the attenuator will need 1 repair. — **TOTAL (EACH)** 1.00

24 **FLEXIBLE GUIDEPOST - 6832**

Note: See RPM-Guidp Sheet — **TOTAL (EACH)** 1,143.00

25 **PAINT LINE - 6806**

Note: See Paint Stripe Calc on HMA tab — **TOTAL (L.F.)** 6,300.00

26 **RECESSED PAVEMENT MARKINGS - 6889**

Note: See RPM-Guidp Sheet — **TOTAL (HUND)** 38.00

27 **TEMPORARY PAVEMENT MARKINGS - 6888**

Note: See Temporary Paint on HMA tab — **TOTAL (L.F.)** 4,200.00

28 **PORTABLE CHANGEABLE MESSAGE SIGN - 6994** — **TOTAL (EA)** 2.00

29 **OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGN - 6995**

Note: Set Up 40 Days prior to Construction

Working Days	60
Prior to Construction Days	40
24 hours a day	2400
2 Signs	2
Total Hours	4800

TOTAL (HR) 4,800.00

30 **PROJECT TEMPORARY TRAFFIC CONTROL - 6971**

Item consists of Contractor furnished barricades, cones, flashers, traffic safety drums, and Cl. B signs.
Surfacing / paving require restricted roadway width or detour routing and are intensive traffic control operations.
Note: Total based on 5% of total construction costs (not including Mobilization)

TOTAL (L.S.) 1.00

31 **FLAGGERS AND SPOTTERS - 6980**

Note: Assumed 10 hr working days.
Each flagger works a 10 hr. day, and 3 laborers will be working every chargeable working day.
Assume 5 Days at the beginning, and 5 Days at the end of construction to set up Detour

Laborers	3
Working Days	10
Hours per Day	10
Total (Hours)	300

TOTAL (HR) 300.00

32 **TRAFFIC CONTROL VEHICLE - 6968**

Assume: A TCS will be on the project site every chargeable contract day.
TCS will require a vehicle to transport temporary traffic control devices and Cl. B signs.
Working Days (total) 60

TOTAL (DAY) 60.00

33 **TRAFFIC CONTROL SUPERVISOR - 6972**

Note: Assumed 10 hr working days.
Assume: The TCS will be working every chargeable contract day.
TCS often sets up and removes temporary traffic control devices / Cl. B signs. (Additional 5 days)

Chargeable Working Days	65
Working Hours per Day	10
Total (Hours)	650

TOTAL (HR) 650.00

34 **CONSTRUCTION SIGNS CLASS A - 6982**

Sign Type	Area ft^2	Qty	Total Area
Give 'Em A Brake (G28-101)	28	2	56
Road Work Ahead, 48in x 48 in (W20-1)	16	6	96
Road Work Next "X" Miles (G20-1)	10	2	20
End Road Work (G20-2a)	8	2	16
For Project Information Call XXX-XXXX (G24-501)	12	2	24
Traffic Fines Double in Work Zones (I20-301)	16	2	32
Thank You/ WSDOT-Contractor Name Sign	16	2	32
		Total (S.F.)	276

TOTAL (S.F.) 276.00

OTHER ITEMS

35 **ROADSIDE CLEANUP - 7480**

TOTAL (L.S.) 1.00

36 **SPCC PLAN - 7736**

TOTAL (L.S.) 1.00

37 **STRUCTURE SURVEYING - 7037**

Channel Surveying, Retaining Wall Survey

TOTAL (L.S.) 1.00

38 **ROADWAY SURVEYING - 7038**

Roadway Surveying

TOTAL (L.S.) 1.00

39 **SHORING - 7007**

Note: One wall per trench for River Retaining Wall
Two shoring walls needed for Flooding Retaining Walls

Length of Wall Section (LF)	Height of Wall (ft)	Depth to Bedrock (ft)	Wall(s) (S.F.)

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN
THE ITEM HAS BEEN CHANGED.
DELETE THIS NOTE.

HMA (Hot Mixed Asphalt) QUANTITY CALCULATIONS

PROJECT: **US 2, Wenatchee River - Alternative 2**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/17/2008

BEGIN MP	END MP	HMA LENGTH FEET	HMA WIDTH FEET	HMA AREA SF	HMA DEPTH FEET	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL	# OF LANES	# OF LIFTS
MAINLINE PAVING													
	Site 1	0.00	0.0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	2	0
	Site 3	0.00	34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Site 7	0.00	34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Site 9	0.00	34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Flooding Area - Site 2	1100.00	34.0	37400.00	0.5	1419.81	1434.01	4155.56	0.21	3300.00	2200.00	2	2.5
	Flooding Area- Site5	1000.00	34.0	34000.00	0.5	1290.74	1303.65	3777.78	0.19	3000.00	2000.00	2	2.5
BRIDGE END PAVING													

MAINLINE PAVING	2,710.56	2,737.66	7,933.33	0.40	6,300.00	4,200.00
BRIDGE END PAVING	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	2,710.56	2,737.66	7,933.33	0.40	6,300.00	4,200.00
ROUNDED TOTALS FOR ESTIMATE	**2,700.00**	**2,700.00**	**8,000.00**	**0.40**	**6,300.00**	**4,200.00**

Washington State Department of Transportation

G:\ENGINEERING\PE201\PROJECTS\SR??\SCOPING\

CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 5**
Proposed roadway area would be raised (w/ retaining walls) to prevent flooding.

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.

AS OF DATE: 4/17/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
PREPARATION						
1	MOBILIZATION	0001	L.S.	10.00%	1.00	$152,211.26
2	CLEARING AND GRUBBING	0025	ACRE	$6,600.00	0.00	$0.00
3	REMOVING GUARDRAIL	0170	L.F.	$5.00	1,000.00	$5,000.00
4	REMOVE GUARDRAIL ANCHOR	0182	EACH	$360.00	2.00	$720.00
5	REMOVE GUIDEPOSTS	0185	EACH	$6.00	166.00	$996.00
GRADING						
6	ROADWAY EXCAVATION INLC. HAUL	0310	C.Y.	$6.00	2,500.00	$15,000.00
7	COMMON BORROW INCL. HAUL	0405	C.Y.	$7.00	4,030	$28,210.00
8	EMBANKMENT COMPACTION	0470	C.Y.	$4.00	8,060	$32,240.00
DRAINAGE						
9	STREAMBED BOULDER	1097	EACH	$3,000.00	0.00	$0.00
10	CHANNEL EXCAVATION	1035	C.Y.	$30.00	0.00	$0.00
11	HEAVY LOOSE RIPRAP	1076	C.Y.	$100.00	0.00	$0.00
LIQUID ASPHALT						
12	ANTI-STRIPPING ADDITIVE (0.5*(HMA Tons+ ATB Tons)	5334	EST.	$650.00	1.00	$650.00
HOT MIX ASPHALT						
13	PLANING BITUMINOUS PAVEMENT	5711	S.Y.	$1.25	3,800.00	$4,750.00
14	HMA CL.1/2" PG 64-28 Depth: 0.50'	5767	TON	$65.00	1,300.00	$84,500.00
15	JOB MIX COMPLIANCE PRICE ADJUSTMENT (0.03*$HMA Total)	5830	EST.	$2,535.00	1.00	$2,535.00
16	COMPACTION PRICE ADJUSTMENT (0.02*($HMA)	5835	EST.	$1,690.00	1.00	$1,690.00
EROSION CONTROL AND PLANTING						
17	ESC LEAD	6403	DAY	$200.00	6.00	$1,200.00
18	SILT FENCE	6373	L.F.	$4.00	1,500	$6,000.00
19	WATER POLLUTION/EROSION CONTROL	6490	EST.	$191,400.00	0.00	$0.00
TRAFFIC						
20	RAISING EXISTING BEAM GUARDRAIL	6783	L.F.	$4.00	1,000.00	$4,000.00
21	TRUCK MOUNTED IMPACT ATTENUATOR	7447	EACH	$7,500.00	1.00	$7,500.00
22	OPERATION OF TRUCK MOUNTED IMPACT ATTENUATO	7449	HR	$30.00	20.00	$600.00
23	REPAIR T.M. IMPACT ATTENUATOR	7450	EACH	$2,500.00	1.00	$2,500.00
24	FLEXIBLE GUIDE POST	6832	EACH	$28.00	166.00	$4,648.00
25	PAINT LINE	6806	L.F.	$2.00	3,000.00	$6,000.00
26	RECESSED PAVEMENT MARKER	6889	HUND.	$265.00	6.00	$1,590.00
27	TEMPORARY PAVEMENT MARKING	6888	L.F.	$0.50	2,000.00	$1,000.00
28	PORTABLE CHANGEABLE MESSAGE SIGN	6994	EACH	$5,500.00	2.00	$11,000.00
29	OPERATION OF PORTABLE CHANGEABLE MESSAGE SI(	6995	HR	$2.50	2,400.00	$6,000.00
30	PROJECT TEMPORARY TRAFFIC CONTROL	6971	L.S.	5.00%	1.00	$72,481.55
31	FLAGGERS AND SPOTTERS	6980	HR	$57.00	300.00	$17,100.00
32	TRAFFIC CONTROL VEHICLE	6968	DAY	$100.00	10.00	$1,000.00
33	TRAFFIC CONTROL SUPERVISOR	6974	HOUR	$50.00	150.00	$7,500.00
34	CONSTRUCTION SIGNS CLASS A	6982	S.F.	$12.00	276.00	$3,312.00
OTHER ITEMS						
35	ROADSIDE CLEANUP	7480	L.S.	$2,000.00	1.00	$2,000.00
36	SPCC PLAN	7736	L.S.	$1,000.00	1.00	$1,000.00
37	STRUCTURE SURVEYING	7037	L.S.	$5,000.00	1.00	$5,000.00
38	ROADWAY SURVEYING	7038	L.S.	$5,000.00	1.00	$5,000.00
39	SHORING	7007	S.F.	$2.00	26,400.00	$52,800.00
40	BACKFILL FOR ROCK WALL	7167	TON	$35.00	5,750.00	$201,250.00
41	SHOTCRETE FACING (GROUTING RIPRAP)	7561	S.F.	$20.00	0.00	$0.00
STRUCTURE						
42	ST. REIN. BAR FOR RETAINING WALL	4150	LB	$2.00	47,670.00	$95,340.00
43	CONC. CLASS 4000 FOR RETAINING WALL	4139	C.Y.	$1,000.00	830.00	$830,000.00

MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR	1.00%	$16,743.24
CONSTRUCTION TOTAL		$1,691,067.04
SALES TAX	8.00%	$135,285.36
SUB TOTAL		$1,826,352.41
CONSTRUCTION ENGINEERING (CE)	15%	$273,952.86
CONTINGENCIES	4%	$73,054.10
CN		**$2,173,359.36**
RW		$0.00
Mitigation Costs		$0.00
PE	24%	$521,606.25
PROJECT TOTAL		**$2,694,965.61**

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

SCOPING ESTIMATE - SUMMARY

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 5**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/18/2008

PREPARATION

1 MOBILIZATION - 0001

Note: Mobilization is a percentage of the pre-total. (See Estimate Tab)

2 CLEARING AND GRUBBING - 0025

Total	0.0000

TOTAL (ACRE)	0.00

3 REMOVING GUARDRAIL - 0170

Note: Flooding Areas include 200' (LF) transitions on both ends

	Length (LF)
Flooding Area Site 5	1000
Total	1000

TOTAL (LF)	1000.00

4 REMOVE GUARDRAIL ANCHOR - 0182

Mp	Lt/Rt	Qty.

Note: Assume the each length has one on each end (1x2 = 2)

TOTAL (EA)	2.00

5 **REMOVE GUIDEPOSTS - 0185**

Note: Assume that the number of Guideposts to be removed equals the number to install
(See RPM-Guidepost Tab for Quantity)

TOTAL (EA)	166.00

GRADING

6 **ROADWAY EXCAVATION INCL. HAUL - 0310**

	Length(LF)	Width (LF)	Roadway Depth(LF)	Sum (C.Y.)
Flooding Area Site 5	1000	34	2	2518.518519
			Total (C.Y.)	2518.518519

TOTAL (CY)	2500.00

7 **COMMON BORROW INCL. HAUL - 0405**

Note: Ten feet added to wall heights to meet bed rock

Length of Wall (LF)	Width (LF)	Height (LF)	Sum (C.Y.)
		Total (C.Y.)	0

Note: Assume Triangular Distribution

Flooding Roadway:
Note: Assume 200' approach lengths, and 4 feet of height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard
Assume triangular approach and descent

	Approach	Flood	Road Width	Fill Needed (CF)
			Total (CY)	0.00

	Approach	Flood	Road Width	Fill Needed (CF)
Flood Area Site 5 approach	200	4	34	13600
Flood Area Site 5 decent	200	4	34	13600
			Total (CY)	1007.41

Note: Four feet height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard

	Roadway	Flood	Road Width	Fill Needed (CF)
Flood Area Site 5	600	4	34	81600
			Total (CY)	3022.22

Total of Both Sections (CY)	4029.63

TOTAL (CY)	4030.00

8 **EMBANKMENT COMPACTION - 0470**

Note: Compact base of wall and stockpile file
Total = 2 X Common Borrow Value

TOTAL (CY)	8060.00

DRAINAGE

9 **STREAMBED BOULDER - 1097**

Note: Equals the LF of channel divided by the Average Diameter

Length (LF)	Average Boulder Diameter (LF)	
Total Boulders Needed (Each)		0

TOTAL (EACH)	0.00

10 **CHANNEL EXCAVATION - 1035**

Note: Recontouring Channel and the Toe of the River Bank

Length of Channel(LF)	Width of Channel (LF)	Excavation Depth (LF)	Sum (C.Y.)
		Total (C.Y.)	0.00

TOTAL (C.Y.) 0.00

11 **HEAVY LOOSE RIPRAP - 1076**

Note: Assume that boulders (#9) are buried up to half of the diameter (4') at the toe of the reinforced wall
Assume Riprap height will be half the height of the exposed wall minus the above mentioned boulder.
Assume Riprap is a 2' diameter boulder

Wall Height Exposed (LF)	Height (LF) - Half of Wall Ht. Out of Ground minus 1/2 Boulder Dia.	Height (LF)	Length (LF)	Sum (C.Y.)
			Total (C.Y.)	0

Height (LF) - From the Roadway to the River	Height (LF) - Half of the slope height	Length (LF)	Sum (C.Y.)
		Total (C.Y.)	0

TOTAL (C.Y.) 0.00

LIQUID ASPHALT

12 **ANTI-STRIPPING ADDITIVE - 5334**

(0.5*(HMA))

TOTAL (EST.) 650.00

HOT MIX ASPHALT

13 **PLANING BITUMINOUS PAVEMENT - 5711**

See the HMA section of this excel file for quantity calculations.

TOTAL (SY) 3,800.00

14 **HMA CL. 1/2" PG 64-28 - 5767**

See the HMA section of this excel file for quantity calculations.

TOTAL (TON) 1,300.00

15 **JOB MIX COMPLIANCE PRICE ADJUSTMENT - 5830**

(0.03*$HMA)

TOTAL (EST.) See Estimate

16 **COMPACTION PRICE ADJUSTMENT - 5835**

(0.02*$HMA)

TOTAL (EST.) See Estimate

EROSION CONTROL AND PLANTING

17 **ESC LEAD - 6403**

Referring to Std. Spec 8-01.3(1)B
ESC inspects at least once every 5 working days and each working day there is a runoff event.

10 working days/5 ESC days =	2	days for ESC Lead	Working Days	10
Assumed 4 rainy days	4	days for runoff event		
Total	6	days for ESC lead		

TOTAL (DAY) 6.00

18 **SILT FENCE - 6373**

Note: Equals the entire length of the project times 1.5

	Length (LF)	
Flooding Area Site 5	1000	(includes ramp up and down lengths)
Total (LF)	1000	
Total (1.5 Increase)	1500	

TOTAL (L.F.)	1500.00

19 **TEMP. WATER POLLUTION/EROSION CONTROL**

Note: Water filled berms can be reused, pricing information is for one section/set up.
Assume all set-up and installation costs are covered in the total price

One Water filled berm - stream diversion	
Length of Diversion Needed (LF)	1500
Width of Diversion Needed (2x -LF) ~20'	40
Losses for connections (2x - LF) ~12'	24
Cost for Aqua-Berm per LF	100
Total Cost for Berm $	$ 156,400.00
Dewatering Activities - (Pumping, etc.)	
Total Cost associated with Dewatering per site	$ 35,000.00
Total (EST. for One Setup)	$ 191,400.00
One Setup for Each Area	0
Moderate Hazardous Areas[1]	0
Total Setups	0

TOTAL (EST.)	0.00

[1] Since the lengths for the moderate hazardous areas are short, assume that 2 setups will cover all three areas.

TRAFFIC

Working Days = 10.00 Working Hours (10-hr days) = 100

20 **RAISING EXISTING BEAM GUARDRAIL - 6783**

	Length of Road (LF)	
Flooding Area Site 5	1000	(includes ramp up and down lengths)
Total (LF)	1000	

TOTAL (L.F.)	1,000.00

21 **TRUCK-MOUNTED IMPACT ATTENUATOR - 7447**

TOTAL (EACH)	1.00

22 **OPERATION OF TRUCK-MOUNTED IMPACT ATTENUATOR - 7449**

Note: Assume 2 ten hour days

TOTAL (HR)	20.00

23 **REPAIR TRUCK-MOUNTED IMPACT ATTENUATOR - 7450**

Note: assume the attenuator will need 1 repair.

TOTAL (EACH)	1.00

24 **FLEXIBLE GUIDEPOST - 6832**

Note: See RPM-Guidp Sheet

TOTAL (EACH)	166.00

25 **PAINT LINE - 6806**

Note: See Paint Stripe Calc on HMA tab

TOTAL (L.F.)	3,000.00

26 **RECESSED PAVEMENT MARKINGS - 6889**

Note: See RPM-Guidp Sheet

TOTAL (HUND)	6.00

27 **TEMPORARY PAVEMENT MARKINGS - 6888**

Note: See Temporary Paint on HMA tab

TOTAL (L.F.)	2,000.00

28 **PORTABLE CHANGEABLE MESSAGE SIGN - 6994**

TOTAL (EA)	2.00

29 **OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGN - 6995**

Note: Set Up 40 Days prior to Construction

Working Days	10
Prior to Construction Days	40
24 hours a day	1200
2 Signs	2
Total Hours	2400

TOTAL (HR)	2,400.00

30 **PROJECT TEMPORARY TRAFFIC CONTROL - 6971**

Item consists of Contractor furnished barricades, cones, flashers, traffic safety drums, and Cl. B signs.
Surfacing / paving require restricted roadway width or detour routing and are intensive traffic control operations.
Note: Total based on 5% of total construction costs (not including Mobilization)

TOTAL (L.S.) 1.00

31 **FLAGGERS AND SPOTTERS - 6980**

Note: Assumed 10 hr working days.
Each flagger works a 10 hr. day, and 3 laborers will be working every chargeable working day.
Assume 5 Days at the beginning, and 5 Days at the end of construction to set up Detour

Laborers	3
Working Days	10
Hours per Day	10
Total (Hours)	300

TOTAL (HR) 300.00

32 **TRAFFIC CONTROL VEHICLE - 6968**

Assume: A TCS will be on the project site every chargeable contract day.
TCS will require a vehicle to transport temporary traffic control devices and Cl. B signs.
Working Days (total) 10

TOTAL (DAY) 10.00

33 **TRAFFIC CONTROL SUPERVISOR - 6972**

Note: Assumed 10 hr working days.
Assume: The TCS will be working every chargeable contract day.
TCS often sets up and removes temporary traffic control devices / Cl. B signs. (Additional 5 days)

Chargeable Working Days	15
Working Hours per Day	10
Total (Hours)	150

TOTAL (HR) 150.00

34 **CONSTRUCTION SIGNS CLASS A - 6982**

Sign Type	Area ft^2	Qty	Total Area
Give 'Em A Brake (G28-101)	28	2	56
Road Work Ahead, 48in x 48 in (W20-1)	16	6	96
Road Work Next "X" Miles (G20-1)	10	2	20
End Road Work (G20-2a)	8	2	16
For Project Information Call XXX-XXXX (G24-501)	12	2	24
Traffic Fines Double in Work Zones (I20-301)	16	2	32
Thank You/ WSDOT-Contractor Name Sign	16	2	32
		Total (S.F.)	276

TOTAL (S.F.) 276.00

OTHER ITEMS

35 **ROADSIDE CLEANUP - 7480**

TOTAL (L.S.) 1.00

36 **SPCC PLAN - 7736**

TOTAL (L.S.) 1.00

37 **STRUCTURE SURVEYING - 7037**

Channel Surveying, Retaining Wall Survey

TOTAL (L.S.) 1.00

38 **ROADWAY SURVEYING - 7038**

Roadway Surveying

TOTAL (L.S.) 1.00

39 **SHORING - 7007**

Note: One wall per trench for River Retaining Wall
Two shoring walls needed for Flooding Retaining Walls

Length of Wall Section (LF)	Height of Wall (ft)	Depth to Bedrock (ft)	Wall(s) (S.F.)

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN
THE ITEM HAS BEEN CHANGED.
DELETE THIS NOTE.

HMA (Hot Mixed Asphalt) QUANTITY CALCULATIONS

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 5**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/17/2008

BEGIN MP	END MP	HMA LENGTH FEET	HMA WIDTH FEET	HMA AREA SF	HMA DEPTH FEET	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL	# OF LANES	# OF LIFTS
MAINLINE PAVING													
	Site 1		0.0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	2	0
	Site 3		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Site 7		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Site 9		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Flooding Area - Site 2		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Flooding Area- Site5	1000.00	34.0	34000.00	0.5	1290.74	1303.65	3777.78	0.19	3000.00	2000.00	2	2.5
BRIDGE END PAVING													

MAINLINE PAVING	1,290.74	1,303.65	3,777.78	0.19	3,000.00	2,000.00
BRIDGE END PAVING	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	1,290.74	1,303.65	3,777.78	0.19	3,000.00	2,000.00
ROUNDED TOTALS FOR ESTIMATE	**1,300.00**	**1,300.00**	**3,800.00**	**0.20**	**3,000.00**	**2,000.00**

Washington State Department of Transportation

G:\ENGINEERING\PE201\PROJECTS\SR??\SCOPING\

CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 7**

A laid back retaining wall system protected with boulders and smaller riprap toe would be constructed to prevent river undercutting. Roadway would be repaired upon rock wall completion.
Riprap would be grouted (shotcreted) together.

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.

AS OF DATE: 4/17/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
PREPARATION						
1	MOBILIZATION	0001	L.S.	10.00%	1.00	$1,664,141.75
2	CLEARING AND GRUBBING	0025	ACRE	$6,600.00	1.38	$9,108.00
3	REMOVING GUARDRAIL	0170	L.F.	$5.00	1,500.00	$7,500.00
4	REMOVE GUARDRAIL ANCHOR	0182	EACH	$360.00	2.00	$720.00
5	REMOVE GUIDEPOSTS	0185	EACH	$6.00	246.00	$1,476.00
GRADING						
6	ROADWAY EXCAVATION INLC. HAUL	0310	C.Y.	$6.00	3,800.00	$22,800.00
7	COMMON BORROW INCL. HAUL	0405	C.Y.	$7.00	22,230	$155,610.00
8	EMBANKMENT COMPACTION	0470	C.Y.	$4.00	44,460	$177,840.00
DRAINAGE						
9	STREAMBED BOULDER	1097	EACH	$3,000.00	188.00	$564,000.00
10	CHANNEL EXCAVATION	1035	C.Y.	$30.00	2,300.00	$69,000.00
11	HEAVY LOOSE RIPRAP	1076	C.Y.	$100.00	1,780.00	$178,000.00
LIQUID ASPHALT						
12	ANTI-STRIPPING ADDITIVE (0.5*(HMA Tons+ ATB Tons)	5334	EST.	$1,000.00	1.00	$1,000.00
HOT MIX ASPHALT						
13	PLANING BITUMINOUS PAVEMENT	5711	S.Y.	$1.25	5,700.00	$7,125.00
14	HMA CL.1/2" PG 64-28 Depth: 0.50'	5767	TON	$65.00	2,000.00	$130,000.00
15	JOB MIX COMPLIANCE PRICE ADJUSTMENT (0.03*$HMA Total)	5830	EST.	$3,900.00	1.00	$3,900.00
16	COMPACTION PRICE ADJUSTMENT (0.02*($HMA)	5835	EST.	$2,600.00	1.00	$2,600.00
EROSION CONTROL AND PLANTING						
17	ESC LEAD	6403	DAY	$200.00	6.00	$1,200.00
18	SILT FENCE	6373	L.F.	$4.00	2,250	$9,000.00
19	WATER POLLUTION/EROSION CONTROL	6490	EST.	$191,400.00	1.00	$191,400.00
TRAFFIC						
20	RAISING EXISTING BEAM GUARDRAIL	6783	L.F.	$4.00	1,500.00	$6,000.00
21	TRUCK MOUNTED IMPACT ATTENUATOR	7447	EACH	$7,500.00	1.00	$7,500.00
22	OPERATION OF TRUCK MOUNTED IMPACT ATTENUATO	7449	HR	$30.00	20.00	$600.00
23	REPAIR T.M. IMPACT ATTENUATOR	7450	EACH	$2,500.00	1.00	$2,500.00
24	FLEXIBLE GUIDE POST	6832	EACH	$28.00	246.00	$6,888.00
25	PAINT LINE	6806	L.F.	$2.00	4,500.00	$9,000.00
26	RECESSED PAVEMENT MARKER	6889	HUND.	$265.00	8.00	$2,120.00
27	TEMPORARY PAVEMENT MARKING	6888	L.F.	$0.50	3,000.00	$1,500.00
28	PORTABLE CHANGEABLE MESSAGE SIGN	6994	EACH	$5,500.00	2.00	$11,000.00
29	OPERATION OF PORTABLE CHANGEABLE MESSAGE SIG	6995	HR	$2.50	2,400.00	$6,000.00
30	PROJECT TEMPORARY TRAFFIC CONTROL	6971	L.S.	5.00%	1.00	$792,448.45
31	FLAGGERS AND SPOTTERS	6980	HR	$57.00	300.00	$17,100.00
32	TRAFFIC CONTROL VEHICLE	6968	DAY	$100.00	10.00	$1,000.00
33	TRAFFIC CONTROL SUPERVISOR	6974	HOUR	$50.00	150.00	$7,500.00
34	CONSTRUCTION SIGNS CLASS A	6982	S.F.	$12.00	276.00	$3,312.00
OTHER ITEMS						
35	ROADSIDE CLEANUP	7480	L.S.	$2,000.00	1.00	$2,000.00
36	SPCC PLAN	7736	L.S.	$1,000.00	1.00	$1,000.00
37	STRUCTURE SURVEYING	7037	L.S.	$5,000.00	1.00	$5,000.00
38	ROADWAY SURVEYING	7038	L.S.	$5,000.00	1.00	$5,000.00
39	SHORING	7007	S.F.	$2.00	75,000.00	$150,000.00
40	BACKFILL FOR ROCK WALL	7167	TON	$35.00	19,410.00	$679,350.00
41	SHOTCRETE FACING (GROUTING RIPRAP)	7561	S.F.	$20.00	6,000.00	$120,000.00
STRUCTURE						
42	ST. REIN. BAR FOR RETAINING WALL	4150	LB	$2.00	1,166,160.00	$2,332,320.00
43	CONC. CLASS 4000 FOR RETAINING WALL	4139	C.Y.	$1,000.00	10,940.00	$10,940,000.00

MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR	1.00%	$183,055.59
CONSTRUCTION TOTAL		$18,488,614.79
SALES TAX	8.00%	$1,479,089.18
SUB TOTAL		$19,967,703.97
CONSTRUCTION ENGINEERING (CE)	15%	$2,995,155.60
CONTINGENCIES	4%	$798,708.16
CN		**$23,761,567.72**
RW		$0.00
Mitigation Costs		$0.00
PE	24%	$5,702,776.25
PROJECT TOTAL		**$29,464,343.98**

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

SCOPING ESTIMATE - SUMMARY

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 7**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/18/2008

PREPARATION

1 MOBILIZATION - 0001

Note: Mobilization is a percentage of the pre-total. (See Estimate Tab)

2 CLEARING AND GRUBBING - 0025

	Site 7
Length (LF)	1500
Slope Length (LF)	40
Total (Acres)	1.37741047
Total	1.3774

TOTAL (ACRE)	1.38

3 REMOVING GUARDRAIL - 0170

Note: Flooding Areas include 200' (LF) transitions on both ends

	Length (LF)
Site 7	1500
Total	1500

TOTAL (LF)	1500.00

4 REMOVE GUARDRAIL ANCHOR - 0182

Mp	Lt/Rt	Qty.

Note: Assume the each length has one on each end (1x2 = 2)

TOTAL (EA)	2.00

5 **REMOVE GUIDEPOSTS - 0185**

Note: Assume that the number of Guideposts to be removed equals the number to install
(See RPM-Guidepost Tab for Quantity)

TOTAL (EA) 246.00

GRADING

6 **ROADWAY EXCAVATION INCL. HAUL - 0310**

	Length(LF)	Width (LF)	Roadway Depth(LF)	Sum (C.Y.)
Site 7	1500	34	2	3777.777778
			Total (C.Y.)	3777.777778

TOTAL (CY) 3800.00

7 **COMMON BORROW INCL. HAUL - 0405**

Note: Ten feet added to wall heights to meet bed rock

	Length of Wall (LF)	Width (LF)	Height (LF)	Sum (C.Y.)
Site 7	1500	8	50	22222.22222

Total (C.Y.) 22222.22222

Note: Assume Triangular Distribution

Flooding Roadway:
Note: Assume 200' approach lengths, and 4 feet of height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard
Assume triangular approach and descent

Total of Both Sections (CY) 0.00

TOTAL (CY) 22230.00

8 **EMBANKMENT COMPACTION - 0470**

Note: Compact base of wall and stockpile file
Total = 2 X Common Borrow Value

TOTAL (CY) 44460.00

DRAINAGE

9 **STREAMBED BOULDER - 1097**

Note: Equals the LF of channel divided by the Average Diameter

	Length (LF)	Average Boulder Diameter (LF)	
Site 7	1500	8	187.5
		Total Boulders Needed (Each)	187.5

TOTAL (EACH) 188.00

10 **CHANNEL EXCAVATION - 1035**

Note: Recontouring Channel and the Toe of the River Bank

	Length of Channel(LF)	Width of Channel (LF)	Excavation Depth (LF)	Sum (C.Y.)
Site 7	1,500	10	4	2222.22
			Total (C.Y.)	2222.22

TOTAL (C.Y.) 2300.00

11 **HEAVY LOOSE RIPRAP - 1076**

Note: Assume that boulders (#9) are buried up to half of the diameter (4') at the toe of the reinforced wall
Assume Riprap height will be half the height of the exposed wall minus the above mentioned boulder.
Assume Riprap is a 2' diameter boulder

	Wall Height Exposed (LF)	Height (LF) - Half of Wall Ht. Out of Ground minus 1/2 Boulder Dia.	Height (LF)	Length (LF)	Sum (C.Y.)
Site 7	40	16	16	1,500	1777.777778
				Total (C.Y.)	1777.777778

	Height (LF) - From the Roadway to the River	Height (LF) - Half of the slope height	Length (LF)	Sum (C.Y.)
			Total (C.Y.)	0

TOTAL (C.Y.) 1,780.00

LIQUID ASPHALT

12 **ANTI-STRIPPING ADDITIVE - 5334**

(0.5*(HMA))

TOTAL (EST.) 1000.00

HOT MIX ASPHALT

13 **PLANING BITUMINOUS PAVEMENT - 5711**

See the HMA section of this excel file for quantity calculations.

TOTAL (SY) 5,700.00

14 **HMA CL. 1/2" PG 64-28 - 5767**

See the HMA section of this excel file for quantity calculations.

TOTAL (TON) 2,000.00

15 **JOB MIX COMPLIANCE PRICE ADJUSTMENT - 5830**

(0.03*$HMA)

TOTAL (EST.) See Estimate

16 **COMPACTION PRICE ADJUSTMENT - 5835**

(0.02*$HMA)

TOTAL (EST.) See Estimate

EROSION CONTROL AND PLANTING

17 **ESC LEAD - 6403**

Referring to Std. Spec 8-01.3(1)B

ESC inspects at least once every 5 working days and each working day there is a runoff event.

10 working days/5 ESC days =	2	days for ESC Lead	Working Days	10
Assumed 4 rainy days	4	days for runoff event		
Total	6	days for ESC lead		

TOTAL (DAY) 6.00

18 **SILT FENCE - 6373**

Note: Equals the entire length of the project times 1.5

	Length (LF)
Site 7	1500
Total (LF)	1500
Total (1.5 Increase)	2250

TOTAL (L.F.) 2250.00

19 **TEMP. WATER POLLUTION/EROSION CONTROL**

Note: Water filled berms can be reused, pricing information is for one section/set up.

Assume all set-up and installation costs are covered in the total price

One Water filled berm - stream diversion	
Length of Diversion Needed (LF)	1500
Width of Diversion Needed (2x -LF) ~20'	40
Losses for connections (2x - LF) ~12'	24

Cost for Aqua-Berm per LF	100
Total Cost for Berm $	$ 156,400.00
Dewatering Activities - (Pumping, etc.)	
Total Cost associated with Dewatering per site	$ 35,000.00
Total (EST. for One Setup)	$ 191,400.00
One Setup for Each Area	1
	0
Total Setups	1

TOTAL (EST.) 1.00

TRAFFIC

Working Days = 10.00 Working Hours (10-hr days) = 100

20 RAISING EXISTING BEAM GUARDRAIL - 6783

	Length of Road (LF)
Site 7	1500
Total (LF)	1500

TOTAL (L.F.) 1,500.00

21 TRUCK-MOUNTED IMPACT ATTENUATOR - 7447

TOTAL (EACH) 1.00

22 OPERATION OF TRUCK-MOUNTED IMPACT ATTENUATOR - 7449

Note: Assume 2 ten hour days

TOTAL (HR) 20.00

23 REPAIR TRUCK-MOUNTED IMPACT ATTENUATOR - 7450

Note: assume the attenuator will need 1 repair.

TOTAL (EACH) 1.00

24 FLEXIBLE GUIDEPOST - 6832

Note: See RPM-Guidp Sheet

TOTAL (EACH) 246.00

25 PAINT LINE - 6806

Note: See Paint Stripe Calc on HMA tab

TOTAL (L.F.) 4,500.00

26 RECESSED PAVEMENT MARKINGS - 6889

Note: See RPM-Guidp Sheet

TOTAL (HUND) 8.00

27 TEMPORARY PAVEMENT MARKINGS - 6888

Note: See Temporary Paint on HMA tab

TOTAL (L.F.) 3,000.00

28 PORTABLE CHANGEABLE MESSAGE SIGN - 6994

TOTAL (EA) 2.00

29 OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGN - 6995

Note: Set Up 40 Days prior to Construction

Working Days	10
Prior to Construction Days	40
24 hours a day	1200
2 Signs	2
Total Hours	2400

TOTAL (HR) 2,400.00

30 PROJECT TEMPORARY TRAFFIC CONTROL - 6971

Item consists of Contractor furnished barricades, cones, flashers, traffic safety drums, and Cl. B signs.
Surfacing / paving require restricted roadway width or detour routing and are intensive traffic control operations.
Note: Total based on 5% of total construction costs (not including Mobilization)

TOTAL (L.S.) 1.00

31 FLAGGERS AND SPOTTERS - 6980

Note: Assumed 10 hr working days.
Each flagger works a 10 hr. day, and 3 laborers will be working every chargeable working day.
Assume 5 Days at the beginning, and 5 Days at the end of construction to set up Detour

Laborers	3
Working Days	10
Hours per Day	10
Total (Hours)	300

TOTAL (HR) 300.00

32 **TRAFFIC CONTROL VEHICLE - 6968**

Assume: A TCS will be on the project site every chargeable contract day.
TCS will require a vehicle to transport temporary traffic control devices and Cl. B signs.
Working Days (total) 10

TOTAL (DAY) 10.00

33 **TRAFFIC CONTROL SUPERVISOR - 6972**

Note: Assumed 10 hr working days.
Assume: The TCS will be working every chargeable contract day.
TCS often sets up and removes temporary traffic control devices / Cl. B signs. (Additional 5 days)

Chargeable Working Days	15
Working Hours per Day	10
Total (Hours)	150

TOTAL (HR) 150.00

34 **CONSTRUCTION SIGNS CLASS A - 6982**

Sign Type	Area ft^2	Qty	Total Area
Give 'Em A Brake (G28-101)	28	2	56
Road Work Ahead, 48in x 48 in (W20-1)	16	6	96
Road Work Next "X" Miles (G20-1)	10	2	20
End Road Work (G20-2a)	8	2	16
For Project Information Call XXX-XXXX (G24-501)	12	2	24
Traffic Fines Double in Work Zones (I20-301)	16	2	32
Thank You/ WSDOT-Contractor Name Sign	16	2	32
		Total (S.F.)	276

TOTAL (S.F.) 276.00

OTHER ITEMS

35 **ROADSIDE CLEANUP - 7480**

TOTAL (L.S.) 1.00

36 **SPCC PLAN - 7736**

TOTAL (L.S.) 1.00

37 **STRUCTURE SURVEYING - 7037**

Channel Surveying, Retaining Wall Survey

TOTAL (L.S.) 1.00

38 **ROADWAY SURVEYING - 7038**

Roadway Surveying

TOTAL (L.S.) 1.00

39 **SHORING - 7007**

Note: One wall per trench for River Retaining Wall
Two shoring walls needed for Flooding Retaining Walls

Length of Wall Section (LF)	Height of Wall (ft)	Depth to Bedrock (ft)	Wall(s) (S.F.)

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN
THE ITEM HAS BEEN CHANGED.
DELETE THIS NOTE.

HMA (Hot Mixed Asphalt) QUANTITY CALCULATIONS

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 7**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/17/2008

BEGIN MP	END MP	HMA LENGTH FEET	HMA WIDTH FEET	HMA AREA SF	HMA DEPTH FEET	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL	# OF LANES	# OF LIFTS
MAINLINE PAVING													
	Site 1		0.0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	2	0
	Site 3		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Site 7	1500.00	34.0	51000.00	0.5	1936.11	1955.47	5666.67	0.28	4500.00	3000.00	2	2.5
	Site 9		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Flooding Area - Site 2		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Flooding Area- Site5		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
BRIDGE END PAVING													

MAINLINE PAVING	1,936.11	1,955.47	5,666.67	0.28	4,500.00	3,000.00
BRIDGE END PAVING	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	1,936.11	1,955.47	5,666.67	0.28	4,500.00	3,000.00
ROUNDED TOTALS FOR ESTIMATE	**1,900.00**	**2,000.00**	**5,700.00**	**0.30**	**4,500.00**	**3,000.00**

Washington State Department of Transportation

G:\ENGINEERING\PE201\PROJECTS\SR??\SCOPING\

CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 9**

A laid back retaining wall system protected with boulders and smaller riprap toe would be constructed to prevent river undercutting. Roadway would be repaired upon rock wall completion.
Riprap would be grouted (shotcreted) together.

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.

AS OF DATE: 4/17/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
PREPARATION						
1	MOBILIZATION	0001	L.S.	10.00%	1.00	$877,034.87
2	CLEARING AND GRUBBING	0025	ACRE	$6,600.00	0.92	$6,072.00
3	REMOVING GUARDRAIL	0170	L.F.	$5.00	1,000.00	$5,000.00
4	REMOVE GUARDRAIL ANCHOR	0182	EACH	$360.00	2.00	$720.00
5	REMOVE GUIDEPOSTS	0185	EACH	$6.00	166.00	$996.00
GRADING						
6	ROADWAY EXCAVATION INLC. HAUL	0310	C.Y.	$6.00	2,500.00	$15,000.00
7	COMMON BORROW INCL. HAUL	0405	C.Y.	$7.00	21,930	$153,510.00
8	EMBANKMENT COMPACTION	0470	C.Y.	$4.00	43,860	$175,440.00
DRAINAGE						
9	STREAMBED BOULDER	1097	EACH	$3,000.00	125.00	$375,000.00
10	CHANNEL EXCAVATION	1035	C.Y.	$30.00	1,500.00	$45,000.00
11	HEAVY LOOSE RIPRAP	1076	C.Y.	$100.00	710.00	$71,000.00
LIQUID ASPHALT						
12	ANTI-STRIPPING ADDITIVE (0.5*(HMA Tons+ ATB Tons)	5334	EST.	$650.00	1.00	$650.00
HOT MIX ASPHALT						
13	PLANING BITUMINOUS PAVEMENT	5711	S.Y.	$1.25	3,800.00	$4,750.00
14	HMA CL.1/2" PG 64-28 Depth: 0.50'	5767	TON	$65.00	1,300.00	$84,500.00
15	JOB MIX COMPLIANCE PRICE ADJUSTMENT (0.03*$HMA Total)	5830	EST.	$2,535.00	1.00	$2,535.00
16	COMPACTION PRICE ADJUSTMENT (0.02*($HMA)	5835	EST.	$1,690.00	1.00	$1,690.00
EROSION CONTROL AND PLANTING						
17	ESC LEAD	6403	DAY	$200.00	6.00	$1,200.00
18	SILT FENCE	6373	L.F.	$4.00	1,500	$6,000.00
19	WATER POLLUTION/EROSION CONTROL	6490	EST.	$191,400.00	1.00	$191,400.00
TRAFFIC						
20	RAISING EXISTING BEAM GUARDRAIL	6783	L.F.	$4.00	1,000.00	$4,000.00
21	TRUCK MOUNTED IMPACT ATTENUATOR	7447	EACH	$7,500.00	1.00	$7,500.00
22	OPERATION OF TRUCK MOUNTED IMPACT ATTENUATO	7449	HR	$30.00	20.00	$600.00
23	REPAIR T.M. IMPACT ATTENUATOR	7450	EACH	$2,500.00	1.00	$2,500.00
24	FLEXIBLE GUIDE POST	6832	EACH	$28.00	166.00	$4,648.00
25	PAINT LINE	6806	L.F.	$2.00	3,000.00	$6,000.00
26	RECESSED PAVEMENT MARKER	6889	HUND.	$265.00	6.00	$1,590.00
27	TEMPORARY PAVEMENT MARKING	6888	L.F.	$0.50	2,000.00	$1,000.00
28	PORTABLE CHANGEABLE MESSAGE SIGN	6994	EACH	$5,500.00	2.00	$11,000.00
29	OPERATION OF PORTABLE CHANGEABLE MESSAGE SIG	6995	HR	$2.50	2,400.00	$6,000.00
30	PROJECT TEMPORARY TRAFFIC CONTROL	6971	L.S.	5.00%	1.00	$417,635.65
31	FLAGGERS AND SPOTTERS	6980	HR	$57.00	300.00	$17,100.00
32	TRAFFIC CONTROL VEHICLE	6968	DAY	$100.00	10.00	$1,000.00
33	TRAFFIC CONTROL SUPERVISOR	6974	HOUR	$50.00	150.00	$7,500.00
34	CONSTRUCTION SIGNS CLASS A	6982	S.F.	$12.00	276.00	$3,312.00
OTHER ITEMS						
35	ROADSIDE CLEANUP	7480	L.S.	$2,000.00	1.00	$2,000.00
36	SPCC PLAN	7736	L.S.	$1,000.00	1.00	$1,000.00
37	STRUCTURE SURVEYING	7037	L.S.	$5,000.00	1.00	$5,000.00
38	ROADWAY SURVEYING	7038	L.S.	$5,000.00	1.00	$5,000.00
39	SHORING	7007	S.F.	$2.00	37,000.00	$74,000.00
40	BACKFILL FOR ROCK WALL	7167	TON	$35.00	12,940.00	$452,900.00
41	SHOTCRETE FACING (GROUTING RIPRAP)	7561	S.F.	$20.00	2,400.00	$48,000.00
STRUCTURE						
42	ST. REIN. BAR FOR RETAINING WALL	4150	LB	$2.00	575,300.00	$1,150,600.00
43	CONC. CLASS 4000 FOR RETAINING WALL	4139	C.Y.	$1,000.00	5,400.00	$5,400,000.00

MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR	1.00%	$96,473.84
CONSTRUCTION TOTAL		$9,743,857.35
SALES TAX	8.00%	$779,508.59
SUB TOTAL		$10,523,365.94
CONSTRUCTION ENGINEERING (CE)	15%	$1,578,504.89
CONTINGENCIES	4%	$420,934.64
CN		**$12,522,805.47**
RW		$0.00
Mitigation Costs		$0.00
PE	24%	$3,005,473.31
PROJECT TOTAL		**$15,528,278.78**

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

SCOPING ESTIMATE - SUMMARY

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 9**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/18/2008

PREPARATION

1 MOBILIZATION - 0001

Note: Mobilization is a percentage of the pre-total. (See Estimate Tab)

2 CLEARING AND GRUBBING - 0025

	Site 9
Length (LF)	1000
Slope Length (LF)	40
Total (Acres)	0.91827365
Total	0.9183

TOTAL (ACRE)	0.92

3 REMOVING GUARDRAIL - 0170

Note: Flooding Areas include 200' (LF) transitions on both ends

	Length (LF)
Site 9	1000
Total	1000

TOTAL (LF)	1000.00

4 REMOVE GUARDRAIL ANCHOR - 0182

Mp	Lt/Rt	Qty.

Note: Assume the each length has one on each end (1x2 = 2)

TOTAL (EA)	2.00

5 **REMOVE GUIDEPOSTS - 0185**

Note: Assume that the number of Guideposts to be removed equals the number to install
(See RPM-Guidepost Tab for Quantity)

TOTAL (EA) 166.00

GRADING

6 **ROADWAY EXCAVATION INCL. HAUL - 0310**

	Length(LF)	Width (LF)	Roadway Depth(LF)	Sum (C.Y.)
Site 9	1000	34	2	2518.518519
			Total (C.Y.)	2518.518519

TOTAL (CY) 2500.00

7 **COMMON BORROW INCL. HAUL - 0405**

Note: Ten feet added to wall heights to meet bed rock

	Length of Wall (LF)	Width (LF)	Height (LF)	Sum (C.Y.)
Site 9	1000	8	37	10962.96296
			Total (C.Y.)	10962.96296

Note: Assume Triangular Distribution

Flooding Roadway:
Note: Assume 200' approach lengths, and 4 feet of height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard
Assume triangular approach and descent

Total (CY)	0.00
Total of Both Sections (CY)	10962.96

TOTAL (CY) 21930.00

8 **EMBANKMENT COMPACTION - 0470**

Note: Compact base of wall and stockpile file
Total = 2 X Common Borrow Value

TOTAL (CY) 43860.00

DRAINAGE

9 **STREAMBED BOULDER - 1097**

Note: Equals the LF of channel divided by the Average Diameter

	Length (LF)	Average Boulder Diameter (LF)	
Site 9	1000	8	125
		Total Boulders Needed (Each)	125

TOTAL (EACH) 125.00

10 **CHANNEL EXCAVATION - 1035**

Note: Recontouring Channel and the Toe of the River Bank

	Length of Channel(LF)	Width of Channel (LF)	Excavation Depth (LF)	Sum (C.Y.)
Site 9	1,000	10	4	1481.48
			Total (C.Y.)	1481.48

TOTAL (C.Y.) 1500.00

11 **HEAVY LOOSE RIPRAP - 1076**

Note: Assume that boulders (#9) are buried up to half of the diameter (4') at the toe of the reinforced wall
Assume Riprap height will be half the height of the exposed wall minus the above mentioned boulder.
Assume Riprap is a 2' diameter boulder

	Wall Height Exposed (LF)	Height (LF) - Half of Wall Ht. Out of Ground minus 1/2 Boulder Dia.	Height (LF)	Length (LF)	Sum (C.Y.)
Site 9	27	9.5	9.5	1,000	703.7037037
				Total (C.Y.)	703.7037037

	Height (LF) - From the Roadway to the River	Height (LF) - Half of the slope height	Length (LF)	Sum (C.Y.)
			Total (C.Y.)	0

TOTAL (C.Y.) 710.00

LIQUID ASPHALT

12 **ANTI-STRIPPING ADDITIVE - 5334**

(0.5*(HMA))

TOTAL (EST.) 650.00

HOT MIX ASPHALT

13 **PLANING BITUMINOUS PAVEMENT - 5711**

See the HMA section of this excel file for quantity calculations.

TOTAL (SY) 3,800.00

14 **HMA CL. 1/2" PG 64-28 - 5767**

See the HMA section of this excel file for quantity calculations.

TOTAL (TON) 1,300.00

15 **JOB MIX COMPLIANCE PRICE ADJUSTMENT - 5830**

(0.03*$HMA)

TOTAL (EST.) See Estimate

16 **COMPACTION PRICE ADJUSTMENT - 5835**

(0.02*$HMA)

TOTAL (EST.) See Estimate

EROSION CONTROL AND PLANTING

17 **ESC LEAD - 6403**

Referring to Std. Spec 8-01.3(1)B

ESC inspects at least once every 5 working days and each working day there is a runoff event.

10 working days/5 ESC days =	2	days for ESC Lead	Working Days	10
Assumed 4 rainy days	4	days for runoff event		
Total	6	days for ESC lead		

TOTAL (DAY) 6.00

18 **SILT FENCE - 6373**

Note: Equals the entire length of the project times 1.5

	Length (LF)
Site 9	1000
Total (LF)	1000
Total (1.5 Increase)	1500

TOTAL (L.F.) 1500.00

19 **TEMP. WATER POLLUTION/EROSION CONTROL**

Note: Water filled berms can be reused, pricing information is for one section/set up.

Assume all set-up and installation costs are covered in the total price

One Water filled berm - stream diversion	
Length of Diversion Needed (LF)	1500
Width of Diversion Needed (2x -LF) ~20'	40
Losses for connections (2x - LF) ~12'	24
Cost for Aqua-Berm per LF	100

Total Cost for Berm $	$ 156,400.00
Dewatering Activities - (Pumping, etc.)	
Total Cost associated with Dewatering per site	$ 35,000.00
Total (EST. for One Setup)	$ 191,400.00
One Setup for Each Area	1
Total Setups	1

TOTAL (EST.) 1.00

TRAFFIC

Working Days = 10.00 Working Hours (10-hr days) = 100

20 RAISING EXISTING BEAM GUARDRAIL - 6783

	Length of Road (LF)
Site 9	1000
Total (LF)	1000

TOTAL (L.F.) 1,000.00

21 TRUCK-MOUNTED IMPACT ATTENUATOR - 7447

TOTAL (EACH) 1.00

22 OPERATION OF TRUCK-MOUNTED IMPACT ATTENUATOR - 7449

Note: Assume 2 ten hour days

TOTAL (HR) 20.00

23 REPAIR TRUCK-MOUNTED IMPACT ATTENUATOR - 7450

Note: assume the attenuator will need 1 repair.

TOTAL (EACH) 1.00

24 FLEXIBLE GUIDEPOST - 6832

Note: See RPM-Guidp Sheet

TOTAL (EACH) 166.00

25 PAINT LINE - 6806

Note: See Paint Stripe Calc on HMA tab

TOTAL (L.F.) 3,000.00

26 RECESSED PAVEMENT MARKINGS - 6889

Note: See RPM-Guidp Sheet

TOTAL (HUND) 6.00

27 TEMPORARY PAVEMENT MARKINGS - 6888

Note: See Temporary Paint on HMA tab

TOTAL (L.F.) 2,000.00

28 PORTABLE CHANGEABLE MESSAGE SIGN - 6994

TOTAL (EA) 2.00

29 OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGN - 6995

Note: Set Up 40 Days prior to Construction

Working Days	10
Prior to Construction Days	40
24 hours a day	1200
2 Signs	2
Total Hours	2400

TOTAL (HR) 2,400.00

30 PROJECT TEMPORARY TRAFFIC CONTROL - 6971

Item consists of Contractor furnished barricades, cones, flashers, traffic safety drums, and Cl. B signs.
Surfacing / paving require restricted roadway width or detour routing and are intensive traffic control operations.
Note: Total based on 5% of total construction costs (not including Mobilization)

TOTAL (L.S.) 1.00

31 FLAGGERS AND SPOTTERS - 6980

Note: Assumed 10 hr working days.
Each flagger works a 10 hr. day, and 3 laborers will be working every chargeable working day.
Assume 5 Days at the beginning, and 5 Days at the end of construction to set up Detour

Laborers	3

Working Days	10
Hours per Day	10
Total (Hours)	300

TOTAL (HR) 300.00

32 **TRAFFIC CONTROL VEHICLE - 6968**

Assume: A TCS will be on the project site every chargeable contract day.
TCS will require a vehicle to transport temporary traffic control devices and Cl. B signs.
Working Days (total) 10

TOTAL (DAY) 10.00

33 **TRAFFIC CONTROL SUPERVISOR - 6972**

Note: Assumed 10 hr working days.
Assume: The TCS will be working every chargeable contract day.
TCS often sets up and removes temporary traffic control devices / Cl. B signs. (Additional 5 days)

Chargeable Working Days	15
Working Hours per Day	10
Total (Hours)	150

TOTAL (HR) 150.00

34 **CONSTRUCTION SIGNS CLASS A - 6982**

Sign Type	Area ft^2	Qty	Total Area
Give 'Em A Brake (G28-101)	28	2	56
Road Work Ahead, 48in x 48 in (W20-1)	16	6	96
Road Work Next "X" Miles (G20-1)	10	2	20
End Road Work (G20-2a)	8	2	16
For Project Information Call XXX-XXXX (G24-501)	12	2	24
Traffic Fines Double in Work Zones (I20-301)	16	2	32
Thank You/ WSDOT-Contractor Name Sign	16	2	32
		Total (S.F.)	276

TOTAL (S.F.) 276.00

OTHER ITEMS

35 **ROADSIDE CLEANUP - 7480**

TOTAL (L.S.) 1.00

36 **SPCC PLAN - 7736**

TOTAL (L.S.) 1.00

37 **STRUCTURE SURVEYING - 7037**

Channel Surveying, Retaining Wall Survey

TOTAL (L.S.) 1.00

38 **ROADWAY SURVEYING - 7038**

Roadway Surveying

TOTAL (L.S.) 1.00

39 **SHORING - 7007**

Note: One wall per trench for River Retaining Wall
Two shoring walls needed for Flooding Retaining Walls

Length of Wall Section (LF)	Height of Wall (ft)	Depth to Bedrock (ft)	Wall(s) (S.F.)

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN
THE ITEM HAS BEEN CHANGED.
DELETE THIS NOTE.

HMA (Hot Mixed Asphalt) QUANTITY CALCULATIONS

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 9**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/17/2008

BEGIN MP	END MP	HMA LENGTH FEET	HMA WIDTH FEET	HMA AREA SF	HMA DEPTH FEET	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL	# OF LANES	# OF LIFTS
MAINLINE PAVING													
			0.0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	2	0
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Site 4	1000.00	34.0	34000.00	0.5	1290.74	1303.65	3777.78	0.19	3000.00	2000.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
BRIDGE END PAVING													

MAINLINE PAVING	1,290.74	1,303.65	3,777.78	0.19	3,000.00	2,000.00
BRIDGE END PAVING	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	1,290.74	1,303.65	3,777.78	0.19	3,000.00	2,000.00
ROUNDED TOTALS FOR ESTIMATE	**1,300.00**	**1,300.00**	**3,800.00**	**0.20**	**3,000.00**	**2,000.00**

Executive Summary Alternative 1

Roadway Stabilization – US 2
MP 94.00-98.10

By: ENTRIX, Inc. Date 4/17/2008

PROJECT SYNOPSIS:

DESCRIPTION OF EXISTING CONDITIONS:

Currently US Highway 2 runs along the Wenatchee River in the north central region of Washington State. Two historical high water events (November 25, 1990 and November 30, 1995) caused embankment erosion and roadway failure. Pre-emptive repairs were also made during the 2006 fall/winter season to prevent complete roadway failure. High water levels in the river undercut staged riprap that holds the toe of the roadway embankments. Since 1990, the State has spent a little more than $4 million dollars on repairs and maintenance in this troublesome area.

PURPOSE OF PROJECT:

The purpose of this project is to increase roadway durability/reliability along US Highway 2 in this area associated with river washout. Additionally two locations will raise the existing roadway to prevent sheet flow flooding across the roadway.

DESCRIPTION OF PROPOSED PROJECT:

Site 1 – MP 94.00 to 94.29 (1,500 Linear Feet)

Construct the addition of a rock toe protection to an existing retaining wall. Boulder (8'-10' diameter) toe protection will be installed to protect the toe of the wall in the river channel. Each boulder will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the wall height.

Site 2 - MP 94 to MP 94.13 (700 Linear Feet, and 1,100 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be raised four feet above the existing elevation. This elevation gain is needed to preventing further flooding and to provide an adequate amount of free board. A 200 (LF) ramp will be required leading up to the section in

question as well as an additional ramp back down to meet the existing roadway. A retaining wall system will be required along the creek side of the roadway to obtain this elevation gain. It is assumed that the wall will be buried 8' underground, and be 6' above ground for a total wall height of 14'. The ramp up section will have a retaining wall that begins at grade ramping up to a height of 14' (vice versa for the ramping down section). The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 3 - MP 95.16 to MP 95.35 (1,000 Linear Feet)

From the existing roadway, a retaining wall sloped at 1:15 (Horizontal: Vertical) will extend down below the river keying into the bedrock layer. For this section the proposed wall height (above ground) will be 27 ft (typical). Boulder (8'-10' diameter) toe protection will be installed to protect the toe of the wall in the river channel. Each boulder will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the wall height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 4 – MP 95.50 to 95.75 (1400 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 5 - MP 95.80 to MP 95.91 (600 Linear Feet, and 1,000 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be raised four feet above the existing elevation. This elevation gain is needed to preventing further flooding and to provide an adequate amount of free board. A 200 (LF) ramp will be required leading up to the section in question as well as an additional ramp back down to meet the existing roadway. A retaining wall system will be required along the creek side of the roadway to obtain this elevation gain. It is assumed that the wall will be buried 8' underground, and be 6' above ground for a total wall height of 14'. The ramp up section will have a retaining wall that begins at grade ramping up to a height of 14' (vice versa for the ramping down section).

The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 6 – MP 96.10 to 96.15 (400 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2’ diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 7 - MP 96.79 to MP 97.11 (1,500 Linear Feet)

From the existing roadway, a retaining wall sloped at 1:15 (Horizontal: Vertical) will extend down below the river keying into the bedrock layer. For this section the proposed wall height (above ground) will be 40 ft (typical). Boulder (8’-10’ diameter) toe protection will be installed to protect the toe of the wall in the river channel. Each boulder will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (2’ diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the wall height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 8 – MP 97.55 to 97.70 (870 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2’ diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

COST ESTIMATING INFORMATION:

All cost estimating information can be found with the provided worksheets. Unit costs associated with this proposed alternative can be found in Appendix A.

PROJECT SCHEDULE AND COSTS:

CN = 2012
CPMS AD Date = X/X/XX
Scheduled AD Date = X/X/XX

Scoping Estimate:

CN = $56.4 million
RW = $0
PE = $13.6 million
TOTAL (uninflated April 2008) = $70.0 million
TOTAL (Inflated for April 2012 CN [1]) = $80.1 million

[1] Inflation Factor of 14.4% was used based on WashDOT Spreadsheet (from April 2008 to April 2012).

APPENDIX A
UNIT COSTS

UNIT COST INFORMATION
For Scoping Estimate US-2 Alt. 1.xls

Notes:
Data collected from the Washington State Unit Bid History Database Web site.
(http://www.wsdot.wa.gov/biz/contaa/uba/bid.cfm)
All cost averages researched are dated from 2004 to 2008

Item #	Historical Amount / Code
1	Mobilization 0001- (Given as 10% of pre-total).
2	Clearing and Grubbing 0025- From the Washington State Unit Bid History Database. ▪ NCR- (North Central Region) Ave. $631.36/acre. ▪ State average = $3,341.74/acre. ▪ More information given for statewide average. ▪ Use $3,300/acre x 2 = $6,600, due to accessibility issues.
3	Removing Guardrail 0170- From the Washington State Unit Bid History Database. ▪ NCR Ave.- low bid = $1.70 ▪ 3/12/07 Similar length- low bid = $7.00 ▪ Use~ $5.00 / LF to remove.
4	Remove Guardrail Anchor 0182- From the Washington State Unit Bid History Database. ▪ NCR Ave. - low bid = $5.77. ▪ State Ave. - $194.13. ▪ Double to $360, due to the minimal value/effort required for remote access.
5	Remove Guideposts 0185- From the Washington State Unit Bid History Database. ▪ NCR Ave. - low bid = $5.77. ▪ Sate Ave. - $3.98. ▪ Assume ~ $6.00.
6	Roadway Excavation Incl. Haul 0310- From Washington State Unit Bid History Database. ▪ NCR Ave. - low bid = $5.18. ▪ State Ave. - $6.33. ▪ Assume $6.00.
7	Common Borrow Incl. Haul 0405- From the Washington State Unit Bid History Database. ▪ NCR Ave. – low bid = $6.27.

- State Ave. - $3.25.
- Assume $7.00, for location and region.

8 Embankment Compaction 0470 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid = $0.77.
- State Ave. - $1.29
- Small quantity price increases / and remote accessibility
- Assume $4.00

9 Streambed Boulder 1097 – From the Washington State Unit Bid History Database. – No Record of bid amount.
- Call contractor previous work – estimator
- Selland Construction – Jerry Zook(estimator)
- Assume the use of DOT quarry site (cost savings)
- Assume the need of 2 cranes, one on each end (source and delivery site).
- For the requested size, need to shoot and blast rock.
- Excess waste, could be used for riprap.
- Low boys needed for transportation (cables and flagging required).
- Construction site crane would probably need to be larger of the two cranes (boom and hydraulics for placement).
- 8'-10' diameter boulders
- Approximately $3000.00 per boulder.

10 Channel Excavation 1035 – From the Washington State Unit Bid History Database.
- Statewide (2 bids that included haul) Ave. $30.37.
- Assume $30.00, difficult terrain w/o hauling.

11 Heavy Loose Riprap 1076 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid $76.86.
- State Ave. - $55.03.
- Difficult location to deliver / access.
- Assume $100.00.

12 Anti-Stripping Additive 5334 – Calculated.
- 0.5 x (HMA [tons]) = $3650.00 (total)
- Unit price $3650.00, quantity = 1.

13 Planing Bituminous Pavement 5711 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid = $1.03.
- State Ave. – bid = $1.68.
- Assume $1.25.

14 HMA CL. ½'' PG 5767 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid = $42.84.
- State Ave. – bid = $51.55.
- Small quantity drives up the price along with remote location.
- Assume $65.00/ton.

15 Job Mix Compliance Price Adjustment 5830 – Calculated, given in spreadsheet.

- 0.03 x ($HMA)
- 0.03 x ($HMA) = $14,235.
- Unit price $14,235, quantity = 1.

16 Compaction Price Adjustment 5835 – Calculated, given in spreadsheet.

- 0.02 x ($HMA)
- 0.02 x ($HMA) = $9,490.
- Unit price $9,490, quantity = 1.

17 ESC Lead 6403 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid = $152.39
- State Ave. – low bid = $115.79
- Remote location and relatively small number of hours.
- Assume $200.

18 Silt Fence 6373 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid = $3.87.
- State Ave. - $3.62
- Small quantity, higher price.
- Assume $4.00.

19 Water Pollution / Erosion Control - 6490 – Estimated (water filled berm calculations and dewatering/stream diversion).

- See spreadsheet scoping estimate for calculated values.
- Unit Price $191,400.00, quantity = 6.

20 Raising Existing Beam Guardrail 6783 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid $3.48.
- State Ave. - $4.50.
- Smaller quantity.
- Assume $4.00.

21 Truck Mounted Impact Attenuator 7447 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid = $7,316.67.
- State Ave. - $7,372.60.

- Recent 12/17/07 Data ~ $5,250.00.
- Remote location.
- Use $7,500.

22 Operation of Truck Mounted Impact Attenuator 7449 – From the Washington State Unit Bid History Database.
- NCR Ave. – Low bid = $26.00.
- State Ave. – Low bid = $28.16.
- Assume $30.00.

23 Repair T.M. Impact Attenuator 7450 – From the Washington State Unit Bid History Database.
- ~ Similar number - $1,000 - $2,000.
- Assume $2,500.

24 Flexible Guide Post 6832 – From the Washington State Unit Bid History Database.
- NCR Ave. – Low bid $26.84.
- State Ave. - $26.16.
- Location
- Assume $28.00.

25 Paint Line 6806 – From the Washington State Unit Bid History Database.
- NCR Ave. - $0.14.
- State Ave. - $0.11.
- Small Quantity (less than one mile total)
- Remote location for paint truck.
- Assume $2.00.

26 Recessed Pavement Marker 6889 – From the Washington State Unit Bid History Database.
- NCR Ave. - $780.41.
- State Ave. - $833.76.
- Assume $10,000 total/38 = minimum cost for man power and equipment.
- Use $265.00 for unit cost.

27 Temporary Pavement Marking 6888 – From the Washington State Unit Bid History Database.
- NCR Ave. - $0.13.
- State Ave. - $0.16.
- Small Quantity (less than a mile total)
- Assume $0.50.

28 Portable Changeable Message Sign 6994 – From the Washington State Unit Bid History Database.

- NCR Ave. - $5,111.81.
- State Ave. - $4,650.39.
- Due to location and region.
- Use piece $5,500.

29 Operation of Portable Changeable Message Sign 6995 – From the Washington State Unit Bid History Database.
- NCR Ave. - $2.49.
- State Ave. - $2.81.
- Assume similar numbers - $2.50.

30 Project Temporary Traffic Control - 6971
- Calculated at 5% of the total construction cost
- Value based on detours and extensive Traffic Control issues.
- Calculated value (for all sites) = $1,781,834.

31 Flaggers and Spotters 6980 – From the Washington State Unit Bid History Database.
- NCR Ave. - $39.62.
- State Ave. - $31.82.
- Newer numbers, 11/13/2007 = $54.00.
- Increased latest value by 5%.
- Assume $57.00.

32 Traffic Control Vehicle 6968 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $64.33 (only values are in 2004).
- Assume $100 per day.

33 Traffic Control Supervisor 6972 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $31.17 (newest entry 2005).
- Assume $50.00.

34 Construction Signs Class A 6982 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid $8.43.
- State Ave. - $13.21.
- Small Quantity.
- Assume $12.00.

35 Roadside Cleanup 7480 – Estimate.
- Assume $1,000.
- Given in spreadsheet, no unit cost.

36 SPCC Plan 7736 – SPCC Plan
- Lump Sum = $2,000.
- Given in spreadsheet, no unit cost.

37 Structure Surveying 7037 – Lump Sum.
- Estimate, based on Eng. judgment.
- Assume $30,000.

38 Roadway Surveying 7038 – Lump Sum.
- Estimate based on Eng. judgment.
- Assume $30,000.

39 Shoring 7007 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $1.07
- Location drives price up.
- Assume $2.00.

40 Backfill for rock wall 7167 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $33.85.
- Location and accessibility drive costs up.
- Assume $35.00.

41 Shotcrete Facing (Grouting Riprap) 7561 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $12.08.
- Location drives price up, and older values given in database.
- Assume $20.00.

42 St. Rein. Bar for Retaining Wall 4150 – From the Washington State Unit Bid History Database.
- NCR Ave. – $1.25 (only one value).
- State Ave. - $1.13.
- Assume $2.00.

43 Conc. Class 4000 for Retaining Wall 4139 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid = $1,000 (only one value).
- State Ave. - $566.07.
- Based on location and access.
- Assume $1,000.

Executive Summary Alternative 2

Roadway Stabilization – US 2
MP 94.00-98.10

By: ENTRIX, Inc. Date 4/17/2008

PROJECT SYNOPSIS:

DESCRIPTION OF EXISTING CONDITIONS:

Currently US Highway 2 runs along the Wenatchee River in the north central region of Washington State. Two historical high water events (November 25, 1990 and November 30, 1995) caused embankment erosion and roadway failure. Pre-emptive repairs were also made during the 2006 fall/winter season to prevent complete roadway failure. High water levels in the river undercut staged riprap that holds the toe of the roadway embankments. Since 1990, the State has spent a little more than $4 million dollars on repairs and maintenance in this troublesome area.

PURPOSE OF PROJECT:

The purpose of this project is to increase roadway durability/reliability along US Highway 2 in this area associated with river washout. Additionally two locations will raise the existing roadway to prevent sheet flow flooding across the roadway.

DESCRIPTION OF PROPOSED PROJECT:

Site 1 – MP 94.00 to 94.29 (1,500 Linear Feet)

Construct the addition of a rock toe protection to an existing retaining wall. Boulder (8'-10' diameter) toe protection will be installed to protect the toe of the wall in the river channel. Each boulder will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (riprap) will be grouted together preventing scour and undercutting along the retaining wall. This riprap/grouting protection will extend up to half of the wall height.

Site 2 - MP 94.29 TO MP 94.13 (700 Linear Feet, and 1,100 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be raised four feet above the existing elevation. This elevation gain is needed to preventing further flooding and to provide an adequate amount of free board. A 200 (LF) ramp will be required leading up to the section in

question as well as an additional ramp back down to meet the existing roadway. A retaining wall system will be required along the creek side of the roadway to obtain this elevation gain. It is assumed that the wall will be buried 8' underground, and be 6' above ground for a total wall height of 14'. The ramp up section will have a retaining wall that begins at grade ramping up to a height of 14' (vice versa for the ramping down section). The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 3 - MP 95.16 TO MP 95.35 (1,000 Linear Feet)

From the existing roadway, a boulder and riprap protected toe will be placed along the existing slope. Each boulder (8'-10' diameter) will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the slope height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 4 – MP 95.50 to 95.75 (1400 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 5 - MP 95.80 TO MP 95.91 (600 Linear Feet, and 1,000 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be raised four feet above the existing elevation. This elevation gain is needed to preventing further flooding and to provide an adequate amount of free board. A 200 (LF) ramp will be required leading up to the section in question as well as an additional ramp back down to meet the existing roadway. A retaining wall system will be required along the creek side of the roadway to obtain this elevation gain. It is assumed that the wall will be buried 8' underground, and be 6' above ground for a total wall height of 14'. The ramp up section will have a retaining wall that begins at grade ramping up to a height of 14' (vice versa for the ramping down section). The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 6 – MP 96.10 to 96.15 (400 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 7 - MP 96.79 TO MP 97.11 (1,500 Linear Feet)

From the existing roadway, a boulder and riprap protected toe will be placed along the existing slope. Each boulder (8'-10' diameter) will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the slope height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

Site 8 – MP 97.55 to 97.70 (870 Linear Feet)

Riprap toe protection is proposed for this moderate hazardous area. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. The riprap/grouting protection will extend up to half of the slope height.

Site 9 - MP 97.70 TO MP 97.75 (1,000 Linear Feet)

From the existing roadway, a boulder and riprap protected toe will be placed along the existing slope. Each boulder (8'-10' diameter) will be partially buried (half of the boulder diameter), with approximately four feet of the rock exposed. Varying sized smaller boulders (2' diameter riprap typical) will be grouted together preventing scour and undercutting along the river bank slope. This riprap/grouting protection will extend up to half of the slope height. The roadway and all safety features will be replaced and reconstructed upon construction completion.

COST ESTIMATING INFORMATION:

All cost estimating information for this alternative can be found with the provided worksheets. Unit costs associated with this proposed alternative can be found in Appendix A.

PROJECT SCHEDULE AND COSTS:

CN = 2012
CPMS AD Date = X/X/XX
Scheduled AD Date = X/X/XX

Scoping Estimate:

CN = $12.5 million
RW = $0
PE = $2.9 million
TOTAL (uninflated April 2008) = $15.4 million
TOTAL (Inflated for April 2012 CN [1]) = $17.6 million

[1] Inflation Factor of 14.4% was used based on WashDOT Spreadsheet (from April 2008 to April 2012).

APPENDIX A
UNIT COSTS

UNIT COST INFORMATION
For Scoping Estimate US-2 Alt. 2.xls

Notes:
Data collected from the Washington State Unit Bid History Database Web site.
(http://www.wsdot.wa.gov/biz/contaa/uba/bid.cfm)
All cost averages researched are dated from 2004 to 2008.

Item #	Historical Amount / Code
1	Mobilization 0001- (Given as 10% of pre-total).
2	Clearing and Grubbing 0025- From the Washington State Unit Bid History Database. ▪ NCR- (North Central Region) Ave. $631.36/acre. ▪ State average = $3,341.74/acre. ▪ More information given for statewide average. ▪ Use $3,300/acre x 2 = $6,600, due to accessibility issues.
3	Removing Guardrail 0170- From the Washington State Unit Bid History Database. ▪ NCR Ave.- low bid = $1.70 ▪ 3/12/07 Similar length- low bid = $7.00 ▪ Use~ $5.00 / LF to remove.
4	Remove Guardrail Anchor 0182- From the Washington State Unit Bid History Database. ▪ NCR Ave. - low bid = $5.77. ▪ State Ave. - $194.13. ▪ Double to $360, due to the minimal value/effort required for remote access.
5	Remove Guideposts 0185- From the Washington State Unit Bid History Database. ▪ NCR Ave. - low bid = $5.77. ▪ Sate Ave. - $3.98. ▪ Assume ~ $6.00.
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7	Common Borrow Incl. Haul 0405- From the Washington State Unit Bid History Database. ▪ NCR Ave. – low bid = $6.27.

- State Ave. - $3.25.
- Assume $7.00, for location and region.

8 Embankment Compaction 0470 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid = $0.77.
- State Ave. - $1.29
- Small quantity price increases / and remote accessibility
- Assume $4.00

9 Streambed Boulder 1097 – From the Washington State Unit Bid History Database. – No Record of bid amount.
- Call contractor previous work – estimator
- Selland Construction – Jerry Zook(estimator)
- Assume the use of DOT quarry site (cost savings)
- Assume the need of 2 cranes, one on each end (source and delivery site).
- For the requested size, need to shoot and blast rock.
- Excess waste, could be used for riprap.
- Low boys needed for transportation (cables and flagging required).
- Construction site crane would probably need to be larger of the two cranes (boom and hydraulics for placement).
- 8'-10' diameter boulders
- Approximately $3000.00 per boulder.

10 Channel Excavation 1035 – From the Washington State Unit Bid History Database.
- Statewide (2 bids that included haul) Ave. $30.37.
- Assume $30.00, difficult terrain w/o hauling.

11 Heavy Loose Riprap 1076 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid $76.86.
- State Ave. - $55.03.
- Difficult location to deliver / access.
- Assume $100.00.

12 Anti-Stripping Additive 5334 – Calculated.
- 0.5 x (HMA [tons]) = $3650.00 (total)
- Unit price $3650.00, quantity = 1.

13 Planing Bituminous Pavement 5711 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid = $1.03.
- State Ave. – bid = $1.68.
- Assume $1.25.

14 HMA CL. ½'' PG 5767 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid = $42.84.
- State Ave. – bid = $51.55.
- Small quantity drives up the price along with remote location.
- Assume $65.00/ton.

15 Job Mix Compliance Price Adjustment 5830 – Calculated, given in spreadsheet.

- 0.03 x ($HMA)
- 0.03 x ($HMA) = $14,235.
- Unit price $14,235, quantity = 1.

16 Compaction Price Adjustment 5835 – Calculated, given in spreadsheet.

- 0.02 x ($HMA)
- 0.02 x ($HMA) = $9,490.
- Unit price $9,490, quantity = 1.

17 ESC Lead 6403 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid = $152.39
- State Ave. – low bid = $115.79
- Remote location and relatively small number of hours.
- Assume $200.

18 Silt Fence 6373 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid = $3.87.
- State Ave. - $3.62
- Small quantity, higher price.
- Assume $4.00.

19 Water Pollution / Erosion Control - 6490 – Estimated (water filled berm calculations and dewatering).

- See spreadsheet scoping estimate for calculated values.
- Unit Price $191,400.00, quantity = 6.

20 Raising Existing Beam Guardrail 6783 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid $3.48.
- State Ave. - $4.50.
- Smaller quantity.
- Assume $4.00.

21 Truck Mounted Impact Attenuator 7447 – From the Washington State Unit Bid History Database.

- NCR Ave. – low bid = $7,316.67.
- State Ave. - $7,372.60.

- Recent 12/17/07 Data ~ $5,250.00.
- Remote location.
- Use $7,500.

22 Operation of Truck Mounted Impact Attenuator 7449 – From the Washington State Unit Bid History Database.
- NCR Ave. – Low bid = $26.00.
- State Ave. – Low bid = $28.16.
- Assume $30.00.

23 Repair T.M. Impact Attenuator 7450 – From the Washington State Unit Bid History Database.
- Similar number - $1,000 - $2,000.
- Assume $2,500.

24 Flexible Guide Post 6832 – From the Washington State Unit Bid History Database.
- NCR Ave. – Low bid $26.84.
- State Ave. - $26.16.
- Location
- Assume $28.00.

25 Paint Line 6806 – From the Washington State Unit Bid History Database.
- NCR Ave. - $0.14.
- State Ave. - $0.11.
- Small Quantity (less than one mile total)
- Remote location for paint truck.
- Assume $2.00.

26 Recessed Pavement Marker 6889 – From the Washington State Unit Bid History Database.
- NCR Ave. - $780.41.
- State Ave. - $833.76.
- Assume $10,000 total/38 = minimum cost for man power and equipment.
- Use $265.00 for unit cost.

27 Temporary Pavement Marking 6888 – From the Washington State Unit Bid History Database.
- NCR Ave. - $0.13.
- State Ave. - $0.16.
- Small Quantity (less than a mile total)
- Assume $0.50.

28 Portable Changeable Message Sign 6994 – From the Washington State Unit Bid History Database.

- NCR Ave. - $5,111.81.
- State Ave. - $4,650.39.
- Due to location and region.
- Use piece $5,500.

29 Operation of Portable Changeable Message Sign 6995 – From the Washington State Unit Bid History Database.
- NCR Ave. - $2.49.
- State Ave. - $2.81.
- Assume similar numbers - $2.50.

30 Project Temporary Traffic Control - 6971
- Calculated at 5% of the total construction cost
- Value based on detours and extensive Traffic Control issues.
- Calculated value (for all sites) = $1,781,834.

31 Flaggers and Spotters 6980 – From the Washington State Unit Bid History Database.
- NCR Ave. - $39.62.
- State Ave. - $31.82.
- Newer numbers, 11/13/2007 = $54.00.
- Increased latest value by 5%.
- Assume $57.00.

32 Traffic Control Vehicle 6968 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $64.33 (only values are in 2004).
- Assume $100 per day.

33 Traffic Control Supervisor 6972 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $31.17 (newest entry 2005).
- Assume $50.00.

34 Construction Signs Class A 6982 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid $8.43.
- State Ave. - $13.21.
- Small Quantity.
- Assume $12.00.

35 Roadside Cleanup 7480 – Estimate.
- Assume $1,000.
- Given in spreadsheet, no unit cost.

36 SPCC Plan 7736 – SPCC Plan
- Lump Sum = $2,000.
- Given in spreadsheet, no unit cost.

37 Structure Surveying 7037 – Lump Sum.
- Estimate, based on Eng. judgment.
- Assume $30,000.

38 Roadway Surveying 7038 – Lump Sum.
- Estimate based on Eng. judgment.
- Assume $10,000.

39 Shoring 7007 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $1.07
- Location drives price up.
- Assume $2.00.

40 Backfill for rock wall 7167 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $33.85.
- Location and accessibility drive costs up.
- Assume $35.00.

41 Shotcrete Facing (Grouting Riprap) 7561 – From the Washington State Unit Bid History Database.
- NCR Ave. – None.
- State Ave. - $12.08.
- Location drives price up, and older values given in database.
- Assume $20.00.

42 St. Rein. Bar for Retaining Wall 4150 – From the Washington State Unit Bid History Database.
- NCR Ave. – $1.25 (only one value).
- State Ave. - $1.13.
- Assume $2.00.

43 Conc. Class 4000 for Retaining Wall 4139 – From the Washington State Unit Bid History Database.
- NCR Ave. – low bid = $1,000 (only one value).
- State Ave. - $566.07.
- Based on location and access.
- Assume $1,000.

Executive Summary Alternative 3

Roadway Stabilization – US 2
MP 94.00-98.10

By: ENTRIX, Inc. Date 4/21/2008

PROJECT SYNOPSIS:

DESCRIPTION OF EXISTING CONDITIONS:

Currently US Highway 2 runs along the Wenatchee River in the north central region of Washington State. Two historical high water events (November 25, 1990 and November 30, 1995) caused embankment erosion and roadway failure. Pre-emptive repairs were also made during the 2006 fall/winter season to prevent complete roadway failure. High water levels in the river undercut staged riprap that holds the toe of the roadway embankments. Since 1990, the State has spent a little more than $4 million dollars on repairs and maintenance in this troublesome area.

PURPOSE OF PROJECT:

The purpose of this project is to increase roadway durability/reliability along US Highway 2 in this area associated with river washout. Additionally two locations will raise the existing roadway elevation preventing sheet flow flooding across the roadway.

DESCRIPTION OF PROPOSED PROJECT:

Site 1 – MP 94.00 to 94.29 (1,500 Linear Feet)

An existing retaining wall is located in throughout this section. No improvements to the existing wall or section are proposed for this alternative.

Site 2 - MP 94 to MP 94.13 (700 Linear Feet, and 1,200 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be replaced with a viaduct section. This section would be elevated from the current roadway elevation to prevent historical flooding. Similar to the other viaduct sections, a 250’ linear foot ramp will be required leading up to the section in question as well as an additional ramp back down to meet the existing roadway (increasing the total length in question by 500’ linear

feet). The viaduct roadway will include all safety features during construction and upon completion.

Site 2 - MP 95.16 to MP 95.35 (1,000 Linear Feet, and 1,500 Linear Feet Total Including Ramps))

The existing roadway would be removed and replace with a viaduct roadway providing the river corridor with more area to pass larger flows, while maintaining the roadway integrity. The viaduct section will have to transition into the existing roadway increasing the total length by 500' linear feet. It can be assumed that 250' linear feet are needed for tying into and out of viaduct section. The viaduct roadway will include all safety features during construction and upon completion.

Site 3 - MP 95.16 to MP 95.35 (1,000 Linear Feet, and 1,500 Linear Feet Total Including Ramps)

The existing roadway would be removed and replace with a viaduct roadway providing the river corridor with more area to pass larger flows, while maintaining the roadway integrity. The viaduct section will have to transition into the existing roadway increasing the total length by 500' linear feet. It can be assumed that 250' linear feet are needed for tying into and out of viaduct section. The viaduct roadway will include all safety features during construction and upon completion.

Site 5 - MP 95.80 to MP 95.91 (600 Linear Feet, and 1,100 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be replaced with a viaduct section. This section would be elevated from the current roadway elevation to prevent historical flooding. Similar to the other viaduct sections, a 250' linear foot ramp will be required leading up to the section in question as well as an additional ramp back down to meet the existing roadway (increasing the total length in question by 500' linear feet). The viaduct roadway will include all safety features during construction and upon completion.

Site 7 - MP 96.79 to MP 97.11 (1,500 Linear Feet, and 2,000 Linear Feet Total Including Ramps)

The existing roadway would be removed and replace with a viaduct roadway providing the river corridor with more area to pass larger flows,

while maintaining the roadway integrity. The viaduct section will have to transition into the existing roadway increasing the total length by 500' linear feet. It can be assumed that 250' linear feet are needed for tying into and out of viaduct section. The viaduct roadway will include all safety features during construction and upon completion.

COST ESTIMATING INFORMATION:

All cost estimating information for this alternative can be found in Appendix A. Unit costs associated with this proposed alternative can be found in Appendix B.

PROJECT SCHEDULE AND COSTS:

CN = 2012
CPMS AD Date = X/X/XX
Scheduled AD Date = X/X/XX

Scoping Estimate:
CN = $139.5 million
RW = $0
PE = $50.2 million
TOTAL (uninflated April 2008) = $189.7 million
TOTAL (Inflated for April 2012 CN [1]) = $217 million

[1] Inflation Factor of 14.4% was used based on WashDOT Spreadsheet (from April 2008 to April 2012).

APPENDIX A
COST ESTIMATE INFORMATION

COST ESTIMATE INFORMATION
For Scoping Estimate US-2 Alt. 3

Alternative 3, proposes viaduct roadway sections to provide roadway stability and prevent roadway flooding. Below are lengths associated with each area.

Site 1 (Existing Retaining Wall Section)
No improvements are proposed in this area.

Site 2
This section proposes the viaduct roadway for a length of 1000' LF. In order to tie back into the existing roadway additional transitions lengths of 250' LF are required on each side. The total length for viaduct construction proposed equals 1500' LF.

Site 3
This section proposes the viaduct roadway for a length of 1500' LF. In order to tie back into the existing roadway additional transitions lengths of 250' LF are required on each side. The total length for viaduct construction proposed equals 2000' LF.

Site 4
This section proposes the viaduct roadway for a length of 1000' LF. In order to tie back into the existing roadway additional transitions lengths of 250' LF are required on each side. The total length for viaduct construction proposed equals 1500' LF.

Flooding Area Site 5
In order to prevent roadway flooding, additional viaduct work is proposed in this area. The area is question is approximately 700' LF, and additional transitional lengths of 250'LF are required to tie back into the existing roadway. The total length for viaduct construction proposed equals 1200'LF.

Flooding Area Site 6
In order to prevent roadway flooding, additional viaduct work is proposed in this area. The area is question is approximately 600' LF, and additional transitional lengths of 250'LF are required to tie back into the existing roadway. The total length for viaduct construction proposed equals 1100'LF.

Total Length of Viaduct Construction for all areas in question equals ***7300'*** **LF**.

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 3**

Viaduct sections would be constructed in hazardous / potential problem areas.

DESIGNED BY: Entrix, Inc.

CHECKED BY: Entrix, Inc.

AS OF DATE: 4/23/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
VIADUCT						
1	Viaduct Construction (All Inclusive)	####	L.F.	$14,721.75	7,300.00	$107,468,775.00
	MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR			1.00%		$1,074,687.75
	CONSTRUCTION TOTAL					$108,543,462.75
	SALES TAX			8.00%		$8,683,477.02
	SUB TOTAL					$117,226,939.77
	CONSTRUCTION ENGINEERING (CE)			15%		$17,584,040.97
	CONTINGENCIES			4%		$4,689,077.59
	CN					**$139,500,058.33**
	RW					$0.00
	Mitigation Costs					$0.00
	PE[1]			36%		$50,220,021.00
	PROJECT TOTAL[2]					**$189,720,079.32**

[1] PE Percentage Rate found on page 23 of "EstimatingGuidlines.pdf", for Catastrophic Reduction use 13%. This value was increased by a factor of 2.8 for consultant costs.

[2] If a more detailed cost estimate is required or needed for this alternative, it is proposed that a transportation engineering firm or someone with similar expertise be consulted to cost estimate this alternative.

APPENDIX B
UNIT COST ESTIMATE

UNIT COST INFORMATION
For Scoping Estimate US-2 Alt. 3.xls

Notes:
Due to our lack of expertise in this area and lack of information in regards to viaduct construction from the WashDOT standard items table, the following assumptions were made:

- Assume Viaduct Construction is similar to Bridge Construction.
- From 11/21/05, a construction cost of $2.7 million was accepted in the north central region for a 400' LF bridge.
- The cost per linear foot of bridge equaled $6,750/LF (in 2005).
- Using the inflation table provided by WashDOT, the present day cost per linear foot of bridge would be $9814.50/LF.
    - 11/05 inflation value of 183.60
    - 4/08 inflation value of 229.00
    - Increased the 2005 value by 45.4%
- Due to the location of the proposed viaduct alignment and difficulty constructing such a project the cost per linear foot was increased by 50%
    - Assumed Cost $14,721.75/LF.
- Total Viaduct length equals 7100' LF.

If a more detailed cost estimate is required or needed for this alternative, it is proposed that a transportation engineering firm or someone with similar expertise be consulted to cost estimate this alternative.

Washington State Department of Transportation

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CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 1**

Along an existing retaining wall, a boulder and riprap protected toe is proposed.
Riprap would be grouted (shotcreted) together.
For three additional sites, a layed back retaining wall system protected with boulders and smaller riprap toe would be constructed to prevent river undercutting.
Two additional roadway areas would be raised (w/ retaining walls) to prevent flooding.
Three moderate hazardous lengths would be riprapped and grouted the slope banks. (No boulder placement).

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.

AS OF DATE: 4/17/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
PREPARATION						
1	MOBILIZATION	0001	L.S.	10.00%	1.00	$3,956,116.92
2	CLEARING AND GRUBBING	0025	ACRE	$6,600.00	4.80	$31,680.00
3	REMOVING GUARDRAIL	0170	L.F.	$5.00	7,100.00	$35,500.00
4	REMOVE GUARDRAIL ANCHOR	0182	EACH	$360.00	12.00	$4,320.00
5	REMOVE GUIDEPOSTS	0185	EACH	$6.00	1,143.00	$6,858.00
GRADING						
6	ROADWAY EXCAVATION INLC. HAUL	0310	C.Y.	$6.00	14,100.00	$84,600.00
7	COMMON BORROW INCL. HAUL	0405	C.Y.	$7.00	52,770	$369,390.00
8	EMBANKMENT COMPACTION	0470	C.Y.	$4.00	105,540	$422,160.00
DRAINAGE						
9	STREAMBED BOULDER	1097	EACH	$3,000.00	626.00	$1,878,000.00
10	CHANNEL EXCAVATION	1035	C.Y.	$30.00	9,400.00	$282,000.00
11	HEAVY LOOSE RIPRAP	1076	C.Y.	$100.00	8,000.00	$800,000.00
LIQUID ASPHALT						
12	ANTI-STRIPPING ADDITIVE (0.5*(HMA Tons+ ATB Tons)	5334	EST.	$3,650.00	1.00	$3,650.00
HOT MIX ASPHALT						
13	PLANING BITUMINOUS PAVEMENT	5711	S.Y.	$1.25	21,200.00	$26,500.00
14	HMA CL.1/2" PG 64-28 Depth: 0.50'	5767	TON	$65.00	7,300.00	$474,500.00
15	JOB MIX COMPLIANCE PRICE ADJUSTMENT (0.03*$HMA Total)	5830	EST.	$14,235.00	1.00	$14,235.00
16	COMPACTION PRICE ADJUSTMENT (0.02*($HMA)	5835	EST.	$9,490.00	1.00	$9,490.00
EROSION CONTROL AND PLANTING						
17	ESC LEAD	6403	DAY	$200.00	16.00	$3,200.00
18	SILT FENCE	6373	L.F.	$4.00	14,670	$58,680.00
19	WATER POLLUTION/EROSION CONTROL	6490	EST.	$191,400.00	6.00	$1,148,400.00
TRAFFIC						
20	RAISING EXISTING BEAM GUARDRAIL	6783	L.F.	$4.00	7,105.00	$28,420.00
21	TRUCK MOUNTED IMPACT ATTENUATOR	7447	EACH	$7,500.00	1.00	$7,500.00
22	OPERATION OF TRUCK MOUNTED IMPACT ATTENUATO	7449	HR	$30.00	40.00	$1,200.00
23	REPAIR T.M. IMPACT ATTENUATOR	7450	EACH	$2,500.00	1.00	$2,500.00
24	FLEXIBLE GUIDE POST	6832	EACH	$28.00	1,143.00	$32,004.00
25	PAINT LINE	6806	L.F.	$2.00	16,820.00	$33,640.00
26	RECESSED PAVEMENT MARKER	6889	HUND.	$265.00	38.00	$10,070.00
27	TEMPORARY PAVEMENT MARKING	6888	L.F.	$0.50	11,210.00	$5,605.00
28	PORTABLE CHANGEABLE MESSAGE SIGN	6994	EACH	$5,500.00	2.00	$11,000.00
29	OPERATION OF PORTABLE CHANGEABLE MESSAGE SIG	6995	HR	$2.50	4,800.00	$12,000.00
30	PROJECT TEMPORARY TRAFFIC CONTROL	6971	L.S.	5.00%	1.00	$1,883,865.20
31	FLAGGERS AND SPOTTERS	6980	HR	$57.00	300.00	$17,100.00
32	TRAFFIC CONTROL VEHICLE	6968	DAY	$100.00	60.00	$6,000.00
33	TRAFFIC CONTROL SUPERVISOR	6974	HOUR	$50.00	650.00	$32,500.00
34	CONSTRUCTION SIGNS CLASS A	6982	S.F.	$12.00	276.00	$3,312.00
OTHER ITEMS						
35	ROADSIDE CLEANUP	7480	L.S.	$2,000.00	1.00	$2,000.00
36	SPCC PLAN	7736	L.S.	$1,000.00	1.00	$1,000.00
37	STRUCTURE SURVEYING	7037	L.S.	$30,000.00	1.00	$30,000.00
38	ROADWAY SURVEYING	7038	L.S.	$30,000.00	1.00	$30,000.00
39	SHORING	7007	S.F.	$2.00	204,790.00	$409,580.00
40	BACKFILL FOR ROCK WALL	7167	TON	$35.00	57,430.00	$2,010,050.00
41	SHOTCRETE FACING (GROUTING RIPRAP)	7561	S.F.	$20.00	49,400.00	$988,000.00
STRUCTURE						
42	ST. REIN. BAR FOR RETAINING WALL	4150	LB	$2.00	2,420,330.00	$4,840,660.00
43	CONC. CLASS 4000 FOR RETAINING WALL	4139	C.Y.	$1,000.00	23,510.00	$23,510,000.00

MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR	1.00%	$435,172.86
CONSTRUCTION TOTAL		$43,952,458.98
SALES TAX	8.00%	$3,516,196.72
SUB TOTAL		$47,468,655.70
CONSTRUCTION ENGINEERING (CE)	15%	$7,120,298.35
CONTINGENCIES	4%	$1,898,746.23
CN		**$56,487,700.28**
RW		$0.00
Mitigation Costs		$0.00
PE	24%	$13,557,048.07
PROJECT TOTAL		**$70,044,748.35**

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

SCOPING ESTIMATE - SUMMARY

PROJECT: **US 2, Wenatchee River - Alternative 1**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/18/2008

PREPARATION

1 MOBILIZATION - 0001

Note: Mobilization is a percentage of the pre-total. (See Estimate Tab)

2 CLEARING AND GRUBBING - 0025

Site 1		
Length (LF)	0	Existing Retaining wall in place
Slope Length (LF)	40	
Total (Acres)	0	
Site 3		
Length (LF)	1005	
Slope Length (LF)	40	
Total (Acres)	0.92286501	
Site 7		
Length (LF)	1500	
Slope Length (LF)	40	
Total (Acres)	1.37741047	
Site 9		
Length (LF)	1000	
Slope Length (LF)	40	
Total (Acres)	0.91827365	
Mod. Hazardous Area Site 4		
Length (LF)	1400	
Slope Length (LF)	27	
Total (Acres)	0.8677686	
Mod. Hazardous Area Site 6		
Length (LF)	400	
Slope Length (LF)	23	
Total (Acres)	0.21120294	
Mod. Hazardous Area Site 8		
Length (LF)	870	
Slope Length (LF)	25	
Total (Acres)	0.49931129	
Total	4.7968	

TOTAL (ACRE)	4.80

3 REMOVING GUARDRAIL - 0170

Note: Flooding Areas include 200' (LF) transitions on both ends

	Length (LF)	
Site 1	1500	Removal needed inorder to construct/place Boulders and Riprap
Site 3	1005	
Site 7	1500	
Site 9	1000	
Flooding Area Site 2	1100	
Flooding Area Site 5	1000	
Total	7105	

TOTAL (LF)	7100.00

4 REMOVE GUARDRAIL ANCHOR - 0182

Mp	Lt/Rt	Qty.

Note: Assume the each length has one on each end (6x2 = 12)

TOTAL (EA)	12.00

5 **REMOVE GUIDEPOSTS - 0185**

Note: Assume that the number of Guideposts to be removed equals the number to install
(See RPM-Guidepost Tab for Quantity)

TOTAL (EA)	1143.00

GRADING

6 **ROADWAY EXCAVATION INCL. HAUL - 0310**

	Length(LF)	Width (LF)	Roadway Depth(LF)	Sum (C.Y.)	
Site 1	0	34	2	0	(No Roadway Excavation at thi
Site 3	1005	34	2	2531.111111	
Site 7	1500	34	2	3777.777778	
Site 9	1000	34	2	2518.518519	
Flooding Area Site 2	1100	34	2	2770.37037	
Flooding Area Site 5	1000	34	2	2518.518519	
			Total (C.Y.)	14116.2963	

TOTAL (CY)	14100.00

7 **COMMON BORROW INCL. HAUL - 0405**

Note: Ten feet added to wall heights to meet bed rock

	Length of Wall (LF)	Width (LF)	Height (LF)	Sum (C.Y.)	
Site 1	0	8	42	0	(Existing Wall)
Site 3	1005	8	37	11017.77778	
Site 7	1500	8	50	22222.22222	
Site 9	1000	8	37	10962.96296	
			Total (C.Y.)	44202.96296	

Note: Assume Triangular Distribution

Flooding Roadway:
Note: Assume 200' approach lengths, and 4 feet of height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard
Assume triangular approach and descent

	Approach	Flood	Road Width	Fill Needed (CF)
Flood Area Site 2 approach	200	4	34	13600
Flood Area Site 2 decent	200	4	34	13600
			Total (CY)	1007.41

	Approach	Flood	Road Width	Fill Needed (CF)
Flood Area Site 5 approach	200	4	34	13600
Flood Area Site 5 decent	200	4	34	13600
			Total (CY)	1007.41

Note: Four feet height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard

	Roadway	Flood	Road Width	Fill Needed (CF)
Flood Area Site 2	700	4	34	95200
Flood Area Site 5	600	4	34	81600
			Total (CY)	6548.15

Total of Both Sections (CY)	8562.96

TOTAL (CY)	52770.00

8 **EMBANKMENT COMPACTION - 0470**

Note: Compact base of wall and stockpile file
Total = 2 X Common Borrow Value

TOTAL (CY)	105540.00

DRAINAGE

9 **STREAMBED BOULDER - 1097**

Note: Equals the LF of channel divided by the Average Diameter

	Length (LF)	Average Boulder Diameter (LF)	
Site 1	1500	8	187.5

Site 3	1005	8	125.625
Site 7	1500	8	187.5
Site 9	1000	8	125
	Total Boulders Needed (Each)		625.625

TOTAL (EACH) 626.00

10 **CHANNEL EXCAVATION - 1035**

Note: Recontouring Channel and the Toe of the River Bank

	Length of Channel(LF)	Width of Channel (LF)	Excavation Depth (LF)	Sum (C.Y.)	
Site 1	1500	10	4	2222.22	
Site 3	1005	10	4	1488.89	
Site 7	1,500	10	4	2222.22	
Site 9	1,000	10	4	1481.48	
Mod. Hazardous Area Site 4	1400	10	2	1037.04	(Boulder Placement is not prop
Mod. Hazardous Area Site 6	870	10	2	644.44	(Boulder Placement is not prop
Mod. Hazardous Area Site 8	400	10	2	296.30	(Boulder Placement is not prop
			Total (C.Y.)	9392.59	

TOTAL (C.Y.) 9400.00

11 **HEAVY LOOSE RIPRAP - 1076**

Note: Assume that boulders (#9) are buried up to half of the diameter (4') at the toe of the reinforced wall
Assume Riprap height will be half the height of the exposed wall minus the above mentioned boulder.
Assume Riprap is a 2' diameter boulder

	Wall Height Exposed (LF)	Height (LF) - Half of Wall Ht. Out of Ground minus 1/2 Boulder Dia.	Height (LF)	Length (LF)	Sum (C.Y.)
Site 1	32	12	12	1500	1333.333333
Site 3	27	9.5	9.5	1005	707.2222222
Site 7	40	16	16	1,500	1777.777778
Site 9	27	9.5	9.5	1,000	703.7037037
				Total (C.Y.)	4522.037037

	Height (LF) - From the Roadway to the River	Height (LF) - Half of the slope height	Length (LF)	Sum (C.Y.)
Mod. Hazardous Area Site 4	26.6	13.3	1400	1379.259259
Mod. Hazardous Area Site 6	22.55	11.275	400	334.0740741
Mod. Hazardous Area Site 8	25.15	12.575	870	810.3888889
			Total (C.Y.)	2523.722222

TOTAL (C.Y.) 8,000.00

LIQUID ASPHALT

12 **ANTI-STRIPPING ADDITIVE - 5334**

(0.5*(HMA))

TOTAL (EST.) 3650.00

HOT MIX ASPHALT

13 **PLANING BITUMINOUS PAVEMENT - 5711**

See the HMA section of this excel file for quantity calculations.

TOTAL (SY) 21,200.00

14 **HMA CL. 1/2" PG 64-28 - 5767**

See the HMA section of this excel file for quantity calculations.

TOTAL (TON) 7,300.00

15 **JOB MIX COMPLIANCE PRICE ADJUSTMENT - 5830**

(0.03*$HMA)

TOTAL (EST.) See Estimate

16 **COMPACTION PRICE ADJUSTMENT - 5835**
(0.02*$HMA)

TOTAL (EST.) See Estimate

EROSION CONTROL AND PLANTING

17 **ESC LEAD - 6403**
Referring to Std. Spec 8-01.3(1)B
ESC inspects at least once every 5 working days and each working day there is a runoff event.

60 working days/5 ESC days =	12	days for ESC Lead	Working Days	60
Assumed 4 rainy days	4	days for runoff event		
Total	16	days for ESC lead		

TOTAL (DAY) 16.00

18 **SILT FENCE - 6373**
Note: Equals the entire length of the project times 1.5

	Length (LF)	
Site 1	1500	
Site 3	1005	
Site 7	1500	
Site 9	1000	
Flooding Area Site 2	1100	(includes ramp up and down lengths)
Flooding Area Site 5	1000	(includes ramp up and down lengths)
Mod. Hazard Area Site 4	1400	
Mod. Hazard Area Site 6	870	
Mod. Hazard Area Site 8	400	
Total (LF)	9775	
Total (1.5 Increase)	14662.5	

TOTAL (L.F.) 14670.00

19 **TEMP. WATER POLLUTION/EROSION CONTROL**
Note: Water filled berms can be reused, pricing information is for one section/set up.
Assume all set-up and installation costs are covered in the total price

One Water filled berm - stream diversion	
Length of Diversion Needed (LF)	1500
Width of Diversion Needed (2x -LF) ~20'	40
Losses for connections (2x - LF) ~12'	24
Cost for Aqua-Berm per LF	100
Total Cost for Berm $	$ 156,400.00

Dewatering Activities - (Pumping, etc.)	
Total Cost associated with Dewatering per site	$ 35,000.00

Total (EST. for One Setup)	$ 191,400.00
One Setup for Each Area	4
Moderate Hazardous Areas[1]	2
Total Setups	6

TOTAL (EST.) 6.00

[1] Since the lengths for the moderate hazardous areas are short, assume that 2 setups will cover all three areas.

TRAFFIC

Working Days = 60.00 Working Hours (10-hr days) = 600

20 **RAISING EXISTING BEAM GUARDRAIL - 6783**

	Length of Road (LF)	
Site 1	1500	
Site 3	1005	
Site 7	1500	
Site 9	1000	
Flooding Area Site 2	1100	(includes ramp up and down lengths)
Flooding Area Site 5	1000	(includes ramp up and down lengths)
Total (LF)	7105	

		TOTAL (L.F.)	7,105.00
21	**TRUCK-MOUNTED IMPACT ATTENUATOR - 7447**	**TOTAL (EACH)**	1.00
22	**OPERATION OF TRUCK-MOUNTED IMPACT ATTENUATOR - 7449**		
	Note: Assume four ten hour days	**TOTAL (HR)**	40.00
23	**REPAIR TRUCK-MOUNTED IMPACT ATTENUATOR - 7450**		
	Note: assume the attenuator will need 1 repair.	**TOTAL (EACH)**	1.00
24	**FLEXIBLE GUIDEPOST - 6832**		
	Note: See RPM-Guidp Sheet	**TOTAL (EACH)**	1,143.00
25	**PAINT LINE - 6806**		
	Note: See Paint Stripe Calc on HMA tab	**TOTAL (L.F.)**	16,820.00
26	**RECESSED PAVEMENT MARKINGS - 6889**		
	Note: See RPM-Guidp Sheet	**TOTAL (HUND)**	38.00
27	**TEMPORARY PAVEMENT MARKINGS - 6888**		
	Note: See Temporary Paint on HMA tab	**TOTAL (L.F.)**	11,210.00
28	**PORTABLE CHANGEABLE MESSAGE SIGN - 6994**	**TOTAL (EA)**	2.00
29	**OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGN - 6995**		
	Note: Set Up 40 Days prior to Construction		
	Working Days 60		
	Prior to Construction Days 40		
	24 hours a day 2400		
	2 Signs 2		
	Total Hours 4800		
		TOTAL (HR)	4,800.00
30	**PROJECT TEMPORARY TRAFFIC CONTROL - 6971**		
	Item consists of Contractor furnished barricades, cones, flashers, traffic safety drums, and Cl. B signs.		
	Surfacing / paving require restricted roadway width or detour routing and are intensive traffic control operations.		
	Note: Total based on 5% of total construction costs (not including Mobilization)		
		TOTAL (L.S.)	1.00
31	**FLAGGERS AND SPOTTERS - 6980**		
	Note: Assumed 10 hr working days.		
	Each flagger works a 10 hr. day, and 3 laborers will be working every chargeable working day.		
	Assume 5 Days at the beginning, and 5 Days at the end of construction to set up Detour		
	Laborers 3		
	Working Days 10		
	Hours per Day 10		
	Total (Hours) 300		
		TOTAL (HR)	300.00
32	**TRAFFIC CONTROL VEHICLE - 6968**		
	Assume: A TCS will be on the project site every chargeable contract day.		
	TCS will require a vehicle to transport temporary traffic control devices and Cl. B signs.		
	Working Days (total) 60		
		TOTAL (DAY)	60.00
33	**TRAFFIC CONTROL SUPERVISOR - 6972**		
	Note: Assumed 10 hr working days.		
	Assume: The TCS will be working every chargeable contract day.		
	TCS often sets up and removes temporary traffic control devices / Cl. B signs. (Additional 5 days)		
	Chargeable Working Days 65		

Working Hours per Day	10
Total (Hours)	650

TOTAL (HR) 650.00

34 **CONSTRUCTION SIGNS CLASS A - 6982**

Sign Type	Area ft^2	Qty	Total Area
Give 'Em A Brake (G28-101)	28	2	56
Road Work Ahead, 48in x 48 in (W20-1)	16	6	96
Road Work Next "X" Miles (G20-1)	10	2	20
End Road Work (G20-2a)	8	2	16
For Project Information Call XXX-XXXX (G24-501)	12	2	24
Traffic Fines Double in Work Zones (I20-301)	16	2	32
Thank You/ WSDOT-Contractor Name Sign	16	2	32
		Total (S.F.)	276

TOTAL (S.F.) 276.00

OTHER ITEMS

35 **ROADSIDE CLEANUP - 7480**

TOTAL (L.S.) 1.00

36 **SPCC PLAN - 7736**

TOTAL (L.S.) 1.00

37 **STRUCTURE SURVEYING - 7037**

Channel Surveying, Retaining Wall Survey

TOTAL (L.S.) 1.00

38 **ROADWAY SURVEYING - 7038**

Roadway Surveying

TOTAL (L.S.) 1.00

39 **SHORING - 7007**

Note: One wall per trench for River Retaining Wall
Two shoring walls needed for Flooding Retaining Walls

Length of Wall Section (LF)	Height of Wall (ft)	Depth to Bedrock (ft)	Wall(s) (S.F.)

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN
THE ITEM HAS BEEN CHANGED.
DELETE THIS NOTE.

HMA (Hot Mixed Asphalt) QUANTITY CALCULATIONS

PROJECT: **US 2, Wenatchee River - Alternative 1**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/17/2008

BEGIN MP	END MP	HMA LENGTH FEET	HMA WIDTH FEET	HMA AREA SF	HMA DEPTH FEET	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL	# OF LANES	# OF LIFTS
MAINLINE PAVING													
	Site 1	0.00	0.0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	2	0
	Site 3	1005.00	34.0	34170.00	0.5	1297.19	1310.17	3796.67	0.19	3015.00	2010.00	2	2.5
	Site 7	1500.00	34.0	51000.00	0.5	1936.11	1955.47	5666.67	0.28	4500.00	3000.00	2	2.5
	Site 9	1000.00	34.0	34000.00	0.5	1290.74	1303.65	3777.78	0.19	3000.00	2000.00	2	2.5
	Flooding Area - Site 2	1100.00	34.0	37400.00	0.5	1419.81	1434.01	4155.56	0.21	3300.00	2200.00	2	2.5
	Flooding Area- Site5	1000.00	34.0	34000.00	0.5	1290.74	1303.65	3777.78	0.19	3000.00	2000.00	2	2.5
BRIDGE END PAVING													

MAINLINE PAVING	7,234.60	7,306.95	21,174.44	1.06	16,815.00	11,210.00
BRIDGE END PAVING	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	7,234.60	7,306.95	21,174.44	1.06	16,815.00	11,210.00
ROUNDED TOTALS FOR ESTIMATE	**7,200.00**	**7,300.00**	**21,200.00**	**1.10**	**16,820.00**	**11,210.00**

Washington State Department of Transportation

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CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 1**
Along an existing retaining wall, a boulder and riprap protected toe is proposed.
Riprap would be grouted (shotcreted) together.

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.

AS OF DATE: 4/17/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
PREPARATION						
1	MOBILIZATION	0001	L.S.	10.00%	1.00	$120,520.68
2	CLEARING AND GRUBBING	0025	ACRE	$6,600.00	0.00	$0.00
3	REMOVING GUARDRAIL	0170	L.F.	$5.00	1,500.00	$7,500.00
4	REMOVE GUARDRAIL ANCHOR	0182	EACH	$360.00	2.00	$720.00
5	REMOVE GUIDEPOSTS	0185	EACH	$6.00	246.00	$1,476.00
GRADING						
6	ROADWAY EXCAVATION INLC. HAUL	0310	C.Y.	$6.00	0.00	$0.00
7	COMMON BORROW INCL. HAUL	0405	C.Y.	$7.00	0	$0.00
8	EMBANKMENT COMPACTION	0470	C.Y.	$4.00	0	$0.00
DRAINAGE						
9	STREAMBED BOULDER	1097	EACH	$3,000.00	188.00	$564,000.00
10	CHANNEL EXCAVATION	1035	C.Y.	$30.00	2,300.00	$69,000.00
11	HEAVY LOOSE RIPRAP	1076	C.Y.	$100.00	1,340.00	$134,000.00
LIQUID ASPHALT						
12	ANTI-STRIPPING ADDITIVE (0.5*(HMA Tons+ ATB Tons)	5334	EST.	$0.00	1.00	$0.00
HOT MIX ASPHALT						
13	PLANING BITUMINOUS PAVEMENT	5711	S.Y.	$1.25	0.00	$0.00
14	HMA CL.1/2" PG 64-28 Depth: 0.50'	5767	TON	$65.00	0.00	$0.00
15	JOB MIX COMPLIANCE PRICE ADJUSTMENT (0.03*$HMA Total)	5830	EST.	$0.00	1.00	$0.00
16	COMPACTION PRICE ADJUSTMENT (0.02*($HMA)	5835	EST.	$0.00	1.00	$0.00
EROSION CONTROL AND PLANTING						
17	ESC LEAD	6403	DAY	$200.00	6.00	$1,200.00
18	SILT FENCE	6373	L.F.	$4.00	2,250	$9,000.00
19	WATER POLLUTION/EROSION CONTROL	6490	EST.	$191,400.00	1.00	$191,400.00
TRAFFIC						
20	RAISING EXISTING BEAM GUARDRAIL	6783	L.F.	$4.00	1,500.00	$6,000.00
21	TRUCK MOUNTED IMPACT ATTENUATOR	7447	EACH	$7,500.00	1.00	$7,500.00
22	OPERATION OF TRUCK MOUNTED IMPACT ATTENUATOR	7449	HR	$30.00	20.00	$600.00
23	REPAIR T.M. IMPACT ATTENUATOR	7450	EACH	$2,500.00	1.00	$2,500.00
24	FLEXIBLE GUIDE POST	6832	EACH	$28.00	246.00	$6,888.00
25	PAINT LINE	6806	L.F.	$2.00	0.00	$0.00
26	RECESSED PAVEMENT MARKER	6889	HUND.	$265.00	8.00	$2,120.00
27	TEMPORARY PAVEMENT MARKING	6888	L.F.	$0.50	0.00	$0.00
28	PORTABLE CHANGEABLE MESSAGE SIGN	6994	EACH	$5,500.00	2.00	$11,000.00
29	OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGI	6995	HR	$2.50	2,400.00	$6,000.00
30	PROJECT TEMPORARY TRAFFIC CONTROL	6971	L.S.	5.00%	1.00	$57,390.80
31	FLAGGERS AND SPOTTERS	6980	HR	$57.00	300.00	$17,100.00
32	TRAFFIC CONTROL VEHICLE	6968	DAY	$100.00	10.00	$1,000.00
33	TRAFFIC CONTROL SUPERVISOR	6974	HOUR	$50.00	150.00	$7,500.00
34	CONSTRUCTION SIGNS CLASS A	6982	S.F.	$12.00	276.00	$3,312.00
OTHER ITEMS						
35	ROADSIDE CLEANUP	7480	L.S.	$2,000.00	1.00	$2,000.00
36	SPCC PLAN	7736	L.S.	$1,000.00	1.00	$1,000.00
37	STRUCTURE SURVEYING	7037	L.S.	$5,000.00	1.00	$5,000.00
38	ROADWAY SURVEYING	7038	L.S.	$5,000.00	0.00	$0.00
39	SHORING	7007	S.F.	$2.00	0.00	$0.00
40	BACKFILL FOR ROCK WALL	7167	TON	$35.00	0.00	$0.00
41	SHOTCRETE FACING (GROUTING RIPRAP)	7561	S.F.	$20.00	4,500.00	$90,000.00
STRUCTURE						
42	ST. REIN. BAR FOR RETAINING WALL	4150	LB	$2.00	0.00	$0.00
43	CONC. CLASS 4000 FOR RETAINING WALL	4139	C.Y.	$1,000.00	0.00	$0.00

MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR	1.00%	$13,257.27
CONSTRUCTION TOTAL		$1,338,984.75
SALES TAX	8.00%	$107,118.78
SUB TOTAL		$1,446,103.54
CONSTRUCTION ENGINEERING (CE)	15%	$216,915.53
CONTINGENCIES	4%	$57,844.14
CN		**$1,720,863.21**
RW		$0.00
Mitigation Costs		$0.00
PE	24%	$413,007.17
PROJECT TOTAL		**$2,133,870.38**

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

SCOPING ESTIMATE - SUMMARY

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 1**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/18/2008

PREPARATION

1 MOBILIZATION - 0001

Note: Mobilization is a percentage of the pre-total. (See Estimate Tab)

2 CLEARING AND GRUBBING - 0025

	Site 1	
Length (LF)	0	Existing Retaining wall in place
Slope Length (LF)	40	
Total (Acres)	0	
Total	0.0000	

TOTAL (ACRE)	0.00

3 REMOVING GUARDRAIL - 0170

Note: Flooding Areas include 200' (LF) transitions on both ends

	Length (LF)	
Site 1	1500	Removal needed inorder to construct/place Boulders and Riprap
Total	1500	

TOTAL (LF)	1500.00

4 REMOVE GUARDRAIL ANCHOR - 0182

Mp	Lt/Rt	Qty.

Note: Assume the each length has one on each end (1x2 = 2)

TOTAL (EA)	2.00

5 **REMOVE GUIDEPOSTS - 0185**

Note: Assume that the number of Guideposts to be removed equals the number to install
(See RPM-Guidepost Tab for Quantity)

TOTAL (EA)	246.00

GRADING

6 **ROADWAY EXCAVATION INCL. HAUL - 0310**

	Length(LF)	Width (LF)	Roadway Depth(LF)	Sum (C.Y.)	
Site 1	0	34	2	0	(No Roadway Excavation at thi
			Total (C.Y.)	0	

TOTAL (CY)	0.00

7 **COMMON BORROW INCL. HAUL - 0405**

Note: Ten feet added to wall heights to meet bed rock

	Length of Wall (LF)	Width (LF)	Height (LF)	Sum (C.Y.)	
Site 1	0	8	42	0	(Existing Wall)
			Total (C.Y.)	0	

Note: Assume Triangular Distribution

Flooding Roadway:

TOTAL (CY)	0.00

8 **EMBANKMENT COMPACTION - 0470**

Note: Compact base of wall and stockpile file
Total = 2 X Common Borrow Value

TOTAL (CY)	0.00

DRAINAGE

9 **STREAMBED BOULDER - 1097**

Note: Equals the LF of channel divided by the Average Diameter

	Length (LF)	Average Boulder Diameter (LF)	
Site 1	1500	8	187.5
		Total Boulders Needed (Each)	187.5

TOTAL (EACH)	188.00

10 **CHANNEL EXCAVATION - 1035**

Note: Recontouring Channel and the Toe of the River Bank

	Length of Channel(LF)	Width of Channel (LF)	Excavation Depth (LF)	Sum (C.Y.)
Site 1	1500	10	4	2222.22
			Total (C.Y.)	2222.22

TOTAL (C.Y.)	2300.00

11 **HEAVY LOOSE RIPRAP - 1076**

Note: Assume that boulders (#9) are buried up to half of the diameter (4') at the toe of the reinforced wall
Assume Riprap height will be half the height of the exposed wall minus the above mentioned boulder.
Assume Riprap is a 2' diameter boulder

	Wall Height Exposed (LF)	Height (LF) - Half of Wall Ht. Out of Ground minus 1/2 Boulder Dia.	Height (LF)	Length (LF)	Sum (C.Y.)
Site 1	32	12	12	1500	1333.333333
				Total (C.Y.)	1333.333333

TOTAL (C.Y.)	1,340.00

LIQUID ASPHALT

12 **ANTI-STRIPPING ADDITIVE - 5334**

(0.5*(HMA))

TOTAL (EST.)	0.00

HOT MIX ASPHALT

13 **PLANING BITUMINOUS PAVEMENT - 5711**

See the HMA section of this excel file for quantity calculations.

TOTAL (SY)	0.00

14 **HMA CL. 1/2" PG 64-28 - 5767**

See the HMA section of this excel file for quantity calculations.

TOTAL (TON)	0.00

15 **JOB MIX COMPLIANCE PRICE ADJUSTMENT - 5830**

(0.03*$HMA)

TOTAL (EST.)	See Estimate

16 **COMPACTION PRICE ADJUSTMENT - 5835**

(0.02*$HMA)

TOTAL (EST.)	See Estimate

EROSION CONTROL AND PLANTING

17 **ESC LEAD - 6403**

Referring to Std. Spec 8-01.3(1)B

ESC inspects at least once every 5 working days and each working day there is a runoff event.

10 working days/5 ESC days =	2	days for ESC Lead	Working Days	10
Assumed 4 rainy days	4	days for runoff event		
Total	6	days for ESC lead		

TOTAL (DAY)	6.00

18 **SILT FENCE - 6373**

Note: Equals the entire length of the project times 1.5

	Length (LF)
Site 1	1500
Total (LF)	1500
Total (1.5 Increase)	2250

TOTAL (L.F.)	2250.00

19 **TEMP. WATER POLLUTION/EROSION CONTROL**

Note: Water filled berms can be reused, pricing information is for one section/set up.

Assume all set-up and installation costs are covered in the total price

One Water filled berm - stream diversion

Length of Diversion Needed (LF)	1500
Width of Diversion Needed (2x -LF) ~20'	40
Losses for connections (2x - LF) ~12'	24
Cost for Aqua-Berm per LF	100
Total Cost for Berm $	$ 156,400.00

Dewatering Activities - (Pumping, etc.)	
Total Cost associated with Dewatering per site	$ 35,000.00
Total (EST. for One Setup)	$ 191,400.00

TOTAL (EST.)	1.00

TRAFFIC

Working Days = 60.00 Working Hours (10-hr days) = 600

20 **RAISING EXISTING BEAM GUARDRAIL - 6783**

	Length of Road (LF)
Site 1	1500
Total (LF)	1500

TOTAL (L.F.) 1,500.00

21 **TRUCK-MOUNTED IMPACT ATTENUATOR - 7447**

TOTAL (EACH) 1.00

22 **OPERATION OF TRUCK-MOUNTED IMPACT ATTENUATOR - 7449**

Note: Assume 2 ten hour days

TOTAL (HR) 20.00

23 **REPAIR TRUCK-MOUNTED IMPACT ATTENUATOR - 7450**

Note: assume the attenuator will need 1 repair.

TOTAL (EACH) 1.00

24 **FLEXIBLE GUIDEPOST - 6832**

Note: See RPM-Guidp Sheet

TOTAL (EACH) 246.00

25 **PAINT LINE - 6806**

Note: See Paint Stripe Calc on HMA tab

TOTAL (L.F.) 0.00

26 **RECESSED PAVEMENT MARKINGS - 6889**

Note: See RPM-Guidp Sheet

TOTAL (HUND) 8.00

27 **TEMPORARY PAVEMENT MARKINGS - 6888**

Note: See Temporary Paint on HMA tab

TOTAL (L.F.) 0.00

28 **PORTABLE CHANGEABLE MESSAGE SIGN - 6994**

TOTAL (EA) 2.00

29 **OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGN - 6995**

Note: Set Up 40 Days prior to Construction

Working Days	10
Prior to Construction Days	40
24 hours a day	1200
2 Signs	2
Total Hours	2400

TOTAL (HR) 2,400.00

30 **PROJECT TEMPORARY TRAFFIC CONTROL - 6971**

Item consists of Contractor furnished barricades, cones, flashers, traffic safety drums, and Cl. B signs.
Surfacing / paving require restricted roadway width or detour routing and are intensive traffic control operations.
Note: Total based on 5% of total construction costs (not including Mobilization)

TOTAL (L.S.) 1.00

31 **FLAGGERS AND SPOTTERS - 6980**

Note: Assumed 10 hr working days.
Each flagger works a 10 hr. day, and 3 laborers will be working every chargeable working day.
Assume 5 Days at the beginning, and 5 Days at the end of construction to set up Detour

Laborers	3
Working Days	10
Hours per Day	10
Total (Hours)	300

TOTAL (HR) 300.00

32 **TRAFFIC CONTROL VEHICLE - 6968**

Assume: A TCS will be on the project site every chargeable contract day.
TCS will require a vehicle to transport temporary traffic control devices and Cl. B signs.
Working Days (total) 10

TOTAL (DAY) 10.00

33 **TRAFFIC CONTROL SUPERVISOR - 6972**

Note: Assumed 10 hr working days.
Assume: The TCS will be working every chargeable contract day.
TCS often sets up and removes temporary traffic control devices / Cl. B signs. (Additional 5 days)

Chargeable Working Days	15
Working Hours per Day	10
Total (Hours)	150

TOTAL (HR) 150.00

34 **CONSTRUCTION SIGNS CLASS A - 6982**

Sign Type	Area ft^2	Qty	Total Area
Give 'Em A Brake (G28-101)	28	2	56
Road Work Ahead, 48in x 48 in (W20-1)	16	6	96
Road Work Next "X" Miles (G20-1)	10	2	20
End Road Work (G20-2a)	8	2	16
For Project Information Call XXX-XXXX (G24-501)	12	2	24
Traffic Fines Double in Work Zones (I20-301)	16	2	32
Thank You/ WSDOT-Contractor Name Sign	16	2	32
		Total (S.F.)	276

TOTAL (S.F.) 276.00

OTHER ITEMS

35 **ROADSIDE CLEANUP - 7480**

TOTAL (L.S.) 1.00

36 **SPCC PLAN - 7736**

TOTAL (L.S.) 1.00

37 **STRUCTURE SURVEYING - 7037**

Channel Surveying, Retaining Wall Survey

TOTAL (L.S.) 1.00

38 **ROADWAY SURVEYING - 7038**

Roadway Surveying

TOTAL (L.S.) 0.00

39 **SHORING - 7007**

Note: One wall per trench for River Retaining Wall
Two shoring walls needed for Flooding Retaining Walls

Length of Wall Section (LF)	Height of Wall (ft)	Depth to Bedrock (ft)	Wall(s) (S.F.)

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

HMA (Hot Mixed Asphalt) QUANTITY CALCULATIONS

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 1**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc. AS OF DATE: 4/17/2008
CHECKED BY: Entrix, Inc.

BEGIN MP	END MP	HMA LENGTH FEET	HMA WIDTH FEET	HMA AREA SF	HMA DEPTH FEET	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL	# OF LANES	# OF LIFTS
MAINLINE PAVING													
	Site 1	0.00	0.0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	2	0
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
BRIDGE END PAVING													

	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL
MAINLINE PAVING	0.00	0.00	0.00	0.00	0.00	0.00
BRIDGE END PAVING	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	0.00	0.00	0.00	0.00	0.00	0.00
ROUNDED TOTALS FOR ESTIMATE	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Washington State Department of Transportation

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CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 2**
Proposed roadway area would be raised (w/ retaining walls) to prevent flooding.

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.

AS OF DATE: 4/17/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
PREPARATION						
1	MOBILIZATION	0001	L.S.	10.00%	1.00	$215,691.00
2	CLEARING AND GRUBBING	0025	ACRE	$6,600.00	0.00	$0.00
3	REMOVING GUARDRAIL	0170	L.F.	$5.00	1,100.00	$5,500.00
4	REMOVE GUARDRAIL ANCHOR	0182	EACH	$360.00	2.00	$720.00
5	REMOVE GUIDEPOSTS	0185	EACH	$6.00	182.00	$1,092.00
GRADING						
6	ROADWAY EXCAVATION INLC. HAUL	0310	C.Y.	$6.00	2,800.00	$16,800.00
7	COMMON BORROW INCL. HAUL	0405	C.Y.	$7.00	4,540	$31,780.00
8	EMBANKMENT COMPACTION	0470	C.Y.	$4.00	9,080	$36,320.00
DRAINAGE						
9	STREAMBED BOULDER	1097	EACH	$3,000.00	0.00	$0.00
10	CHANNEL EXCAVATION	1035	C.Y.	$30.00	0.00	$0.00
11	HEAVY LOOSE RIPRAP	1076	C.Y.	$100.00	0.00	$0.00
LIQUID ASPHALT						
12	ANTI-STRIPPING ADDITIVE (0.5*(HMA Tons+ ATB Tons)	5334	EST.	$3,650.00	1.00	$3,650.00
HOT MIX ASPHALT						
13	PLANING BITUMINOUS PAVEMENT	5711	S.Y.	$1.25	21,200.00	$26,500.00
14	HMA CL.1/2" PG 64-28 Depth: 0.50'	5767	TON	$65.00	7,300.00	$474,500.00
15	JOB MIX COMPLIANCE PRICE ADJUSTMENT (0.03*$HMA Total)	5830	EST.	$14,235.00	1.00	$14,235.00
16	COMPACTION PRICE ADJUSTMENT (0.02*($HMA)	5835	EST.	$9,490.00	1.00	$9,490.00
EROSION CONTROL AND PLANTING						
17	ESC LEAD	6403	DAY	$200.00	6.00	$1,200.00
18	SILT FENCE	6373	L.F.	$4.00	1,650	$6,600.00
19	WATER POLLUTION/EROSION CONTROL	6490	EST.	$191,400.00	0.00	$0.00
TRAFFIC						
20	RAISING EXISTING BEAM GUARDRAIL	6783	L.F.	$4.00	1,100.00	$4,400.00
21	TRUCK MOUNTED IMPACT ATTENUATOR	7447	EACH	$7,500.00	1.00	$7,500.00
22	OPERATION OF TRUCK MOUNTED IMPACT ATTENUATOR	7449	HR	$30.00	20.00	$600.00
23	REPAIR T.M. IMPACT ATTENUATOR	7450	EACH	$2,500.00	1.00	$2,500.00
24	FLEXIBLE GUIDE POST	6832	EACH	$28.00	182.00	$5,096.00
25	PAINT LINE	6806	L.F.	$2.00	16,820.00	$33,640.00
26	RECESSED PAVEMENT MARKER	6889	HUND.	$265.00	6.00	$1,590.00
27	TEMPORARY PAVEMENT MARKING	6888	L.F.	$0.50	11,210.00	$5,605.00
28	PORTABLE CHANGEABLE MESSAGE SIGN	6994	EACH	$5,500.00	2.00	$11,000.00
29	OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGI	6995	HR	$2.50	2,400.00	$6,000.00
30	PROJECT TEMPORARY TRAFFIC CONTROL	6971	L.S.	5.00%	1.00	$102,710.00
31	FLAGGERS AND SPOTTERS	6980	HR	$57.00	300.00	$17,100.00
32	TRAFFIC CONTROL VEHICLE	6968	DAY	$100.00	10.00	$1,000.00
33	TRAFFIC CONTROL SUPERVISOR	6974	HOUR	$50.00	150.00	$7,500.00
34	CONSTRUCTION SIGNS CLASS A	6982	S.F.	$12.00	276.00	$3,312.00
OTHER ITEMS						
35	ROADSIDE CLEANUP	7480	L.S.	$2,000.00	1.00	$2,000.00
36	SPCC PLAN	7736	L.S.	$1,000.00	1.00	$1,000.00
37	STRUCTURE SURVEYING	7037	L.S.	$5,000.00	1.00	$5,000.00
38	ROADWAY SURVEYING	7038	L.S.	$5,000.00	1.00	$5,000.00
39	SHORING	7007	S.F.	$2.00	29,200.00	$58,400.00
40	BACKFILL FOR ROCK WALL	7167	TON	$35.00	6,330.00	$221,550.00
41	SHOTCRETE FACING (GROUTING RIPRAP)	7561	S.F.	$20.00	0.00	$0.00
STRUCTURE						
42	ST. REIN. BAR FOR RETAINING WALL	4150	LB	$2.00	53,010.00	$106,020.00
43	CONC. CLASS 4000 FOR RETAINING WALL	4139	C.Y.	$1,000.00	920.00	$920,000.00

MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR		1.00%	$23,726.01
CONSTRUCTION TOTAL			$2,396,327.01
SALES TAX		8.00%	$191,706.16
SUB TOTAL			$2,588,033.17
CONSTRUCTION ENGINEERING (CE)		15%	$388,204.98
CONTINGENCIES		4%	$103,521.33
CN			**$3,079,759.47**
RW			$0.00
Mitigation Costs			$0.00
PE		24%	$739,142.27
PROJECT TOTAL			**$3,818,901.75**

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

SCOPING ESTIMATE - SUMMARY

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 2**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/18/2008

PREPARATION

1 MOBILIZATION - 0001

Note: Mobilization is a percentage of the pre-total. (See Estimate Tab)

2 CLEARING AND GRUBBING - 0025

Total	0.0000

TOTAL (ACRE)	0.00

3 REMOVING GUARDRAIL - 0170

Note: Flooding Areas include 200' (LF) transitions on both ends

	Length (LF)
Flooding Area Site 2	1100
Total	1100

TOTAL (LF)	1100.00

4 REMOVE GUARDRAIL ANCHOR - 0182

Mp	Lt/Rt	Qty.

Note: Assume the each length has one on each end (1x2 =)

TOTAL (EA)	2.00

5 **REMOVE GUIDEPOSTS - 0185**

Note: Assume that the number of Guideposts to be removed equals the number to install
(See RPM-Guidepost Tab for Quantity)

TOTAL (EA) 182.00

GRADING

6 **ROADWAY EXCAVATION INCL. HAUL - 0310**

	Length(LF)	Width (LF)	Roadway Depth(LF)	Sum (C.Y.)
Flooding Area Site 2	1100	34	2	2770.37037
			Total (C.Y.)	2770.37037

TOTAL (CY) 2800.00

7 **COMMON BORROW INCL. HAUL - 0405**

Note: Ten feet added to wall heights to meet bed rock

Length of Wall (LF)	Width (LF)	Height (LF)	Sum (C.Y.)
		Total (C.Y.)	0

Note: Assume Triangular Distribution

Flooding Roadway:
Note: Assume 200' approach lengths, and 4 feet of height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard
Assume triangular approach and descent

	Approach	Flood	Road Width	Fill Needed (CF)
Flood Area Site 2 approach	200	4	34	13600
Flood Area Site 2 decent	200	4	34	13600
			Total (CY)	1007.41

	Approach	Flood	Road Width	Fill Needed (CF)
			Total (CY)	0.00

Note: Four feet height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard

	Roadway	Flood	Road Width	Fill Needed (CF)
Flood Area Site 2	700	4	34	95200
			Total (CY)	3525.93
			Total of Both Sections (CY)	4533.33

TOTAL (CY) 4540.00

8 **EMBANKMENT COMPACTION - 0470**

Note: Compact base of wall and stockpile file
Total = 2 X Common Borrow Value

TOTAL (CY) 9080.00

DRAINAGE

9 **STREAMBED BOULDER - 1097**

Note: Equals the LF of channel divided by the Average Diameter

Length (LF)	Average Boulder Diameter (LF)	
Total Boulders Needed (Each)		0

TOTAL (EACH) 0.00

10 **CHANNEL EXCAVATION - 1035**

Note: Recontouring Channel and the Toe of the River Bank

	Length of Channel(LF)	Width of Channel (LF)	Excavation Depth (LF)	Sum (C.Y.)
			Total (C.Y.)	0.00

TOTAL (C.Y.) 0.00

11 **HEAVY LOOSE RIPRAP - 1076**

Note: Assume that boulders (#9) are buried up to half of the diameter (4') at the toe of the reinforced wall
Assume Riprap height will be half the height of the exposed wall minus the above mentioned boulder.
Assume Riprap is a 2' diameter boulder

Wall Height Exposed (LF)	Height (LF) - Half of Wall Ht. Out of Ground minus 1/2 Boulder Dia.	Height (LF)	Length (LF)	Sum (C.Y.)
			Total (C.Y.)	0

	Height (LF) - From the Roadway to the River	Height (LF) - Half of the slope height	Length (LF)	Sum (C.Y.)
			Total (C.Y.)	0

TOTAL (C.Y.) 0.00

LIQUID ASPHALT

12 **ANTI-STRIPPING ADDITIVE - 5334**

(0.5*(HMA))

TOTAL (EST.) 3650.00

HOT MIX ASPHALT

13 **PLANING BITUMINOUS PAVEMENT - 5711**

See the HMA section of this excel file for quantity calculations.

TOTAL (SY) 21,200.00

14 **HMA CL. 1/2" PG 64-28 - 5767**

See the HMA section of this excel file for quantity calculations.

TOTAL (TON) 7,300.00

15 **JOB MIX COMPLIANCE PRICE ADJUSTMENT - 5830**

(0.03*$HMA)

TOTAL (EST.) See Estimate

16 **COMPACTION PRICE ADJUSTMENT - 5835**

(0.02*$HMA)

TOTAL (EST.) See Estimate

EROSION CONTROL AND PLANTING

17 **ESC LEAD - 6403**

Referring to Std. Spec 8-01.3(1)B
ESC inspects at least once every 5 working days and each working day there is a runoff event.

10 working days/5 ESC days =	2	days for ESC Lead	Working Days	10
Assumed 4 rainy days	4	days for runoff event		
Total	6	days for ESC lead		

TOTAL (DAY) 6.00

18 **SILT FENCE - 6373**

Note: Equals the entire length of the project times 1.5

	Length (LF)	
Flooding Area Site 2	1100	(includes ramp up and down lengths)
Total (LF)	1100	
Total (1.5 Increase)	1650	

TOTAL (L.F.) 1650.00

19 **TEMP. WATER POLLUTION/EROSION CONTROL**

Note: Water filled berms can be reused, pricing information is for one section/set up.
Assume all set-up and installation costs are covered in the total price

One Water filled berm - stream diversion	
Length of Diversion Needed (LF)	1500
Width of Diversion Needed (2x -LF) ~20'	40
Losses for connections (2x - LF) ~12'	24
Cost for Aqua-Berm per LF	100
Total Cost for Berm $	$ 156,400.00
Dewatering Activities - (Pumping, etc.)	
Total Cost associated with Dewatering per site	$ 35,000.00
Total (EST. for One Setup)	$ 191,400.00
One Setup for Each Area	0
Total Setups	0

TOTAL (EST.) 0.00

TRAFFIC

Working Days = 10.00 Working Hours (10-hr days) = 100

20 **RAISING EXISTING BEAM GUARDRAIL - 6783**

	Length of Road (LF)	
Flooding Area Site 2	1100	(includes ramp up and down lengths)
Total (LF)	1100	

TOTAL (L.F.) 1,100.00

21 **TRUCK-MOUNTED IMPACT ATTENUATOR - 7447** **TOTAL (EACH)** 1.00

22 **OPERATION OF TRUCK-MOUNTED IMPACT ATTENUATOR - 7449**

Note: Assume 2 ten hour days **TOTAL (HR)** 20.00

23 **REPAIR TRUCK-MOUNTED IMPACT ATTENUATOR - 7450**

Note: assume the attenuator will need 1 repair. **TOTAL (EACH)** 1.00

24 **FLEXIBLE GUIDEPOST - 6832**

Note: See RPM-Guidp Sheet **TOTAL (EACH)** 182.00

25 **PAINT LINE - 6806**

Note: See Paint Stripe Calc on HMA tab **TOTAL (L.F.)** 16,820.00

26 **RECESSED PAVEMENT MARKINGS - 6889**

Note: See RPM-Guidp Sheet **TOTAL (HUND)** 6.00

27 **TEMPORARY PAVEMENT MARKINGS - 6888**

Note: See Temporary Paint on HMA tab **TOTAL (L.F.)** 11,210.00

28 **PORTABLE CHANGEABLE MESSAGE SIGN - 6994** **TOTAL (EA)** 2.00

29 **OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGN - 6995**

Note: Set Up 40 Days prior to Construction

Working Days	10
Prior to Construction Days	40
24 hours a day	1200
2 Signs	2
Total Hours	2400

TOTAL (HR) 2,400.00

30 **PROJECT TEMPORARY TRAFFIC CONTROL - 6971**

Item consists of Contractor furnished barricades, cones, flashers, traffic safety drums, and Cl. B signs.
Surfacing / paving require restricted roadway width or detour routing and are intensive traffic control operations.
Note: Total based on 5% of total construction costs (not including Mobilization)

TOTAL (L.S.) 1.00

31 **FLAGGERS AND SPOTTERS - 6980**

Note: Assumed 10 hr working days.
Each flagger works a 10 hr. day, and 3 laborers will be working every chargeable working day.
Assume 5 Days at the beginning, and 5 Days at the end of construction to set up Detour

Laborers	3
Working Days	10
Hours per Day	10
Total (Hours)	300

TOTAL (HR) 300.00

32 **TRAFFIC CONTROL VEHICLE - 6968**

Assume: A TCS will be on the project site every chargeable contract day.
TCS will require a vehicle to transport temporary traffic control devices and Cl. B signs.
Working Days (total) 10

TOTAL (DAY) 10.00

33 **TRAFFIC CONTROL SUPERVISOR - 6972**

Note: Assumed 10 hr working days.
Assume: The TCS will be working every chargeable contract day.
TCS often sets up and removes temporary traffic control devices / Cl. B signs. (Additional 5 days)

Chargeable Working Days	15
Working Hours per Day	10
Total (Hours)	150

TOTAL (HR) 150.00

34 **CONSTRUCTION SIGNS CLASS A - 6982**

Sign Type	Area ft^2	Qty	Total Area
Give 'Em A Brake (G28-101)	28	2	56
Road Work Ahead, 48in x 48 in (W20-1)	16	6	96
Road Work Next "X" Miles (G20-1)	10	2	20
End Road Work (G20-2a)	8	2	16
For Project Information Call XXX-XXXX (G24-501)	12	2	24
Traffic Fines Double in Work Zones (I20-301)	16	2	32
Thank You/ WSDOT-Contractor Name Sign	16	2	32
		Total (S.F.)	276

TOTAL (S.F.) 276.00

OTHER ITEMS

35 **ROADSIDE CLEANUP - 7480**

TOTAL (L.S.) 1.00

36 **SPCC PLAN - 7736**

TOTAL (L.S.) 1.00

37 **STRUCTURE SURVEYING - 7037**

Channel Surveying, Retaining Wall Survey

TOTAL (L.S.) 1.00

38 **ROADWAY SURVEYING - 7038**

Roadway Surveying

TOTAL (L.S.) 1.00

39 **SHORING - 7007**

Note: One wall per trench for River Retaining Wall
Two shoring walls needed for Flooding Retaining Walls

Length of Wall Section (LF)	Height of Wall (ft)	Depth to Bedrock (ft)	Wall(s) (S.F.)

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN
THE ITEM HAS BEEN CHANGED.
DELETE THIS NOTE.

HMA (Hot Mixed Asphalt) QUANTITY CALCULATIONS

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 2**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/17/2008

BEGIN MP	END MP	HMA LENGTH FEET	HMA WIDTH FEET	HMA AREA SF	HMA DEPTH FEET	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL	# OF LANES	# OF LIFTS
MAINLINE PAVING													
		0.00	0.0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	2	0
		1005.00	34.0	34170.00	0.5	1297.19	1310.17	3796.67	0.19	3015.00	2010.00	2	2.5
		1500.00	34.0	51000.00	0.5	1936.11	1955.47	5666.67	0.28	4500.00	3000.00	2	2.5
		1000.00	34.0	34000.00	0.5	1290.74	1303.65	3777.78	0.19	3000.00	2000.00	2	2.5
Flooding Area - Site 2		1100.00	34.0	37400.00	0.5	1419.81	1434.01	4155.56	0.21	3300.00	2200.00	2	2.5
Flooding Area- Site5		1000.00	34.0	34000.00	0.5	1290.74	1303.65	3777.78	0.19	3000.00	2000.00	2	2.5
BRIDGE END PAVING													

MAINLINE PAVING	7,234.60	7,306.95	21,174.44	1.06	16,815.00	11,210.00
BRIDGE END PAVING	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	7,234.60	7,306.95	21,174.44	1.06	16,815.00	11,210.00
ROUNDED TOTALS FOR ESTIMATE	**7,200.00**	**7,300.00**	**21,200.00**	**1.10**	**16,820.00**	**11,210.00**

Washington State Department of Transportation

G:\ENGINEERING\PE201\PROJECTS\SR??\SCOPING\

CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 3**

A laid back retaining wall system protected with boulders and smaller riprap toe would be constructed to prevent river undercutting. Roadway would be repaired upon rock wall completion.
Riprap would be grouted (shotcreted) together.

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.

AS OF DATE: 4/17/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
PREPARATION						
1	MOBILIZATION	0001	L.S.	10.00%	1.00	$863,190.09
2	CLEARING AND GRUBBING	0025	ACRE	$6,600.00	0.93	$6,138.00
3	REMOVING GUARDRAIL	0170	L.F.	$5.00	1,000.00	$5,000.00
4	REMOVE GUARDRAIL ANCHOR	0182	EACH	$360.00	2.00	$720.00
5	REMOVE GUIDEPOSTS	0185	EACH	$6.00	167.00	$1,002.00
GRADING						
6	ROADWAY EXCAVATION INLC. HAUL	0310	C.Y.	$6.00	2,500.00	$15,000.00
7	COMMON BORROW INCL. HAUL	0405	C.Y.	$7.00	11,020	$77,140.00
8	EMBANKMENT COMPACTION	0470	C.Y.	$4.00	22,040	$88,160.00
DRAINAGE						
9	STREAMBED BOULDER	1097	EACH	$3,000.00	126.00	$378,000.00
10	CHANNEL EXCAVATION	1035	C.Y.	$30.00	1,500.00	$45,000.00
11	HEAVY LOOSE RIPRAP	1076	C.Y.	$100.00	710.00	$71,000.00
LIQUID ASPHALT						
12	ANTI-STRIPPING ADDITIVE (0.5*(HMA Tons+ ATB Tons)	5334	EST.	$650.00	1.00	$650.00
HOT MIX ASPHALT						
13	PLANING BITUMINOUS PAVEMENT	5711	S.Y.	$1.25	3,800.00	$4,750.00
14	HMA CL.1/2" PG 64-28 Depth: 0.50'	5767	TON	$65.00	1,300.00	$84,500.00
15	JOB MIX COMPLIANCE PRICE ADJUSTMENT (0.03*$HMA Total)	5830	EST.	$2,535.00	1.00	$2,535.00
16	COMPACTION PRICE ADJUSTMENT (0.02*($HMA)	5835	EST.	$1,690.00	1.00	$1,690.00
EROSION CONTROL AND PLANTING						
17	ESC LEAD	6403	DAY	$200.00	6.00	$1,200.00
18	SILT FENCE	6373	L.F.	$4.00	1,510	$6,040.00
19	WATER POLLUTION/EROSION CONTROL	6490	EST.	$191,400.00	1.00	$191,400.00
TRAFFIC						
20	RAISING EXISTING BEAM GUARDRAIL	6783	L.F.	$4.00	1,005.00	$4,020.00
21	TRUCK MOUNTED IMPACT ATTENUATOR	7447	EACH	$7,500.00	1.00	$7,500.00
22	OPERATION OF TRUCK MOUNTED IMPACT ATTENUATO	7449	HR	$30.00	20.00	$600.00
23	REPAIR T.M. IMPACT ATTENUATOR	7450	EACH	$2,500.00	1.00	$2,500.00
24	FLEXIBLE GUIDE POST	6832	EACH	$28.00	167.00	$4,676.00
25	PAINT LINE	6806	L.F.	$2.00	3,020.00	$6,040.00
26	RECESSED PAVEMENT MARKER	6889	HUND.	$265.00	6.00	$1,590.00
27	TEMPORARY PAVEMENT MARKING	6888	L.F.	$0.50	2,010.00	$1,005.00
28	PORTABLE CHANGEABLE MESSAGE SIGN	6994	EACH	$5,500.00	2.00	$11,000.00
29	OPERATION OF PORTABLE CHANGEABLE MESSAGE SIG	6995	HR	$2.50	2,400.00	$6,000.00
30	PROJECT TEMPORARY TRAFFIC CONTROL	6971	L.S.	5.00%	1.00	$411,042.90
31	FLAGGERS AND SPOTTERS	6980	HR	$57.00	300.00	$17,100.00
32	TRAFFIC CONTROL VEHICLE	6968	DAY	$100.00	10.00	$1,000.00
33	TRAFFIC CONTROL SUPERVISOR	6974	HOUR	$50.00	150.00	$7,500.00
34	CONSTRUCTION SIGNS CLASS A	6982	S.F.	$12.00	276.00	$3,312.00
OTHER ITEMS						
35	ROADSIDE CLEANUP	7480	L.S.	$2,000.00	1.00	$2,000.00
36	SPCC PLAN	7736	L.S.	$1,000.00	1.00	$1,000.00
37	STRUCTURE SURVEYING	7037	L.S.	$5,000.00	1.00	$5,000.00
38	ROADWAY SURVEYING	7038	L.S.	$5,000.00	1.00	$5,000.00
39	SHORING	7007	S.F.	$2.00	37,190.00	$74,380.00
40	BACKFILL FOR ROCK WALL	7167	TON	$35.00	13,010.00	$455,350.00
41	SHOTCRETE FACING (GROUTING RIPRAP)	7561	S.F.	$20.00	2,400.00	$48,000.00
STRUCTURE						
42	ST. REIN. BAR FOR RETAINING WALL	4150	LB	$2.00	578,180.00	$1,156,360.00
43	CONC. CLASS 4000 FOR RETAINING WALL	4139	C.Y.	$1,000.00	5,420.00	$5,420,000.00

MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR	1.00%	$94,950.91
CONSTRUCTION TOTAL		$9,590,041.90
SALES TAX	8.00%	$767,203.35
SUB TOTAL		$10,357,245.25
CONSTRUCTION ENGINEERING (CE)	15%	$1,553,586.79
CONTINGENCIES	4%	$414,289.81
CN		**$12,325,121.85**
RW		$0.00
Mitigation Costs		$0.00
PE	24%	$2,958,029.24
PROJECT TOTAL		**$15,283,151.09**

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

SCOPING ESTIMATE - SUMMARY

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 3**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/18/2008

PREPARATION

1 MOBILIZATION - 0001

Note: Mobilization is a percentage of the pre-total. (See Estimate Tab)

2 CLEARING AND GRUBBING - 0025

	Site 3
Length (LF)	1005
Slope Length (LF)	40
Total (Acres)	0.92286501
Total	0.9229

TOTAL (ACRE)	0.93

3 REMOVING GUARDRAIL - 0170

Note: Flooding Areas include 200' (LF) transitions on both ends

	Length (LF)
Site 3	1005
Total	1005

TOTAL (LF)	1000.00

4 REMOVE GUARDRAIL ANCHOR - 0182

Mp	Lt/Rt	Qty.

Note: Assume the each length has one on each end (1x2 = 2)

TOTAL (EA)	2.00

5 **REMOVE GUIDEPOSTS - 0185**

Note: Assume that the number of Guideposts to be removed equals the number to install
(See RPM-Guidepost Tab for Quantity)

TOTAL (EA)	167.00

GRADING

6 **ROADWAY EXCAVATION INCL. HAUL - 0310**

	Length(LF)	Width (LF)	Roadway Depth(LF)	Sum (C.Y.)
Site 3	1005	34	2	2531.111111
			Total (C.Y.)	2531.111111

TOTAL (CY)	2500.00

7 **COMMON BORROW INCL. HAUL - 0405**

Note: Ten feet added to wall heights to meet bed rock

	Length of Wall (LF)	Width (LF)	Height (LF)	Sum (C.Y.)
Site 3	1005	8	37	11017.77778

Total (C.Y.) 11017.77778

Note: Assume Triangular Distribution

Flooding Roadway:

Total of Both Sections (CY) 0.00

TOTAL (CY)	11020.00

8 **EMBANKMENT COMPACTION - 0470**

Note: Compact base of wall and stockpile file
Total = 2 X Common Borrow Value

TOTAL (CY)	22040.00

DRAINAGE

9 **STREAMBED BOULDER - 1097**

Note: Equals the LF of channel divided by the Average Diameter

	Length (LF)	Average Boulder Diameter (LF)	
Site 3	1005	8	125.625

Total Boulders Needed (Each) 125.625

TOTAL (EACH)	126.00

10 **CHANNEL EXCAVATION - 1035**

Note: Recontouring Channel and the Toe of the River Bank

	Length of Channel(LF)	Width of Channel (LF)	Excavation Depth (LF)	Sum (C.Y.)
Site 3	1005	10	4	1488.89
			Total (C.Y.)	1488.89

TOTAL (C.Y.)	1500.00

11 **HEAVY LOOSE RIPRAP - 1076**

Note: Assume that boulders (#9) are buried up to half of the diameter (4') at the toe of the reinforced wall
Assume Riprap height will be half the height of the exposed wall minus the above mentioned boulder.
Assume Riprap is a 2' diameter boulder

	Wall Height Exposed (LF)	Height (LF) - Half of Wall Ht. Out of Ground minus 1/2 Boulder Dia.	Height (LF)	Length (LF)	Sum (C.Y.)
Site 3	27	9.5	9.5	1005	707.2222222
				Total (C.Y.)	707.2222222
				Total (C.Y.)	0

TOTAL (C.Y.) 710.00

LIQUID ASPHALT

12 **ANTI-STRIPPING ADDITIVE - 5334**

(0.5*(HMA))

TOTAL (EST.) 650.00

HOT MIX ASPHALT

13 **PLANING BITUMINOUS PAVEMENT - 5711**

See the HMA section of this excel file for quantity calculations.

TOTAL (SY) 3,800.00

14 **HMA CL. 1/2" PG 64-28 - 5767**

See the HMA section of this excel file for quantity calculations.

TOTAL (TON) 1,300.00

15 **JOB MIX COMPLIANCE PRICE ADJUSTMENT - 5830**

(0.03*$HMA)

TOTAL (EST.) See Estimate

16 **COMPACTION PRICE ADJUSTMENT - 5835**

(0.02*$HMA)

TOTAL (EST.) See Estimate

EROSION CONTROL AND PLANTING

17 **ESC LEAD - 6403**

Referring to Std. Spec 8-01.3(1)B

ESC inspects at least once every 5 working days and each working day there is a runoff event.

10 working days/5 ESC days =	2	days for ESC Lead	Working Days	10
Assumed 4 rainy days	4	days for runoff event		
Total	6	days for ESC lead		

TOTAL (DAY) 6.00

18 **SILT FENCE - 6373**

Note: Equals the entire length of the project times 1.5

	Length (LF)
Site 3	1005
Total (LF)	1005
Total (1.5 Increase)	1507.5

TOTAL (L.F.) 1510.00

19 **TEMP. WATER POLLUTION/EROSION CONTROL**

Note: Water filled berms can be reused, pricing information is for one section/set up.

Assume all set-up and installation costs are covered in the total price

One Water filled berm - stream diversion	
Length of Diversion Needed (LF)	1500
Width of Diversion Needed (2x -LF) ~20'	40
Losses for connections (2x - LF) ~12'	24
Cost for Aqua-Berm per LF	100
Total Cost for Berm $	$ 156,400.00

Dewatering Activities - (Pumping, etc.)

Total Cost associated with Dewatering per site $ 35,000.00

Total (EST. for One Setup) $ 191,400.00

Total Setups 1

TOTAL (EST.) 1.00

TRAFFIC

Working Days = 10.00 Working Hours (10-hr days) = 100

20 RAISING EXISTING BEAM GUARDRAIL - 6783

	Length of Road (LF)
Site 3	1005
Total (LF)	1005

TOTAL (L.F.) 1,005.00

21 TRUCK-MOUNTED IMPACT ATTENUATOR - 7447 **TOTAL (EACH)** 1.00

22 OPERATION OF TRUCK-MOUNTED IMPACT ATTENUATOR - 7449

Note: Assume 2 ten hour days **TOTAL (HR)** 20.00

23 REPAIR TRUCK-MOUNTED IMPACT ATTENUATOR - 7450

Note: assume the attenuator will need 1 repair. **TOTAL (EACH)** 1.00

24 FLEXIBLE GUIDEPOST - 6832

Note: See RPM-Guidp Sheet **TOTAL (EACH)** 167.00

25 PAINT LINE - 6806

Note: See Paint Stripe Calc on HMA tab **TOTAL (L.F.)** 3,020.00

26 RECESSED PAVEMENT MARKINGS - 6889

Note: See RPM-Guidp Sheet **TOTAL (HUND)** 6.00

27 TEMPORARY PAVEMENT MARKINGS - 6888

Note: See Temporary Paint on HMA tab **TOTAL (L.F.)** 2,010.00

28 PORTABLE CHANGEABLE MESSAGE SIGN - 6994 **TOTAL (EA)** 2.00

29 OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGN - 6995

Note: Set Up 40 Days prior to Construction

Working Days	10
Prior to Construction Days	40
24 hours a day	1200
2 Signs	2
Total Hours	2400

TOTAL (HR) 2,400.00

30 PROJECT TEMPORARY TRAFFIC CONTROL - 6971

Item consists of Contractor furnished barricades, cones, flashers, traffic safety drums, and Cl. B signs.
Surfacing / paving require restricted roadway width or detour routing and are intensive traffic control operations.
Note: Total based on 5% of total construction costs (not including Mobilization)

TOTAL (L.S.) 1.00

31 FLAGGERS AND SPOTTERS - 6980

Note: Assumed 10 hr working days.
Each flagger works a 10 hr. day, and 3 laborers will be working every chargeable working day.
Assume 5 Days at the beginning, and 5 Days at the end of construction to set up Detour

Laborers	3
Working Days	10
Hours per Day	10

Total (Hours) 300

TOTAL (HR) 300.00

32 **TRAFFIC CONTROL VEHICLE - 6968**

Assume: A TCS will be on the project site every chargeable contract day.
TCS will require a vehicle to transport temporary traffic control devices and Cl. B signs.
Working Days (total) 10

TOTAL (DAY) 10.00

33 **TRAFFIC CONTROL SUPERVISOR - 6972**

Note: Assumed 10 hr working days.
Assume: The TCS will be working every chargeable contract day.
TCS often sets up and removes temporary traffic control devices / Cl. B signs. (Additional 5 days)

Chargeable Working Days	15
Working Hours per Day	10
Total (Hours)	150

TOTAL (HR) 150.00

34 **CONSTRUCTION SIGNS CLASS A - 6982**

Sign Type	Area ft^2	Qty	Total Area
Give 'Em A Brake (G28-101)	28	2	56
Road Work Ahead, 48in x 48 in (W20-1)	16	6	96
Road Work Next "X" Miles (G20-1)	10	2	20
End Road Work (G20-2a)	8	2	16
For Project Information Call XXX-XXXX (G24-501)	12	2	24
Traffic Fines Double in Work Zones (I20-301)	16	2	32
Thank You/ WSDOT-Contractor Name Sign	16	2	32
		Total (S.F.)	276

TOTAL (S.F.) 276.00

OTHER ITEMS

35 **ROADSIDE CLEANUP - 7480**

TOTAL (L.S.) 1.00

36 **SPCC PLAN - 7736**

TOTAL (L.S.) 1.00

37 **STRUCTURE SURVEYING - 7037**

Channel Surveying, Retaining Wall Survey

TOTAL (L.S.) 1.00

38 **ROADWAY SURVEYING - 7038**

Roadway Surveying

TOTAL (L.S.) 1.00

39 **SHORING - 7007**

Note: One wall per trench for River Retaining Wall
Two shoring walls needed for Flooding Retaining Walls

Length of Wall Section (LF)	Height of Wall (ft)	Depth to Bedrock (ft)	Wall(s) (S.F.)

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN
THE ITEM HAS BEEN CHANGED.
DELETE THIS NOTE.

HMA (Hot Mixed Asphalt) QUANTITY CALCULATIONS

PROJECT: **US 2, Wenatchee River - Alternative 1 Site 3**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/17/2008

BEGIN MP	END MP	HMA LENGTH FEET	HMA WIDTH FEET	HMA AREA SF	HMA DEPTH FEET	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL	# OF LANES	# OF LIFTS
MAINLINE PAVING													
	Site 1	0.00	0.0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	2	0
	Site 3	1005.00	34.0	34170.00	0.5	1297.19	1310.17	3796.67	0.19	3015.00	2010.00	2	2.5
	Site 7		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
	Site 9		34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
Flooding Area - Site 2			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
Flooding Area- Site5			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
BRIDGE END PAVING													

MAINLINE PAVING	1,297.19	1,310.17	3,796.67	0.19	3,015.00	2,010.00
BRIDGE END PAVING	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	1,297.19	1,310.17	3,796.67	0.19	3,015.00	2,010.00
ROUNDED TOTALS FOR ESTIMATE	**1,300.00**	**1,300.00**	**3,800.00**	**0.20**	**3,020.00**	**2,010.00**

Washington State Department of Transportation

G:\ENGINEERING\PE201\PROJECTS\SR??\SCOPING\

CHANGE RED TO BLUE WHEN DONE.

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 1 Sites 4,6,8**
Three moderate hazardous lengths would be riprapped and grouted the slope banks. (No boulder placement).

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.

AS OF DATE: 4/17/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
PREPARATION						
1	MOBILIZATION	0001	L.S.	10.00%	1.00	$158,568.90
2	CLEARING AND GRUBBING	0025	ACRE	$6,600.00	1.58	$10,428.00
3	REMOVING GUARDRAIL	0170	L.F.	$5.00	0.00	$0.00
4	REMOVE GUARDRAIL ANCHOR	0182	EACH	$360.00	0.00	$0.00
5	REMOVE GUIDEPOSTS	0185	EACH	$6.00	0.00	$0.00
GRADING						
6	ROADWAY EXCAVATION INLC. HAUL	0310	C.Y.	$6.00	0.00	$0.00
7	COMMON BORROW INCL. HAUL	0405	C.Y.	$7.00	0	$0.00
8	EMBANKMENT COMPACTION	0470	C.Y.	$4.00	0	$0.00
DRAINAGE						
9	STREAMBED BOULDER	1097	EACH	$3,000.00	0.00	$0.00
10	CHANNEL EXCAVATION	1035	C.Y.	$30.00	2,000.00	$60,000.00
11	HEAVY LOOSE RIPRAP	1076	C.Y.	$100.00	3,000.00	$300,000.00
LIQUID ASPHALT						
12	ANTI-STRIPPING ADDITIVE (0.5*(HMA Tons+ ATB Tons)	5334	EST.	$0.00	1.00	$0.00
HOT MIX ASPHALT						
13	PLANING BITUMINOUS PAVEMENT	5711	S.Y.	$1.25	0.00	$0.00
14	HMA CL.1/2" PG 64-28 Depth: 0.50'	5767	TON	$65.00	0.00	$0.00
15	JOB MIX COMPLIANCE PRICE ADJUSTMENT (0.03*$HMA Total)	5830	EST.	$0.00	1.00	$0.00
16	COMPACTION PRICE ADJUSTMENT (0.02*($HMA)	5835	EST.	$0.00	1.00	$0.00
EROSION CONTROL AND PLANTING						
17	ESC LEAD	6403	DAY	$200.00	7.00	$1,400.00
18	SILT FENCE	6373	L.F.	$4.00	4,010	$16,040.00
19	WATER POLLUTION/EROSION CONTROL	6490	EST.	$191,400.00	2.00	$382,800.00
TRAFFIC						
20	RAISING EXISTING BEAM GUARDRAIL	6783	L.F.	$4.00	0.00	$0.00
21	TRUCK MOUNTED IMPACT ATTENUATOR	7447	EACH	$7,500.00	0.00	$0.00
22	OPERATION OF TRUCK MOUNTED IMPACT ATTENUATO	7449	HR	$30.00	0.00	$0.00
23	REPAIR T.M. IMPACT ATTENUATOR	7450	EACH	$2,500.00	0.00	$0.00
24	FLEXIBLE GUIDE POST	6832	EACH	$28.00	0.00	$0.00
25	PAINT LINE	6806	L.F.	$2.00	0.00	$0.00
26	RECESSED PAVEMENT MARKER	6889	HUND.	$265.00	0.00	$0.00
27	TEMPORARY PAVEMENT MARKING	6888	L.F.	$0.50	0.00	$0.00
28	PORTABLE CHANGEABLE MESSAGE SIGN	6994	EACH	$5,500.00	2.00	$11,000.00
29	OPERATION OF PORTABLE CHANGEABLE MESSAGE SI(	6995	HR	$2.50	2,640.00	$6,600.00
30	PROJECT TEMPORARY TRAFFIC CONTROL	6971	L.S.	5.00%	1.00	$75,509.00
31	FLAGGERS AND SPOTTERS	6980	HR	$57.00	300.00	$17,100.00
32	TRAFFIC CONTROL VEHICLE	6968	DAY	$100.00	15.00	$1,500.00
33	TRAFFIC CONTROL SUPERVISOR	6974	HOUR	$50.00	200.00	$10,000.00
34	CONSTRUCTION SIGNS CLASS A	6982	S.F.	$12.00	276.00	$3,312.00
OTHER ITEMS						
35	ROADSIDE CLEANUP	7480	L.S.	$2,000.00	1.00	$2,000.00
36	SPCC PLAN	7736	L.S.	$1,000.00	1.00	$1,000.00
37	STRUCTURE SURVEYING	7037	L.S.	$5,000.00	1.00	$5,000.00
38	ROADWAY SURVEYING	7038	L.S.	$5,000.00	0.00	$0.00
39	SHORING	7007	S.F.	$2.00	0.00	$0.00
40	BACKFILL FOR ROCK WALL	7167	TON	$35.00	0.00	$0.00
41	SHOTCRETE FACING (GROUTING RIPRAP)	7561	S.F.	$20.00	34,100.00	$682,000.00
STRUCTURE						
42	ST. REIN. BAR FOR RETAINING WALL	4150	LB	$2.00	0.00	$0.00
43	CONC. CLASS 4000 FOR RETAINING WALL	4139	C.Y.	$1,000.00	0.00	$0.00

MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR	1.00%	$17,442.58
CONSTRUCTION TOTAL		$1,761,700.48
SALES TAX	8.00%	$140,936.04
SUB TOTAL		$1,902,636.52
CONSTRUCTION ENGINEERING (CE)	15%	$285,395.48
CONTINGENCIES	4%	$76,105.46
CN		**$2,264,137.46**
RW		$0.00
Mitigation Costs		$0.00
PE	24%	$543,392.99
PROJECT TOTAL		**$2,807,530.44**

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

SCOPING ESTIMATE - SUMMARY

PROJECT: **US 2, Wenatchee River - Alternative 1 Sites 4,6,8**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/18/2008

PREPARATION

1 MOBILIZATION - 0001

Note: Mobilization is a percentage of the pre-total. (See Estimate Tab)

2 CLEARING AND GRUBBING - 0025

Mod. Hazardous Area Site 4	
Length (LF)	1400
Slope Length (LF)	27
Total (Acres)	0.8677686
Mod. Hazardous Area Site 6	
Length (LF)	400
Slope Length (LF)	23
Total (Acres)	0.21120294
Mod. Hazardous Area Site 8	
Length (LF)	870
Slope Length (LF)	25
Total (Acres)	0.49931129
Total	1.5783

TOTAL (ACRE)	1.58

3 REMOVING GUARDRAIL - 0170

Note: Flooding Areas include 200' (LF) transitions on both ends

	Length (LF)
Total	0

TOTAL (LF)	0.00

4 REMOVE GUARDRAIL ANCHOR - 0182

Mp	Lt/Rt	Qty.

Note: Assume the each length has one on each end (0x2 = 0)

TOTAL (EA)	0.00

5 **REMOVE GUIDEPOSTS - 0185**

Note: Assume that the number of Guideposts to be removed equals the number to install
(See RPM-Guidepost Tab for Quantity)

TOTAL (EA) 0.00

GRADING

6 **ROADWAY EXCAVATION INCL. HAUL - 0310**

Length(LF)	Width (LF)	Roadway Depth(LF)	Sum (C.Y.)
		Total (C.Y.)	0

TOTAL (CY) 0.00

7 **COMMON BORROW INCL. HAUL - 0405**

Note: Ten feet added to wall heights to meet bed rock

Length of Wall (LF)	Width (LF)	Height (LF)	Sum (C.Y.)
		Total (C.Y.)	0

Note: Assume Triangular Distribution

Flooding Roadway:
Note: Assume 200' approach lengths, and 4 feet of height needed to prevent roadway flooding
Four feet of height is based on 2' of observed flow and 2' of freeboard
Assume triangular approach and descent

Total of Both Sections (CY) 0.00

TOTAL (CY) 0.00

8 **EMBANKMENT COMPACTION - 0470**

Note: Compact base of wall and stockpile file
Total = 2 X Common Borrow Value

TOTAL (CY) 0.00

DRAINAGE

9 **STREAMBED BOULDER - 1097**

Note: Equals the LF of channel divided by the Average Diameter

Length (LF)	Average Boulder Diameter (LF)	
Total Boulders Needed (Each)	0	

TOTAL (EACH) 0.00

10 **CHANNEL EXCAVATION - 1035**

Note: Recontouring Channel and the Toe of the River Bank

	Length of Channel(LF)	Width of Channel (LF)	Excavation Depth (LF)	Sum (C.Y.)	
Mod. Hazardous Area Site 4	1400	10	2	1037.04	(Boulder Placement is not prop
Mod. Hazardous Area Site 6	870	10	2	644.44	(Boulder Placement is not prop
Mod. Hazardous Area Site 8	400	10	2	296.30	(Boulder Placement is not prop
			Total (C.Y.)	1977.78	

TOTAL (C.Y.) 2000.00

11 **HEAVY LOOSE RIPRAP - 1076**

Note: Assume that boulders (#9) are buried up to half of the diameter (4') at the toe of the reinforced wall
Assume Riprap height will be half the height of the exposed wall minus the above mentioned boulder.
Assume Riprap is a 2' diameter boulder

Wall Height Exposed (LF)	Height (LF) - Half of Wall Ht. Out of Ground minus 1/2 Boulder Dia.	Height (LF)	Length (LF)	Sum (C.Y.)
			Total (C.Y.)	0

	Height (LF) - From the Roadway to the River	Height (LF) - Half of the slope height	Length (LF)	Sum (C.Y.)
Mod. Hazardous Area Site 4	26.6	13.3	1400	1379.259259
Mod. Hazardous Area Site 6	22.55	11.275	400	334.0740741
Mod. Hazardous Area Site 8	25.15	12.575	870	810.3888889
			Total (C.Y.)	2523.722222

TOTAL (C.Y.) 3,000.00

LIQUID ASPHALT

12 **ANTI-STRIPPING ADDITIVE - 5334**

(0.5*(HMA))

TOTAL (EST.) 0.00

HOT MIX ASPHALT

13 **PLANING BITUMINOUS PAVEMENT - 5711**

See the HMA section of this excel file for quantity calculations.

TOTAL (SY) 0.00

14 **HMA CL. 1/2" PG 64-28 - 5767**

See the HMA section of this excel file for quantity calculations.

TOTAL (TON) 0.00

15 **JOB MIX COMPLIANCE PRICE ADJUSTMENT - 5830**

(0.03*$HMA)

TOTAL (EST.) See Estimate

16 **COMPACTION PRICE ADJUSTMENT - 5835**

(0.02*$HMA)

TOTAL (EST.) See Estimate

EROSION CONTROL AND PLANTING

17 **ESC LEAD - 6403**

Referring to Std. Spec 8-01.3(1)B

ESC inspects at least once every 5 working days and each working day there is a runoff event.

15 working days/5 ESC days =	3	days for ESC Lead	Working Days	15
Assumed 4 rainy days	4	days for runoff event		
Total	7	days for ESC lead		

TOTAL (DAY) 7.00

18 **SILT FENCE - 6373**

Note: Equals the entire length of the project times 1.5

	Length (LF)
Mod. Hazard Area Site 4	1400
Mod. Hazard Area Site 6	870
Mod. Hazard Area Site 8	400
Total (LF)	2670
Total (1.5 Increase)	4005

TOTAL (L.F.) 4010.00

19 **TEMP. WATER POLLUTION/EROSION CONTROL**

Note: Water filled berms can be reused, pricing information is for one section/set up.
Assume all set-up and installation costs are covered in the total price

One Water filled berm - stream diversion	
Length of Diversion Needed (LF)	1500
Width of Diversion Needed (2x -LF) ~20'	40
Losses for connections (2x - LF) ~12'	24
Cost for Aqua-Berm per LF	100
Total Cost for Berm $	$ 156,400.00
Dewatering Activities - (Pumping, etc.)	
Total Cost associated with Dewatering per site	$ 35,000.00
Total (EST. for One Setup)	$ 191,400.00
One Setup for Each Area	0
Moderate Hazardous Areas[1]	2
Total Setups	2

TOTAL (EST.) 2.00

[1] Since the lengths for the moderate hazardous areas are short, assume that 2 setups will cover all three areas.

TRAFFIC

Working Days = 15.00 Working Hours (10-hr days) = 150

20 RAISING EXISTING BEAM GUARDRAIL - 6783

Length of Road (LF)	
Total (LF)	0

TOTAL (L.F.) 0.00

21 TRUCK-MOUNTED IMPACT ATTENUATOR - 7447 — **TOTAL (EACH)** 0.00

22 OPERATION OF TRUCK-MOUNTED IMPACT ATTENUATOR - 7449

Note: Assume zero ten hour days — **TOTAL (HR)** 0.00

23 REPAIR TRUCK-MOUNTED IMPACT ATTENUATOR - 7450

Note: assume the attenuator will need 1 repair. — **TOTAL (EACH)** 0.00

24 FLEXIBLE GUIDEPOST - 6832

Note: See RPM-Guidp Sheet — **TOTAL (EACH)** 0.00

25 PAINT LINE - 6806

Note: See Paint Stripe Calc on HMA tab — **TOTAL (L.F.)** 0.00

26 RECESSED PAVEMENT MARKINGS - 6889

Note: See RPM-Guidp Sheet — **TOTAL (HUND)** 0.00

27 TEMPORARY PAVEMENT MARKINGS - 6888

Note: See Temporary Paint on HMA tab — **TOTAL (L.F.)** 0.00

28 PORTABLE CHANGEABLE MESSAGE SIGN - 6994 — **TOTAL (EA)** 2.00

29 OPERATION OF PORTABLE CHANGEABLE MESSAGE SIGN - 6995

Note: Set Up 40 Days prior to Construction

Working Days	15
Prior to Construction Days	40
24 hours a day	1320
2 Signs	2
Total Hours	2640

TOTAL (HR) 2,640.00

30 PROJECT TEMPORARY TRAFFIC CONTROL - 6971

Item consists of Contractor furnished barricades, cones, flashers, traffic safety drums, and Cl. B signs.
Surfacing / paving require restricted roadway width or detour routing and are intensive traffic control operations.

Note: Total based on 5% of total construction costs (not including Mobilization)

TOTAL (L.S.)	1.00

31 FLAGGERS AND SPOTTERS - 6980

Note: Assumed 10 hr working days.
Each flagger works a 10 hr. day, and 3 laborers will be working every chargeable working day.
Assume 5 Days at the beginning, and 5 Days at the end of construction to set up Detour

Laborers	3
Working Days	10
Hours per Day	10
Total (Hours)	300

TOTAL (HR)	300.00

32 TRAFFIC CONTROL VEHICLE - 6968

Assume: A TCS will be on the project site every chargeable contract day.
TCS will require a vehicle to transport temporary traffic control devices and Cl. B signs.
Working Days (total) 15

TOTAL (DAY)	15.00

33 TRAFFIC CONTROL SUPERVISOR - 6972

Note: Assumed 10 hr working days.
Assume: The TCS will be working every chargeable contract day.
TCS often sets up and removes temporary traffic control devices / Cl. B signs. (Additional 5 days)

Chargeable Working Days	20
Working Hours per Day	10
Total (Hours)	200

TOTAL (HR)	200.00

34 CONSTRUCTION SIGNS CLASS A - 6982

Sign Type	Area ft^2	Qty	Total Area
Give 'Em A Brake (G28-101)	28	2	56
Road Work Ahead, 48in x 48 in (W20-1)	16	6	96
Road Work Next "X" Miles (G20-1)	10	2	20
End Road Work (G20-2a)	8	2	16
For Project Information Call XXX-XXXX (G24-501)	12	2	24
Traffic Fines Double in Work Zones (I20-301)	16	2	32
Thank You/ WSDOT-Contractor Name Sign	16	2	32
		Total (S.F.)	276

TOTAL (S.F.)	276.00

OTHER ITEMS

35 ROADSIDE CLEANUP - 7480

TOTAL (L.S.)	1.00

36 SPCC PLAN - 7736

TOTAL (L.S.)	1.00

37 STRUCTURE SURVEYING - 7037

Channel Surveying, Retaining Wall Survey

TOTAL (L.S.)	1.00

38 ROADWAY SURVEYING - 7038

Roadway Surveying

TOTAL (L.S.)	0.00

39 SHORING - 7007

Note: One wall per trench for River Retaining Wall
Two shoring walls needed for Flooding Retaining Walls

Length of Wall Section (LF)	Height of Wall (ft)	Depth to Bedrock (ft)	Wall(s) (S.F.)

Washington State Department of Transportation

CHANGE RED TO BLUE WHEN THE ITEM HAS BEEN CHANGED. DELETE THIS NOTE.

HMA (Hot Mixed Asphalt) QUANTITY CALCULATIONS

PROJECT: **US 2, Wenatchee River - Alternative 1 Sites 4,6,8**
See Estimate Tab for brief description

DESIGNED BY: Entrix, Inc. AS OF DATE: 4/17/2008
CHECKED BY: Entrix, Inc.

BEGIN MP	END MP	HMA LENGTH FEET	HMA WIDTH FEET	HMA AREA SF	HMA DEPTH FEET	HMA QTY TONS	HMA QTY 1% BUMP	PLANING AREA SY	SHOULDER FINISHING MILE	PAINT LINE FEET	TEMP PAINT TOTAL	# OF LANES	# OF LIFTS
MAINLINE PAVING													
			0.0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	2	0
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
			34.0	0.00	0.5	0.00	0.00	0.00	0.00	0.00	0.00	2	2.5
BRIDGE END PAVING													

MAINLINE PAVING	0.00	0.00	0.00	0.00	0.00	0.00
BRIDGE END PAVING	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	0.00	0.00	0.00	0.00	0.00	0.00
ROUNDED TOTALS FOR ESTIMATE	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

APPENDIX F: Alternative Construction of Viaduct

Alternative Construction of Viaduct

While included here, this is not considered a viable alternative for adressing chronic road maintenance issues in the project reach.
Roadway Stabilization – US 2
MP 94.00-98.10
By: ENTRIX, Inc. Date 4/21/2008

PROJECT SYNOPSIS:

DESCRIPTION OF EXISTING CONDITIONS:

Currently US 2 runs along the Wenatchee River in the north central region of Washington State. Two historical high water events (November 25, 1990 and November 30, 1995) caused significant embankment erosion and roadway failure. Pre-emptive repairs were also made during the 2006 fall/winter season to prevent complete roadway failure. High water levels in the river undercut staged riprap that holds the toe of the roadway embankments. The State has spent a little more than $4 million dollars since 1990 on repairs and maintenance in this troublesome area.

PURPOSE OF PROJECT:

The purpose of this project is to increase roadway durability/reliability along US 2 in this area associated with river washout. Additionally, the existing roadway elevation will be raised in two locations to prevent future sheet flow flooding across the roadway. All sites are shown on Figure F-1.

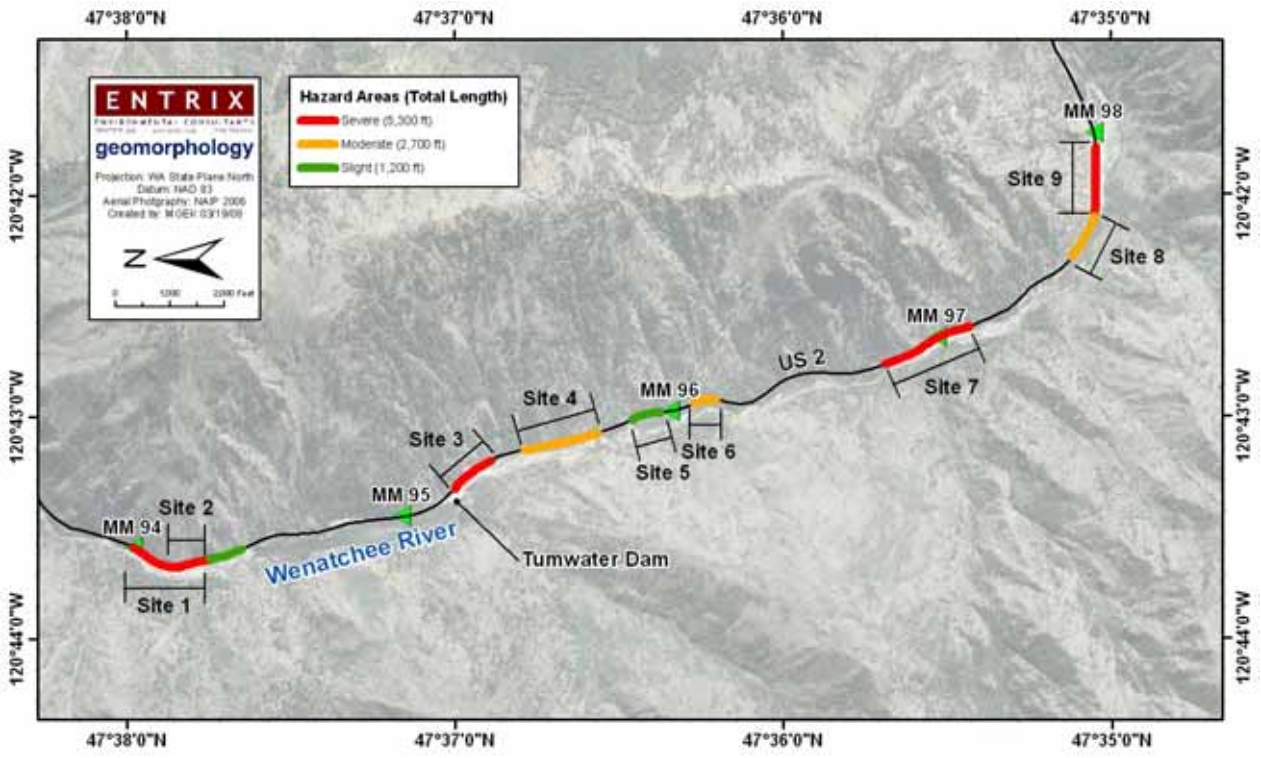

Figure F-1: Project Sites and Road Hazard Areas.

DESCRIPTION OF PROPOSED PROJECT:

Site 1 – MP 94.00 to 94.29 (1,500 Linear Feet)

An existing retaining wall is located in throughout this section. No improvements to the existing wall or section are proposed for this alternative.

Site 2 - MP 94 to MP 94.13 (700 Linear Feet, and 1,200 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be replaced with a viaduct section. This section would be elevated from the current roadway elevation to prevent historical flooding. Similar to the other viaduct sections, a 250 linear foot ramp will be required leading up to the section in question as well as an additional ramp back down to meet the existing roadway (increasing the total length in question by 500 linear feet). The viaduct roadway will include all safety features during construction and upon completion.

Site 3 - MP 95.16 to MP 95.35 (1,000 Linear Feet, and 1,500 Linear Feet Total Including Ramps)

The existing roadway would be removed and replaced with a viaduct roadway providing the river corridor with more area to pass larger flows, while maintaining the roadway integrity. The viaduct section will have to transition into the existing roadway increasing the total length by 500 linear feet. It can be assumed that 250 linear feet are needed for tying into and out of viaduct section. The viaduct roadway will include all safety features during construction and upon completion.

Site 5 - MP 95.80 to MP 95.91 (600 Linear Feet, and 1,100 Linear Feet Total Including Ramps)

To prevent roadway flooding, the existing roadway would be replaced with a viaduct section. This section would be elevated from the current roadway elevation to prevent the recurrence of historical flooding. Similar to the other viaduct sections, a 250 linear foot ramp will be required leading up to the section in question as well as an additional ramp back down to meet the existing roadway (increasing the total length in question by 500 linear feet). The viaduct roadway will include all safety features during construction and upon completion.

Site 7 - MP 96.79 to MP 97.11 (1,500 Linear Feet, and 2,000 Linear Feet Total Including Ramps)

The existing roadway would be removed and replace with a viaduct roadway providing the river corridor with more area to pass larger flows, while maintaining the roadway integrity. The viaduct section will have to transition into the existing roadway increasing the total length by 500 linear feet. It can be assumed that 250 linear feet are needed for tying into and out of viaduct section. The viaduct roadway will include all safety features during construction and upon completion.

Site 9 - MP 97.70 to MP 97.95 (1,000 Linear Feet, and 1,500 Linear Feet Total Including Ramps)

The existing roadway would be removed and replace with a viaduct roadway providing the river corridor with more area to pass larger flows, while maintaining the roadway integrity. The viaduct section will have to transition into the existing roadway increasing the total length by 500 linear feet. It can be assumed that 250 linear feet are needed for tying into and out of viaduct section. The viaduct roadway will include all safety features during construction and upon completion.

COST ESTIMATING INFORMATION:

All cost estimating information and unit costs associated with this proposed alternative can be found below.

PROJECT SCHEDULE AND COSTS:

CN = 2012
CPMS AD Date = TBD
Scheduled AD Date = TBD

Scoping Estimate:

CN = $139.5 million
RW = $0
PE = $50.2 million
TOTAL (uninflated April 2008) = $189.7 million
TOTAL (Inflated for April 2012 CN [1]) = $217 million

[1] Inflation Factor of 14.4% was used based on WSDOT Spreadsheet (from April 2008 to April 2012).

COST ESTIMATE INFORMATION
For Scoping Estimate US-2 Construct Viaduct Alternative

Alternative Three proposes viaduct roadway sections to provide roadway stability and prevent roadway flooding. Below are lengths associated with each area.

Site 1 (Existing Retaining Wall Section)
No improvements are proposed in this area.

Site 3
This section proposes the viaduct roadway for a length of 1000 LF. In order to tie back into the existing roadway additional transitions lengths of 250 LF are required on each side. The total length for viaduct construction proposed equals 1500 LF.

Site 7
This section proposes the viaduct roadway for a length of 1500 LF. In order to tie back into the existing roadway additional transitions lengths of 250 LF are required on each side. The total length for viaduct construction proposed equals 2000 LF.

Site 9
This section proposes the viaduct roadway for a length of 1000 LF. In order to tie back into the existing roadway additional transitions lengths of 250 LF are required on each side. The total length for viaduct construction proposed equals 1500 LF.

Flooding Area Site 2

In order to prevent future roadway flooding, additional viaduct work is proposed in this area. The area is question is approximately 700 LF, and additional transitional lengths of 250 LF are required to tie back into the existing roadway. The total length for viaduct construction proposed equals 1200 LF.

Flooding Area Site 5

In order to prevent future roadway flooding, additional viaduct work is proposed in this area. The area in question is approximately 600 LF, and additional transitional lengths of 250 LF are required to tie back into the existing roadway. The total length for viaduct construction proposed equals 1100 LF.

Total Length of Viaduct Construction for all areas in question equals **7300 LF**.

Washington State Department of Transportation

SCOPING ESTIMATE

PROJECT: **US 2, Wenatchee River - Alternative 3**
Entire Treatment Area

DESIGNED BY: Entrix, Inc.
CHECKED BY: Entrix, Inc.
AS OF DATE: 4/23/2008

ITEM NO.	ITEM	STANDARD ITEM No.	UNITS	UNIT PRICE	QUANTITY	AMOUNT
VIADUCT						
1	Viaduct Construction (All Inclusive)	####	L.F.	$14,721.75	7,300.00	$107,468,775.00
	MISCELLANEOUS CONSTRUCTION ITEMS, 1% FACTOR			1.00%		$1,074,687.75
	CONSTRUCTION TOTAL					$108,543,462.75
	SALES TAX			8.00%		$8,683,477.02
	SUB TOTAL					$117,226,939.77
	CONSTRUCTION ENGINEERING (CE)			15%		$17,584,040.97
	CONTINGENCIES			4%		$4,689,077.59
	CN					**$139,500,058.33**
	RW					$0.00
	PE[1]			36%		$50,220,021.00
	PROJECT TOTAL[2]					**$189,720,079.32**

[1] PE Percentage Rate found on page 23 of "EstimatingGuidlines.pdf", for Catastrophic Reduction use 13% . This value was increased by a factor of 2.8 for consultant costs.

[2] If a more detailed cost estimate is required or needed for this alternative, it is proposed that a transportation engineering firm or someone with similar expertise be consulted to cost estimate this alternative.

UNIT COST INFORMATION
For Scoping Estimate US-2 –Constructing a Viaduct Alternaive

Notes:
Due to lack of information in regards to viaduct construction from the WSDOT standard items table, the following assumptions were made:

- Assume Viaduct Construction is similar to Bridge Construction.
- From 11/21/05, a construction cost of $2.7 million was accepted in the north central region for a 400 LF bridge
- The cost per linear foot of bridge equaled $6,750/LF (in 2005)
- Using the inflation table provided by WSDOT, the present day cost per linear foot of bridge would be $9814.50/LF.
  - 11/05 inflation value of 183.60
  - 4/08 inflation value of 229.00
  - Increased the 2005 value by 45.4%
- Due to the location of the proposed viaduct alignment and difficulty constructing such a project the cost per linear foot was increased by 50%
  - Assumed Cost $14,721.75/LF
- Total Viaduct length equals 7100 LF

If a more detailed cost estimate is required or needed for this alternative, it is proposed that a transportation engineering firm or someone with similar expertise be consulted to cost estimate this alternative.

APPENDIX G: Photographs

Figure 1 - Failure occurring at Mile Post 97.1, Washington US-2, on December 2, 1995. One can envision a roadway prism moved upslope, away from the Wenatchee River, supported by retaining walls and other structure, as seen in the figure below.

Figure 2 - I-70 through Glenwood Canyon, Colorado. The roadway is elevated above the floodplain, bifurcated on separate levels, stepping up the hillslope with a retaining wall and on a viaduct structure. There is a multiple use trail separated from the travel lanes. The retaining wall could bear a form line color and texture more like the natural stone.

Figure 3 – A view of I-70 through Glenwood Canyon, Colorado. The roadway is elevated above the floodplain, bifurcated on separate levels, stepping up the hillslope with a retaining wall and on a viaduct structure. There is a multiple use trail separated from the travel lanes. The concrete retaining wall bears a form line color and texture, and could easily be made to look more like the natural stone.

Figure 4 – Any of the project's retaining walls could bear a form line color and texture more like the natural stone finish, color and texture shown in this example. The texture is a large, coarse stone block, in regular courses. The color mimics the native stone nearby.

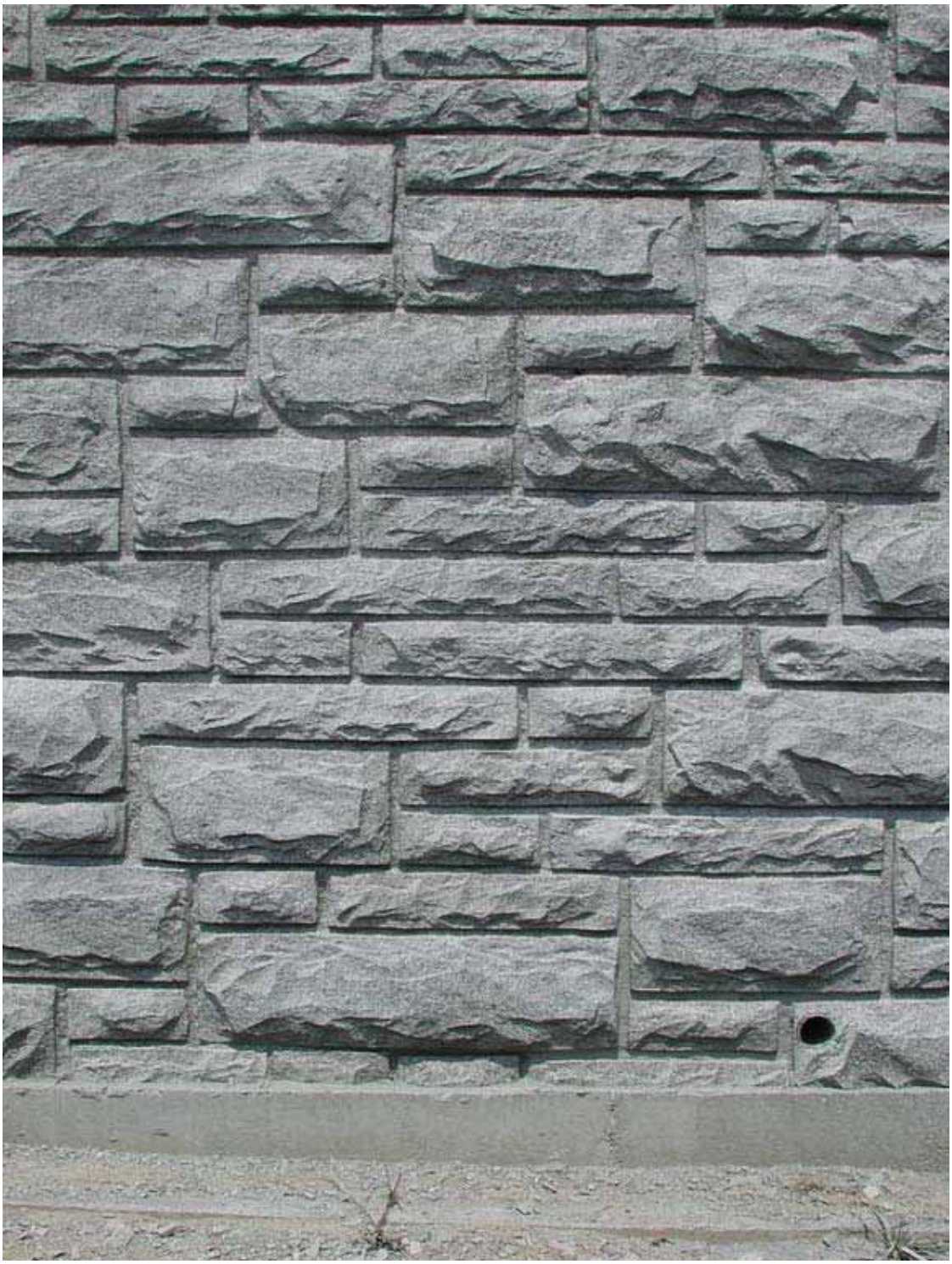

Figure 5 – This concrete retaining wall on the Blue Ridge Parkway bears a split-face granite texture and color produced with the use of form liners and concrete stain. The pattern is a three-height, random ashlar, and was custom-made to give the same appearance as the natural stone retaining walls of the Parkway.

Figure 6 - This concrete facing seen on Utah 189 through Provo Canyon, is designed and built to cover the soil and rock stabilization beneath, and to mimic the native stone in bedding plane, color and texture. The slope stabilization system included a combination of soil nails and rock dowels covered by a temporary shotcrete facing (soil nails only) and a cast-in-place formed finish concrete facing covering all the treated areas.

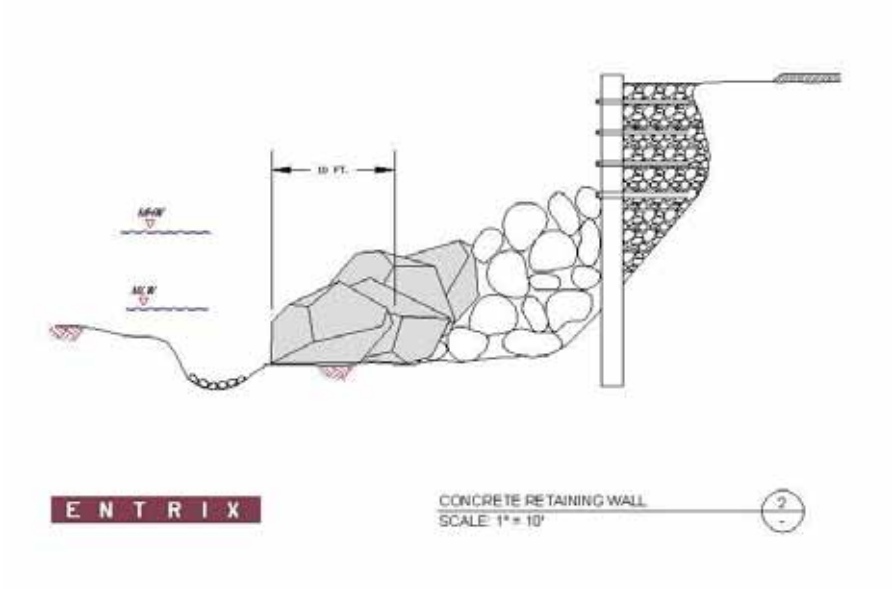

Figure 7 – (Alternates 1 and 2) Rock Toe Protection at Existing Retaining Wall, with 8 to 10 foot diameter boulders below, and 2 foot diameter rip-rap stone up to half the height of the wall.

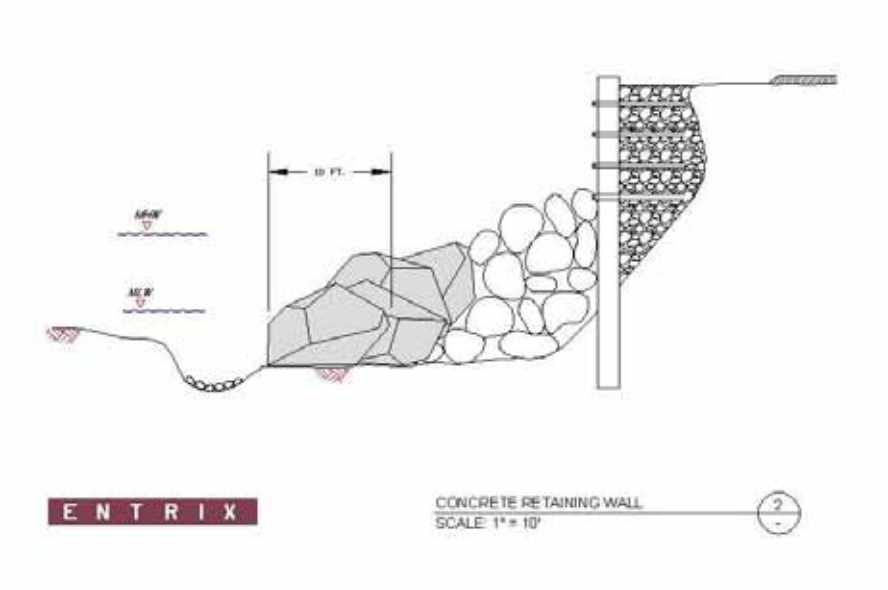

Figure 8 – (Alternate 1) Rock Toe Protection at 1:15 (H:V) Retaining Wall with Form line Finish, with 8 to 10 foot diameter boulders below, and 2 foot diameter rip-rap stone up to half the height of the wall.

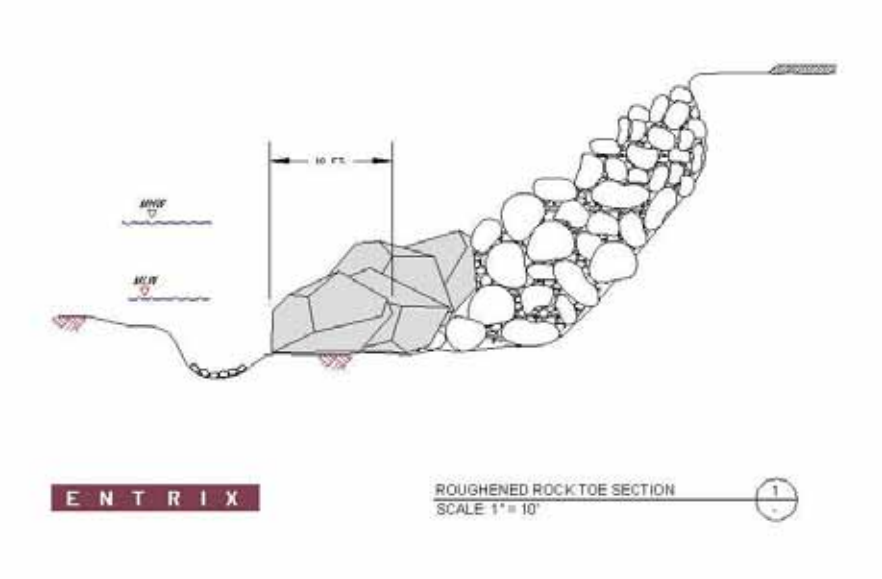

Figure 9 – (Alternate 2) Rock Toe Protection, with 8 to 10 foot diameter boulders below, and 2 foot diameter rip-rap stone up the height of the existing slope.

Photograph Credits:

Figure 1: ENTRIX, Inc.
Figure 2: USDOT, FHWA
Figure 3: USDOT, FHWA
Figure 4: Custom Rock, Inc., St. Paul, MN.
Figure 5: Hunt Valley Contractors, Inc., Owings Mills, MD
Figure 6: DBM Contractors, Inc.
Figure 7: ENTRIX, Inc.
Figure 8: ENTRIX, Inc.
Figure 9: ENTRIX, Inc.

APPENDIX H: Preliminary Outline of Potential Stakeholders

Preliminary Outline of Potential Stakeholders

Purpose

The purpose of this section is to lay out a preliminary assessment of the parties (stakeholders) who have some connection to either Tumwater Canyon, the highway right of way, own property in the canyon or use the canyon for business or personal reasons.

Methodology

Stakeholders potentially interested in this project were identified at meetings held between WSDOT and ENTRIX project staff. Additional stakeholders were identified in the course of the fisheries study, site visits, well log ownership research and the historical and cultural resources assessment conducted by ENTRIX staff.

Analysis

A very preliminary list of stakeholders is presented here. Support for or opposition to the project will depend greatly upon the alternative chosen. It is important to choose a solution for maintenance issues on the project reach of US 2 that takes into account the interests of key stakeholders. Key stakeholders are identified as those who could materially effect the outcome of the decision, or are materially affected by such.

The preliminary assessment of key stakeholders and their concerns are as follows:

- ***Washington State Department of Transportation***

  WSDOT is responsible for maintaining US 2. They are accountable for road repair costs and health and safety issues related to the road and any construction that may occur as a result of this project. WSDOT, as well as the entire state of Washington, has a vested interest in minimizing long term repair costs along the highway through the canyon.

- ***Chelan Public Utilities District***

  The Chelan PUD owns and operates both the Tumwater Dam and fishway in partnership with Washington State Department of Fish and Wildlife (WDFW), two tribes, NOAA, Bureau of Reclamation, and the USFWS. The dam is not used in commercial hydroelectric production and has been this way since 1956. The role of the site as an element of the HCP and ITP that Chelan PUD holds under ESA is to be considered in future decisions. However, Chelan PUD has a stake in both the operation and maintenance of the dam and its fishway. The impact of the dam and associated fishway on upstream fish passage and fish counting is important to Chelan PUD.

- ***City of Leavenworth and Leavenworth Chamber of Commerce***

  On a local scale, the City of Leavenworth and Leavenworth Chamber of Commerce are responsible for ensuring the economic sustainability of Leavenworth through promoting tourism activities. More than 2.5 million tourists come to Leavenworth each year (Leavenworth Chamber of Commerce, 2008). US2 is the major roadway that runs through Leavenworth. Any disruption to the road has a large impact on tourist access and, therefore, the economy of the town.

- ***The Yakama Nation***

  The Yakama Nation co-manages the Wenatchee river fisheries resources and has involvement with salmon restoration efforts at Tumwater Dam. Impacts to salmon in the Wenatchee River may affect sustenance and source of income for the Yakama Nation.

- ***Washington State Department of Fish and Wildlife***

  On a state wide level, the Washington State Department of Fish and Wildlife (WDFW) is responsible for the operation and maintenance of Lake Wenatchee hatchery and the fish sorting facility at Tumwater Dam and is a co-manager with the Tribes. Any amendment to the dam would also impact the fish hatchery. WDFW has indicated that it may be in support of dam removal. The Washington State Historical Society oversees the state historic site at Tumwater Dam and would oppose dam removal, and the Washington State Department of Ecology (DOE) administers permits and oversees state aquatic resources.

- ***National Marine Fisheries Services***

  On a national scale, the National Marine Fisheries Service controls the management of endangered and threatened Salmonid species in Tumwater Canyon, and the United States Fish & Wildlife Service manages the Leavenworth Hatchery and various fisheries restoration efforts in the area. National Marine Fisheries Services has ESA authority and the Secretary can list or de-list. Their preference is to recover salmon and then "de-list." They act in partnership with other stakeholders.

- ***Unites States Forest Service***

  The US Forest Service is the principal landowner in the project area and is responsible for management of the lands adjacent to the river. They will be contacted for permission related to staging areas, access, construction logistics, and possible sources of materials.

Conclusion and Scope

Despite the project's seemingly small four-mile reach, many stakeholders have an interest in the future use of Tumwater Canyon. The highway represents an important east-to-west passage through the Cascade Mountains that is heavily used. Therefore, stakeholder coordination and identification of key project goals is essential to a solution that will benefit all parties. As this project continues and goals are decided and alternatives are chosen, it is critical that all potential stakeholders are kept abreast of developments and findings.

Stakeholder concerns are vital to a project's success and without comments, concerns and agreement among all key stakeholders, a practical and lasting solution would not be possible. Therefore, the first step in this process is refining the identification of key stakeholders in the project in order to understand all concerns that each party may have regarding the future of Tumwater Canyon.

The list of stakeholder above is by no means inclusive or conclusive, and requires refinement, as do their interests. This process can be undertaken thought the multi-criteria analysis process, explained in Appendix C.