DESIGN REPORT

Pilchuck River Bridge #581 Replacement

RC1630, UPI 11-0001-1

Snohomish County
Public Works Department
Steven E. Thomsen, P.E., Public Works Director
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Steve Thomsen, P.E., Public Works Director

Prepared By:

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Pilchuck River Bridge #581 Replacement

RC #1630

FACT SHEET

PROPOSAL:
This project will replace Bridge No. 581 which carries 64th Street NE, a low volume, rural, local access road, over the Pilchuck River. The existing six-span, 179-foot long, single-lane bridge will be replaced with a new single-span, 180-foot long, single-lane bridge. The proposed bridge will be constructed immediately upstream from the existing bridge so pedestrian and vehicle access can be maintained throughout the project. The proposed bridge will be constructed with a prefabricated steel trusses supported by piles or shafts. The project will require mitigation for environmental impacts; the mitigation may require the purchase of additional right of way.

PROPOSPNENT:
Snohomish County Public Works
3000 Rockefeller Avenue
Everett, WA 98201
Phone (425)388-3488

CONTACT PERSON:
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RESPONSIBLE OFFICIAL:
Owen Carter, P.E., County Engineer

AUTHORS:
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Lisa Girven, Project Engineer

REQUIRED PERMITS / ENVIRONMENTAL DOCUMENTATION:

<table>
<thead>
<tr>
<th>ESA Section 7, Consultation and Biological Assessment</th>
<th>National Pollutant Discharge Elimination System (NPDES) permit (if there is &gt; 1 acre of disturbance)</th>
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<td>Shoreline Substantial Development Permit</td>
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<td>Section 401 Water Quality Certification</td>
</tr>
<tr>
<td>State Environmental Policy Act (SEPA) checklist</td>
<td>U.S. Army Corps of Engineers - Section 404 permit</td>
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<tr>
<td>Critical Areas Study and Critical Areas Regulation (CAR) compliance</td>
<td>Section 106, Cultural Resources Compliance &amp; Cultural Resources Investigation</td>
</tr>
<tr>
<td>Hydraulic Project Approval (HPA)</td>
<td>Environmental Classification Summary</td>
</tr>
<tr>
<td>National Environmental Policies Act (NEPA)</td>
<td>Aquatic Land Use Approval</td>
</tr>
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FUNDING:
Federal Bridge Grant
Snohomish County Road Fund

DATE OF ISSUE:
May 10, 2013

DATE OF CONSTRUCTION:
2016
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1. **EXECUTIVE SUMMARY**

Snohomish County Public Works proposes to remove Bridge #581 and replace it with a new single-span, single-lane bridge that is slightly longer. Bridge #581 is on 64th Street NE in the Lochsloy community, between Granite Falls and Lake Stevens. The bridge provides access to a farm on the south side of the Pilchuck River. The project is located in Snohomish County Council District 1.

The existing bridge was constructed in 1960, and portions were rebuilt in 1989 and 2010. Bridge #581 is now a six-span, 179-foot long bridge that is 15-feet wide between curbs. Its various spans have been constructed with either steel plate girders or timber girders. Scour is a concern because the existing bridge is supported by timber piles with unknown penetration depths and because the in-stream piers have a history of accumulating woody debris during high water events. The single-lane bridge has no pavement markings and no specific pedestrian accommodations. The volume of traffic that crosses the bridge is very low and there has been no history of reported accidents in the vicinity of the bridge. The existing bridge is considered structurally deficient and truck load limits are posted.

The proposed bridge is a 180-foot long, single-span, single-lane, prefabricated steel truss bridge that is 15-feet wide between curbs (the same length and width as the existing bridge). The new single-span bridge will eliminate in-stream piers and have more clearance above the 100-year flood elevation to better allow debris to pass under the bridge during high water events. The proposed bridge will remain a single lane structure without pavement markings, and its low traffic volume does not warrant specific pedestrian accommodations.

The proposed bridge will be constructed immediately upstream from the existing bridge, allowing vehicle access to be maintained throughout construction. The bridge foundations will be located outside the ordinary high water mark of the Pilchuck River. Because the road approach on the south side is situated within the mapped floodway, existing approach fill will be removed to balance impacts of new road approach fill so that no additional flood water is displaced. Since the road profile is being raised to increase clearance under the new bridge, avoiding an overall increase of the volume of fill within the floodway, while meeting geometric road design standards, may be challenging. To assure that additional flood water displacement does not occur, Snohomish County Code requires hydraulic analyses to show that encroachment/s will not increase the water elevation during 100-year storm events. A significant portion of the farm roadway connected to the bridge passes through mapped floodway and therefore becomes impassable for periods of time during major flood events; while the new bridge will be functional during flood events, part of the access road to the farm
will continue to flood and become impassable in the same way that it does in the existing condition.

To comply with County design standards for road ends, the new design will incorporate a vehicle turn-around area on the south side of the bridge. At the present time, there is no County right-of-way beyond the bridge. Some individuals have used the bridge to cross over the river onto the private property where they then park and seek river access. Right-of-way acquisition is required for the south bridge approach and vehicle turn-around, but cannot include acquisition of an area for parking unless there is a project-justified need. As no such project need exists, and because past parking activity occurred on private property, the new design may not accommodate parking when there is no known legal obligation to do so.

The project is located within the fish and wildlife habitat conservation area that is established by a buffer zone that extends 150 feet to either side of the river, and mitigation will be required to offset project impacts to buffer and wetlands. Additional right-of-way may need to be purchased to satisfy project mitigation requirements.

The following permits and approvals are anticipated for this project:

<table>
<thead>
<tr>
<th>Permit</th>
<th>Authorizing Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Disturbing Activity Permit</td>
<td>Snohomish County Public Works</td>
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<td>Federal Highway Administration and Washington State Department of Transportation</td>
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<td>National Environmental Policies Act (NEPA)</td>
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<tr>
<td>Section 106, Cultural Resources Compliance</td>
<td>Concurrence from Washington Department of Archaeology and Historic Preservation</td>
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<tr>
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</tr>
</tbody>
</table>
Construction is planned for the summer of 2016, pending permit approvals, right-of-way acquisitions, approvals by WSDOT, and availability of staff.

The Bridge Replacement Advisory Committee selected Pilchuck River Bridge #581 to receive FHWA Highway Bridge Program funds for reconstruction. This is a federal grant administered through WSDOT; the grant covers 80% of the project costs with a 20% local match. Funds for preliminary engineering were obligated in April 2011.

The project cost estimate is shown below; it assumes construction in 2016:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Total Estimated Cost</th>
<th>Local Agency Funding</th>
<th>Federal Funds</th>
<th>Phase Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.E.</td>
<td>$790,444</td>
<td>$158,089</td>
<td>$632,355</td>
<td>March 2011</td>
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<tr>
<td>R/W</td>
<td>$150,000</td>
<td>$30,000</td>
<td>$120,000</td>
<td>September 2013</td>
</tr>
<tr>
<td>Constr.</td>
<td>$3,583,344</td>
<td>$716,669</td>
<td>$2,866,675</td>
<td>2016</td>
</tr>
<tr>
<td>Total</td>
<td>$4,523,788</td>
<td>$904,758</td>
<td>$3,619,030</td>
<td></td>
</tr>
</tbody>
</table>
2. **INTRODUCTION**

Bridge #581 was recommended for replacement by Snohomish County Public Works in 2010. The single lane bridge carries 64th Street NE over the Pilchuck River to serve a 400-acre farm with a horse boarding and training facility and a private residence. The bridge has a sufficiency rating of 34.37 out of 100 points and is posted for load limits. The existing bridge consists of six spans with end piers located in the river. The piers often accumulate large amounts of woody debris during storm events, and the bridge requires frequent inspections to monitor its condition and to remove debris accumulations. Scour is a significant concern because tip elevations of the timber piles are unknown and because the debris accumulations often enable scour at the piers.

The Bridge Replacement Advisory Committee, BRAC, agrees that Bridge #581 should be replaced, and the bridge was approved for federal replacement funds in November, 2010. Field survey work began in the spring of 2011, and a channel migration zone study was completed in February 2013. Hydraulic analysis is being done by Snohomish County Surface Water Management staff. Geotechnical Field investigations were completed in November 2012. The project will implement the preliminary engineering and environmental documentation summarized in this report, together with any proposed recommendations, as it moves forward.

3. **EXISTING CONDITIONS**

Bridge #581 is located approximately 3 miles northeast of the city of Lake Stevens, and about 1/4 mile east of Highway 92, where 64th Street NE crosses the Pilchuck River. The bridge is physically situated in the SW Quarter of Section 27, Township 30 N, Range 6 E, W.M.; a vicinity map is provided at the beginning of this report.

Photographs of the project vicinity, and existing Bridge #581, are shown in Appendix A.

The existing bridge is a 15’ wide (curb-to-curb), 179-foot long, single-lane structure consisting of six spans of varied construction. The two northerly spans are constructed with steel plate girders, while the remaining spans are constructed with timber girders. The driving surface is timber decking. The in-stream piers accumulate large woody debris and are at a high risk for scour. This bridge is closely monitored during high water events and removal of debris accumulation is often required.
The bridge is currently load-limited to 17 tons. The latest inspection report of Bridge #581, dated March 2011, provided a Sufficiency Rating of 34.37 out of 100 points. The bridge is considered “structurally deficient” by National Bridge Inspection Standards.

While there are structural issues with the bridge, the bridge is considered functionally adequate by National Bridge Inspection Standards. The bridge carries a very low volume of vehicle and pedestrian traffic, and most vehicles cross the single-lane bridge at low speeds. There are no accidents on record for 64th Street NE between Highway 92 and the farm.

No utilities are attached to the bridge, but there are overhead power lines along the upstream side of the bridge.

4. TRAFFIC

Traffic safety and capacity are not driving forces for the replacement of this bridge. The new bridge will be designed to current standards and will be the same width as the existing bridge.

4.1. Traffic Counts

The most recent traffic count on this bridge was in June of 2012, and it shows 114 vehicles per day crossing the bridge. This is fairly consistent with the 2010 count of 129 vehicles per day and the 2008 count of 108 vehicles per day. Snohomish County’s traffic division has forecasted an average daily traffic count of 200 vehicles per day in the year 2027.

4.2. Vehicle Speeds

The posted speed limit is 25 mph. The reported 85th percentile speed is 24.6 mph. The reported speed may be in error, or may have been taken elsewhere on 64th St NE, rather than at a point where vehicles are crossing the bridge. On site observations are that vehicles cross the bridge at far slower speeds than 25 mph. The project design speed has been reduced to 20 mph with the approval of the County Engineer.

4.3. Accidents

There are no records of accidents on Bridge #581, or on 64th Street NE. The available records for accident history date from January 2004 to present.
4.4. Detour

No other public roads access the property; therefore, there is no viable detour route. In order to maintain vehicle and pedestrian access throughout construction, the new bridge will be constructed immediately upstream from the existing bridge.

There is a way to access the farm from the Newberg Road by going through gated private roads in the Pilchuck Tree Farm. According to unconfirmed reports, some portions of the private roads are merely rough trails that may only be accessible by four-wheel drive vehicles. Additional unconfirmed reports are that many of the property owners in the Pilchuck Tree Farm would oppose public access on their roads. This route was evaluated as a permanent alternative to the bridge replacement project. The study found that the land route was not a feasible option due to cost, environmental impacts, right-of-way acquisition, and scheduling. The Alternate Route Assessment is included in Appendix E.

5. DESIGN CRITERIA/

5.1. Standards

There are three governing agencies that influence the bridge design: Federal Highway Administration (FHWA), Washington State Department of Transportation (WSDOT) and the County. The proposed bridge design will meet the design criteria set by these agencies. If the design cannot achieve a criterion then a deviation or waiver will be obtained. The low ADT on this road allows for special considerations in the design.

Referenced design standards and guidelines:

GB = AASHTO-A Policy on Geometric Design of Highways and Streets (Green Book)
LAG = WSDOT Local Agency Guidelines (LAG), Chapter 42
EDDS = Snohomish County Engineering Design and Development Standards (EDDS)
LVR = AASHTO Guidelines for Geometric Design of Very Low-Volume Roads (ADT <400)

Per Snohomish County standards, 64th Street NE at Bridge #581 is classified as a 'rural local access road' because it conveys traffic between individual land parcels and higher-order roads, and it does not carry through traffic. Per the AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads, 64th Street NE is considered a 'rural minor access road'.
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Standard</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Speed</td>
<td>EDDS</td>
<td>The design speed has been reduced to 20 MPH with approval of the County Engineer per EDDS section 3-06A.</td>
</tr>
<tr>
<td>Lane Width &amp; Shoulder Width on Approach Roadway</td>
<td>GB, EDDS, LVR</td>
<td>Cross section design for lower volume roads generally addresses total roadway width rather than lane and shoulder width because low volume roads are often unmarked. EDDS requires the entire road surface width to be 24 feet and requires a 5-foot wide paved walkway (EDDS Std Drawing 3-040 and 3-060). North of the bridge, 64th Street SE tapers from 24 feet wide 15-foot wide as it approaches the single lane bridge. South of the bridge there is a widened road approach that allows for parking, turning around, and truck and trailer tracking as they maneuver a horizontal curve. The proposed approach roadway will be similar to the existing with inter-visible pull-offs at each end where drivers can wait for traffic on the bridge to clear. <strong>A Deviation is required to not include a pedestrian walkway.</strong></td>
</tr>
<tr>
<td>Bridge Width</td>
<td>LAG, EDDS, LV</td>
<td>LAG manual 42.61: “minimum width is greater of design roadway width or the existing roadway width”. EDDS 6-038(2) requires a minimum width of 28 feet. AASHTO Low Volume Roads Guidelines allow for replacement of existing one-lane bridges with the same width when there is no evidence of site-specific safety problems and the alignment remains the same or more favorable. <strong>The proposed bridge will be 15 feet wide between curbs</strong> which is the same as the existing bridge. <strong>A Deviation is required to replace the existing bridge without widening.</strong></td>
</tr>
<tr>
<td>Structural Capacity</td>
<td>LAG, EDDS</td>
<td>Bridge design with current AASHTO LRFD Bridge Design Specifications, 2011, 6th edition, and WSDOT Bridge Design Manual. Live Load design vehicle will be the HL-93.</td>
</tr>
<tr>
<td>Horizontal Alignment</td>
<td>EDDS, LVR</td>
<td>EDDS (Section 3-06) does not specify minimum horizontal curve radius for design speeds lower than 25 MPH. AASHTO Low Volume Roads Guidelines provides an equation to calculate the minimum horizontal radius in correlation with the Superelevation Rate and the Design Speed. AASHTO Guidelines for Very Low Volume Roads advises a 125’ minimum horizontal curve radius which may be reduced to a 70’ radius if providing the 125’ minimum radius would require significant additional costs for earthwork or right-of-way acquisition or would have significantly greater environmental impacts. The proposed design provides a 70’ radius horizontal curve which matches existing conditions and significantly reduces costs and environmental impacts.</td>
</tr>
<tr>
<td>Criteria</td>
<td>Standard</td>
<td>Explanation</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Vertical Alignment</td>
<td>EDDS</td>
<td>The bridge profile will be raised at the south end to provide adequate clearance for the 100-year flood. The design will meet the requirements of EDDS Section 3-07 for Vertical Alignment. Aggradation in the river is anticipated to raise the 100 year flood elevation at the bridge by as much as 2 feet in the future; the design allows provides 3’ clearance above the anticipated future 100-year elevation.</td>
</tr>
<tr>
<td>Grade</td>
<td>EDDS</td>
<td>The design will meet the requirements of EDDS Section 3-07 for Grades. Maximum grade allowed is 15% on Local Access Roads. Maximum grade allowed in a cul-de-sac bulb is 6%.</td>
</tr>
<tr>
<td>Traffic Control</td>
<td></td>
<td>The one-lane bridge will require either a yield sign at one end, or a stop sign at both ends. A stop sign at both ends is preferred for the design because it will lessen the sight distance requirements.</td>
</tr>
<tr>
<td>Stopping Sight Distance</td>
<td>EDDS</td>
<td>The design intends to meet the requirements of EDDS Section 3-08 which requires a minimum stopping sight distance of 115 feet for a 20 MPH design speed (on flat grade). If necessary a deviation could be justified to reduce the stopping sight distance to 95 feet due to the low volume of traffic. The proposed one-lane bridge will be controlled with stop signs at each end. The sight distance on approaches is evaluated to the stop sign, rather than through the bridge. Sight distance across the bridge between the vehicle pull-offs is required. Where the profile grade is greater than 3%, the minimum stopping distance will be adjusted to compensate.</td>
</tr>
<tr>
<td>Cross Slope</td>
<td>EDDS, LVR</td>
<td>The north approach will have a crown section with 2% cross-slopes per EDDS Std Drawing 3-040. The South Approach is in a horizontal curve and it will have a 4% maximum superelevation designed to be in compliance with EDDS table 3-4 and the AASHTO Low Volume Roads Guidelines which provides an equation to correlate the design speed with minimum horizontal curve radius and superelevation rates.</td>
</tr>
<tr>
<td>Superelevation</td>
<td>EDDS</td>
<td>EDDS does not apply a maximum superelevation for a design speed of 20 mph (section 3-06, table 3-4).</td>
</tr>
<tr>
<td>Vertical Clearance</td>
<td>LAG, EDDS</td>
<td>LAG manual 42.61 and EDDS section 6 require a 16.5’ minimum vertical clearance for motor vehicles. EDDS section 6 requires a 3’ minimum clearance above the 100-year flood elevation. The design will meet these requirements; however the 100-year flood elevation may increase in the future due to aggradation. The design will attempt to provide 3’ of clearance above the anticipated future 100-year flood elevation.</td>
</tr>
<tr>
<td>Horizontal Clearance</td>
<td>EDDS</td>
<td>The minimum clear zone shall be 10 ft. beyond the travel lane for roads with a posted speed of 35 mph or less (EDDS Std. Drawing 3-040).</td>
</tr>
</tbody>
</table>
Structural

The current edition of the following specifications shall be used in the structural design of the bridge:

- AASHTO LRFD Bridge Design Specifications
- WSDOT Bridge Design Manual
- Snohomish County Engineering Design and Development Standards (EDDS)

Bridge Loads – The following loadings shall be used in the design of the bridge:

- Dead Loads per bridge design with allowance for future utility and overlay per EDDS
- Live Loads per AASHTO LRFD requirements with HL93 Loading, or HS25 Loading with WSDOT consent

6. BRIDGE DESIGN ALTERNATIVES

The proposed bridge will be located immediately upstream of the existing bridge; the existing bridge will remain in service, and the road will remain open, throughout construction. The new bridge will be approximately of the same length as the existing bridge. The new bridge will be a single-span structure, eliminating the need for in-stream piers that can accumulate large woody debris.

The new bridge will be raised to provide more clearance above flood waters, as the Pilchuck River is known to move fallen trees with large root wads during flood events. Snohomish County standards require all new bridges to have at least three feet of clearance above the 100-year flood elevation. The existing bridge does not meet these standards as the water elevation at the south abutment is near the bottom chord of the bridge during moderate floods and above the bottom chord during high floods.

Several options were considered for the proposed Bridge #581 superstructure. The WSDOT Bridge Design Manual and other resources were used to evaluate superstructure options.

1. Prefabricated steel truss

This report recommends the use of a prefabricated steel truss superstructure for the following reasons:

- The design must avoid impacts that would raise the base flood elevation. The depth from the road surface to the lower chord of the steel truss bridge is minimal; this allows the road profile to remain as low as possible, providing
clearance above flood waters while requiring only minimum approach fill within
the floodway.

- The prefabricated steel trusses can be erected with a single crane on one side of
the river. Concrete girders would require a crane to cross the load-restricted
bridge.
- Construction of the new steel truss bridge will not require in-stream work.
- The bridge could be removed and re-assembled in a different location if river
channel conditions change.
- Construction can be completed within one construction season.

2. Pre-stressed Deck Bulb Tee Girders

Deck Bulb Tee girders were evaluated, but the profile of the bridge would need to be
raised substantially higher than with a steel truss due to the girder depth below the
level of the bridge deck. Additionally, a crane would need to cross the existing load
limited bridge to set the concrete girders, so this option was eliminated.

3. Steel Plate Girder

A steel plate girder was considered because it could be designed as a through girder so
that change in road profile could be minimized. The steel plate girder would require a
temporary construction tower in the river to support the girders for splicing. In-water
work would likely delay the project for environmental permitting, and increase relative
costs, so this option was eliminated.

4. Post-tensioned Concrete Through-Girder

A post-tensioned concrete through girder was evaluated, but it would require larger
cranes and temporary supports, and it was subsequently eliminated as an option.

Matrices used to evaluate and compare the various options are included in Appendix B.
7. **SOILS AND FOUNDATIONS**

The foundation design will depend on further geotechnical and hydraulic analysis. The design will allow for the possibility of scour to predicted depths without impact to the structural integrity of the bridge. The County has completed soil borings at the site and County staff is currently preparing the Geotechnical Report for this project.

A Preliminary Geologic, Hydrogeologic and Geologic Hazards Assessment Report has been prepared for this bridge and is included in Appendix C. It was identified that the project site lies within a Sole Source Aquifer and a wellhead protection area. The Geotechnical Report will include recommendations to protect the aquifer resource.

The preliminary report recommends the proposed bridge be supported upon driven pipe piles due to the subsurface soil characteristics and geologic/seismic hazard considerations. Once the driven pipe pile analysis has been completed for the project, more details will become available for foundation design.

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8. **DEVIATIONS**

8.1. **Bridge Width**

An EDDS Deviation is required for the proposed single lane bridge. Snohomish County EDDS requires the bridge roadway to be as wide as the roadway being served, with a minimum width of 28 feet. The AASHTO Guidelines for Geometric Design of Very Low Volume Local Roads advises that when there is no evidence of a site specific safety problem, the replacement bridge can be constructed at the same width as the existing bridge. The existing single-lane bridge is 15 feet wide between curbs. The proposed bridge will be the same width.

8.2. **Pedestrian Walkway**

An EDDS Deviation is required to not include a walkway in the project. EDDS standard Drawings 3-040 and 3-060 require a 5-foot wide paved walkway. The surrounding roads south of Hwy 92 are all unmarked and without pedestrian walkways. No marked pedestrian walkways exist, either before or after the Bridge 581 crossing, and the roadway beyond the bridge approach is a private gravel road. There are no schools in the area.
8.3. Other Deviations

As the design develops, it will be determined if other deviations are appropriate. Some items that may be candidates for deviations are approach slabs and bridge approach guardrail. The slow speed and low ADT may warrant the elimination of bridge approach slabs on this project. The bridge approach guardrail will have crash worthy end treatments at the north end of the bridge, but crash worthy end treatments may be deemed unnecessary at the south end where vehicles are less likely to approach the bridge at high speeds.

9. CONSTRUCTION & ACCESS

The new bridge will be constructed upstream and adjacent to the existing bridge. This will allow the existing bridge to remain in service until the new bridge is open.

The existing bridge is load limited. It is possible, that allowable loads on the bridge could be further reduced if more damage and/or deterioration occur before construction. Pile driving equipment and a crane are the heaviest pieces of machinery needing to cross the existing bridge for construction of the new bridge.

Existing overhead power lines may affect construction operations. See also Section 13 – Utilities in this report.

10. PERMITS / ENVIRONMENTAL DOCUMENTATION

10.1. County

10.1.1. Land Disturbance Activity Permit

The Land Disturbing Activity Permit was formally referred to as a “grading permit”. SCC30.63A “Drainage” and 30.63B “Land Disturbing Activity” detail the requirements for the permit.

10.1.2. Drainage Compliance Approval
The project requires a drainage analysis and report that satisfies the requirements of SCC 30.63A, B, and C. Additional references include, but are not limited to, the Snohomish County Drainage Manual and the Snohomish County Engineering Design & Development Standards (EDDS).

10.1.3. Critical Area Regulation Compliance

Snohomish County is required to designate and protect critical areas pursuant to the Growth Management Act. Critical areas include fish and wildlife habitat conservation areas, wetlands, geologic hazard areas, critical aquifer recharge areas and frequently flooded areas. Development activity by a public agency within Snohomish County is subject to compliance with SCC 30.62 Critical Area Regulations (CAR). The critical areas at the Bridge 581 site will be mapped. A critical area study will be required to evaluate the project impacts to critical areas and their buffers and determine appropriate mitigation measures.

10.1.4. Shoreline Substantial Development Permit

Pursuant to the Shoreline Management Act of 1971 (RCW 90.58), and under SCC Title 30.44, Snohomish County requires a Shoreline Management Permit when substantial development is proposed within shoreline environments. A shoreline permit is required for this project.

10.1.5. Flood Hazard Permit

SCC Title 30.65, Special Flood Hazard Areas, regulates all development within designated flood plains of Snohomish County. Zones have been designated in the floodplains, and varying type and degree of development is allowed in each zone. Replacement of a bridge is allowed, however proposed floodplain activities must be evaluated so that a flood hazard permit can be issued.

10.2. State

10.2.1. State Environmental Policy Act (SEPA)

The Washington State Environmental Policy Act (SEPA) requires all governmental agencies to consider the environmental impacts of a proposed project before decisions are made. An individual SEPA review is required for this project.
10.2.2. **Aquatic Land Use Approval**

Washington State Department of Natural Resources (DNR) requires an easement/right of entry for structures that cross waters of the state.

10.2.3. **Hydraulic Project Approval**

Pursuant to RCW 75.20.100, the Washington Department of Fish and Wildlife (WDFW) requires a Hydraulic Project Approval (HPA) for any project affecting the “waters of the state”. An individual HPA will be required for this project.

10.2.4. **Section 401 Water Quality Certification**

Washington State Department of Ecology requires a section 401 Water Quality Certification in correlation with the Section 404 permit from the Army Corps of Engineers.

10.3. **Federal**

10.3.1. **National Environmental Policy Act (NEPA)**

Major actions which have a federal nexus (i.e., a connection to federal funding, federal permits, or federal land), and may affect the environment, must comply with the National Environmental Policy Act (NEPA). This project has federal permits and federal funding, so NEPA documentation will be required.

The first step in the NEPA documentation process is the preparation of an Environmental Classification Summary (ECS). Then, depending on the nature of the project, either a Categorical Exclusion (CE) or Documented Categorical Exclusion (DCE) will apply.

10.3.2. **US Army Corps of Engineers Section 404 Permit**

In accordance with the Federal Water Pollution Control Act (often referred to as the “Clean Water Act”), the U.S. Army Corps of Engineers’ Section 404 permit is required when dredging or filling activities occur on the water side of the ordinary high water mark in any waters of the United States (33 USC 1344). It is anticipated that this project
will require a Corps permit for placing fill in wetlands and for the removal of the in-stream piers.

10.3.3. National Historic Preservation Act – Section 106 Consultation

Section 106 of the National Historic Preservation Act requires federal agencies to consider the effect of any proposed federal, or federally assisted, undertaking on any site that is included in, or eligible for, inclusion in the National Register of Historic Places (16 USC 470 (f)). A consultant will need to be hired to prepare a Cultural Resources Study for this project.

10.3.4. Endangered Species Act – Section 7 Consultation

To comply with the federal Endangered Species Act, federal agencies must insure that “any action authorized, funded, or carried out by such agency...is not likely to jeopardize the continued existence of [listed species]” (16 USC 1536(a) (2)). This project is funded by a federal agency, and federal authorization is required for various project activities, therefore a Biological Assessment will need to be prepared and a Section 7 consultation will be required.

11. HYDRAULICS

11.1. Channel Migration Zone Study

A consultant was hired to provide a Channel Migration Zone (CMZ) study for this project. The CMZ report is required for compliance with Chapter 30.62 Critical Area Regulations. The study has been completed, and the report concludes that the Pilchuck River is very dynamic in the study area where there are high rates of bank erosion and the potential for the channel to relocate due to avulsions. Because the channel is so dynamic and difficult to predict, it is not reasonable to design protection against all likely channel migration. In the area of the proposed bridge, the right bank (the bank on the right-hand side of an observer facing downstream) consists of glacial till which is resistant to erosion; added bank protection around the proposed right abutment will increase the stability. Currently the left bank at the bridge approach is stabilized by riprap, but progression of the bank erosion that has been occurring on the upstream left bank could cause this riprap to fail. Substantial bank protection is essential to
protect the left abutment. There are signs that a channel avulsion could occur about one quarter mile upstream on the left bank, such an avulsion could redirect the river approximately toward the left bridge approach. This possibility should be kept under observation as part of the overall plans to maintain access across the Pilchuck River at this site, with additional protection measures added as future circumstances require.

The CMZ study noted that aggradation has been occurring at the site and is likely to continue to occur. It is possible that another 2 to 4 feet of sediment may accumulate in the channel and thus reduce the hydraulic capacity of the bridge opening. If 4 feet of sediment was to accumulate in the channel at Bridge 581, Snohomish County estimates that it could raise the 100-year flood elevation by 2 feet. The design will provide an additional 2 feet of clearance above the present-day 100-year flood elevation to account for increased flood elevations that may be seen in the future. If analysis of the design shows that it does not meet zero-rise criteria, the increased bridge clearance may need to be re-evaluated to allow lowering of the bridge approach and placement of less fill.

11.2. Hydraulic Analysis

The County’s Surface Water Management division is developing a 2-dimensional hydraulic model of the reach 2600’ upstream and 2900’ downstream of the bridge. This model will be used to analyze existing and proposed velocities. HEC-RAS modeling is being used to provide the existing and proposed 100-year water surface elevation and to analyze the scour depth.

12. DRAINAGE

This project will be designed in compliance with SCC30.63A “Drainage and 30.63B “Land Disturbing Activity”. The project requires a drainage analysis and report that satisfies the requirements of SCC 30.63A, B, and C. Stormwater design standards for this project include the 2010 Snohomish County Drainage Manual and the Snohomish County Engineering Design & Development Standards (E.D.D.S).

This project will develop a Drainage Report when additional engineering is complete. The existing and proposed conditions will be evaluated to determine the minimum drainage requirements per the 2010 Snohomish County Drainage Manual.
13. UTILITIES

Snohomish County PUD has overhead power lines that cross the Pilchuck River in the location of the proposed bridge. Coordination will be required between Snohomish County Public Works and Snohomish County PUD. At the power pole on the south side of the bridge, the power lines go underground. The County has as-built information showing the approximate location of the underground power lines between the power pole and the farm.

Pilchuck River Bridge 581 provides access to one horse-training facility and one private residence. This is a rural area, and future installation of other utilities is not anticipated.

14. RIGHT-OF-WAY

Right-of-Way acquisitions are required for this project. The proposed bridge will be constructed upstream of the new bridge.

- North end ROW - The County will need to acquire Right-of-Way north of the new bridge and east of 64th Street NE for the new roadway alignment; this property is currently part of a community owned tract.
- South end ROW - The County does not own Right-of-Way south of the bridge; Right-of-Way will need to be acquired from a privately-owned parcel for the bridge approach and turnaround.
- Additional areas - Land will also be required to satisfy requirements for stormwater treatment, stormwater detention, and critical area and buffer impact mitigation.

This project will develop a Right-of-Way plan after additional engineering is complete. The Right-of-Way plan will require approval by the County Engineer and County Council.

15. FUNDING & PROJECT COST

The current project cost estimate is shown below:

- Construction: $3,583,344
- Design (25% of CN): $790,444
- Right-of-Way: $150,000
PROJECT COST $4,523,788

The estimate assumes construction of the bridge in 2016.

This project has a Federal bridge replacement grant. The grant requires a 20% local match. The approved funding is shown below:

- Federal grant: $3,619,030
- Local match (20%): $904,758
- Secured project funds: $4,523,788

The County will provide project updates to WSDOT in the Quarterly Project Reports (QPR). If a budget revision becomes necessary, the County will submit a formal request when the project is nearer to construction.
APPENDIX A

PHOTOGRAPHS
Aerial Photo of the existing bridge taken in July, 2011.

Looking north at existing bridge. The new Bridge will be located to the right.
Looking upstream at the existing bridge.

Looking south at the bridge approach and moderate flooding in the floodplain.
The private access to the farm is cut off by moderate flooding.

South end of existing bridge does not have adequate clearance during heavy flooding. The pictures shown above were taken during flood stage 1.
APPENDIX B

SUPERSTRUCTURE SELECTION EVALUATION
<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Suitable for Site?</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Tensioned Concrete Box Girder</td>
<td>X</td>
<td>Forming and falsework is somewhat complicated, particularly over a flowing river since the bridge must be supported entirely on falsework. Construction time is relatively lengthy due to falsework erection, forming, pouring sequence and curing, and post-tensioning operations. Weight of heavy concrete cross section creates a heavy dead load reaction at the pier. The profile of the bridge would be raised substantially to have adequate clearance above the river and the road approach would need to be raised.</td>
</tr>
<tr>
<td>Prestressed Concrete Deck Bulb Tee</td>
<td>?</td>
<td>Construction details and forming are fairly simple. Girders can be topped with an asphalt overlay for a wearing surface. The girders are at the upper end of the span range. Would require shipping 150'+ girders to the site and erecting them in one piece. Weight of heavy bridge cross section creates a heavy dead load reaction at the pier. A crawler crane would be needed to erect the girders if a crane could not cross the existing bridge. It would cost about $100,000 more for the crane mob. And the crawler crane may be difficult to schedule because it gets tied up on other jobs. The profile of the bridge would be raised substantially to have adequate clearance above the river and the road approach would need to be raised.</td>
</tr>
<tr>
<td>Prestressed Concrete Girder</td>
<td>X</td>
<td>Construction details and forming are fairly simple. Girders require a cast-in-place reinforced concrete deck. The girders are at the upper end of the span range. Would require shipping 150'+ girders to the site and erecting them in one piece. Due to the length and weight of each girder, erection may be a challenge. Weight of heavy concrete cross section creates a heavy dead load reaction at the pier. The profile of the bridge would be raised substantially to have adequate clearance above the river and the road approach would need to be raised.</td>
</tr>
<tr>
<td>Structure Type</td>
<td>Suitable for Site?</td>
<td>Discussion</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Steel Plate Girder</td>
<td>?</td>
<td>Relatively low dead load when compared to a concrete superstructure. Construction details are fairly simple. Various decking options could be considered. Construction time is relatively short. Requires a temporary construction tower to support the girders for splicing – not sure if this will work. Cost of maintenance is higher than for concrete bridges, although weather steel may be considered. The floor beams and stringers could be lowered between the exterior girders to lower the road profile and reduce the need for raising the road approaches. Not aesthetically pleasing.</td>
</tr>
<tr>
<td>Composite Steel Box Girder</td>
<td>X</td>
<td>Typically used for simple spans up to 300 feet. Relatively low dead load when compared to a concrete superstructure. Requires a cast-in-place concrete deck to take advantage of composite section properties. Construction details and forming are more difficult than for a steel plate girder.</td>
</tr>
<tr>
<td>Steel Truss</td>
<td>X</td>
<td>Allows the most clearance above the river without raising the road profile. Construction details are numerous and can be complex. Through trusses restrict horizontal and vertical clearances. Cantilever construction method can facilitate construction over inaccessible areas.</td>
</tr>
<tr>
<td>Prefabricated Steel Truss</td>
<td>X</td>
<td>Similar to MCGR Bridge 660. Relatively low dead load when compared to a concrete superstructure. Various decking options could be considered. Construction time is relatively short. On-site construction details are fairly simple. Aesthetically pleasing. Requires a UBIT truck for bridge inspection. Cost of maintenance is higher than for concrete bridges, although weather steel may be considered.</td>
</tr>
<tr>
<td>Criteria Group</td>
<td>Criteria Description</td>
<td>Criteria Weighting</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Constructability</td>
<td>Can we get the equipment and materials to the far side of the river?</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Is work required within the OTHM/during the fish window?</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Ease of on-site assembly</td>
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</tr>
<tr>
<td></td>
<td>Superstructure Erection Challenges</td>
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<tr>
<td></td>
<td>Are there any challenges to delivering materials to the site (haul route)?</td>
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<td>Environmental</td>
<td>Do we need a ACEO Permit?</td>
<td>15</td>
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<td>Considerations</td>
<td>Do we need a Shoreline Permit?</td>
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<td></td>
<td>Mitigation Requirements</td>
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<td>Will a formal consultation with the Services be required?</td>
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<tr>
<td>Structural/Geotechnical</td>
<td>Amount of pre-design data &amp; analysis required based on dead loads</td>
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<tr>
<td>-------------------------</td>
<td>---------------------------------------------------------------</td>
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<td>score:</td>
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<td>Substructure Costs</td>
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<td></td>
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<td></td>
<td>PE Phase Costs</td>
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<td>Inspection</td>
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<td>Repairability</td>
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<td>Potential for Schedule Impacts</td>
<td>Procurement of materials?</td>
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<tr>
<td></td>
<td>score:</td>
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<td></td>
<td>Construction Scheduling/Working Days Required</td>
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<td></td>
<td>PE Schedule</td>
<td>20</td>
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<tr>
<td></td>
<td>score:</td>
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</tr>
</tbody>
</table>

Total Possible Points = 1450

Total Score: 1105 660
APPENDIX C

PRELIMINARY GEOLOGIC ASSESSMENT REPORT
MEMORANDUM

TO: Lisa Girven, PE – Project Engineer
FROM: Kirk Bailey, LEG, LHG – Engineering Geologist

SUBJECT: Preliminary Geologic, Hydrogeologic and Geologic Hazards Assessment Report
Pilchuck River Bridge 581 Replacement
RC1630-175-37

DATE: March 11, 2013

We understand that the above referenced project as currently proposed will replace the existing Pilchuck River Bridge 581 with a new approximately 20 ft. wide by 200 ft. long two-(2) span bridge placed due east of the existing bridge along the same alignment. Grades may be adjusted to accommodate the longer bridge. Project design is in the preliminary design and permitting stages. The purpose of this memo is to provide preliminary supporting geologic, hydrogeologic and geotechnical information to be utilized during the preparation of the design report, initial permit applications and preliminary design preparations.

The project site is located in central Snohomish County in the Lochsloy area between the City of Lake Stevens and Granite Falls. The surrounding area is primarily rural in nature with limited amounts of rural residential development along SR 92. For reference purposes a Vicinity Map is included at the end of this memorandum showing the approximate location of the project site relative to existing municipal improvements.

GEOLOGIC SETTING

The project site is located within the central portion of the Pilchuck River drainage basin. Topography within the project site is typical for undulating glaciated landscapes throughout the Puget Sound Lowland Physiographic Province. The north-south trending Puget Sound Lowland Physiographic Province, herein
after referred to as the Puget Lowland, covers most of Snohomish County including areas west of the Cascade Mountain foothills and the river basin/river valleys that extend up into the foothills along the eastern part of the County. In general, the Olympic Mountains bound the Puget Lowland to the west and the Cascade Mountains bound it to the east.

The low undulating plains that characterize the landscape within the Puget Lowlands are the result of repeated advances and retreats of the Puget Lobe of the Cordilleran (continental) Glaciers that repeatedly flowed into and out of this area from as far away as Canada during the Pleistocene Epoch (last 2 million years). Current land surfaces in the vicinity of the project site reflect surficial topographic changes directly related to the most recent glacial advance and retreat through the Snohomish County area – geologically referred to as the Vashon Stade of the Fraser Glaciation. The Vashon Stade covered the low-lying areas of Snohomish County with thousands of feet of glacial ice between an estimated 20,000 and 13,000 years ago. Vashon Advance Outwash ($Q_{va}$), Vashon Glacial Till ($Q_{vt}$) and Vashon Recessional Outwash ($Q_{vr}$) soils were all deposited in this area as a result of the glacial advance and retreat of the continental and alpine glaciers during this time period. Existing topography throughout the project area has been slightly altered since the retreat of the glaciers from the area through erosional processes directly related to the Pilchuck River. Recent Alluvium ($Q_{yal}$) has been deposited in and along the Pilchuck River drainage basin as a result of these erosional activities.

SITE GEOLOGY

Surficial geology of the project area has been mapped by the USGS and is shown on the Geologic Map of the Lake Stevens Quadrangle, Snohomish County, Wa. By J.P. Minard dated 1985. The portion of this Geologic Map including the project site is included at the end of this memorandum for reference purposes. In general, the engineering characteristics of the soils found within the project area reflect their depositional mode.

The oldest surficial geologic group mapped in the immediate vicinity of the project site is the Advance Outwash ($Q_{va}$). It consists of fairly clean, fine- to medium-grained sands and gravels laid down as the Vashon aged glaciers advanced into the project area. The Advance Outwash ($Q_{va}$) sands and gravels
have been over-consolidated by hundreds of feet of glacial ice. As such and where undisturbed, they will exhibit excellent engineering characteristics for foundation support, cut slope stability and will meet most gradations for structural fill. Cut slope stability and excavation stability will be lessened where ground water seepage is encountered. Due to potential stability problems, retaining devices, dewatering apparatus and shallow slope laybacks may be necessary to use during construction where evidence of ground water seepage is noted. The sands and gravels of the Advance Outwash ($Q_{va}$) are highly permeable and generally contain significant amounts of ground water. Advance Outwash ($Q_{va}$) is the thickest and most extensive ground water aquifer found in Snohomish County.

Lying on top of the Advance Outwash ($Q_{va}$), Vashon Glacial Till ($Q_{vt}$) soils consist of dense to very dense, fine- to coarse-grained silty sand to sandy silt with gravel. These soils were deposited as lodgment tills below the glacial ice as the glaciers passed through the area. As such, Glacial Till ($Q_{vt}$) has been over-consolidated by hundreds of feet of glacial ice. Locally, these soils are often referred to as “hardpan” due to their dense consistency and cement like nature. Glacial Till ($Q_{vt}$) will exhibit excellent engineering characteristics for soils. It will stand in near vertical cuts, will have excellent foundation support and will exhibit excellent slope stability properties. Due to its high silt content and very dense nature, undisturbed Glacial Till ($Q_{vt}$) is considered an aquiclude – a soil that limits the passage of water in and/or through it. Run-off is generally high in areas where Glacial Till ($Q_{vt}$) is mapped as the surficial soils unit. Material gradations and general moisture sensitivity of the soil makes it difficult to use as a structural fill.

The next to youngest surficially mapped geologic unit found in the vicinity of the project site is Recessional Outwash ($Q_{vr}$). Recessional Outwash ($Q_{vr}$) sands and gravels were deposited in and/or by melt water streams as the Vashon aged glaciers receded out of the project area approximately 13,000 to 11,000 years ago. These soils will exhibit varied engineering characteristics based on topography and/or proximity to the ground water table. Where moisture content does not exceed optimal and the material is well graded, it may be suitable for use as structural fill. The youngest geologic unit in the project site is Recent Alluvium, sometimes differentiated into Younger Alluvium ($Q_{yal}$) and Older Alluvium ($Q_{oal}$), consists of clays, silts, sands and organics deposited in and along the Pilchuck River since the glaciers receded completed out of the Cascade Mountains. Soils within the geologic unit will exhibit engineering characteristics that are consistent with their soils type. They are typically loose and saturated.
PRELIMINARY SITE STRATIGRAPHY

As part of the preliminary site investigations, a test boring has been completed in the immediate vicinity of each abutment location. Test boring locations are shown attached Site Map. Test Boring Logs for B-01 (north abutment) and B-02 (south abutment) are attached at the end of this memorandum for reference purposes. As shown on the Test Boring Logs B-01 and B-02, a good correlation was found between the encountered subsurface soils in the test boring locations and the surficial soils mapped on the Geologic Map.

In general, the soils found below the project site consisted of either Recessional Outwash (Qvr) or Recent Alluvium (Qval) overlying a thick sequence of Glacial Till (Qvt) silty sand to sandy silt and Advance Outwash (Qva) silt. Basal soils at the test boring locations where interpreted as being Transitional Bed (Qtb) silts to sandy silts. Test borings were terminated at depths of 105.5 ft and 115 ft. below ground surface.

GROUND WATER

Due to the proximity of the project site to the Pilchuck River, a shallow ground water table should be anticipated throughout the project site. Ground water will be found throughout the project site in all of the mapped geologic units under either perched, confined or unconfined conditions. All geologic units will contain some amount of ground water, even an aquiclude such as Glacial Till (Qvt), during some periods of the year. Principal aquifers in the vicinity of project site include the Recent Alluvium (Qval) sands and gravels and the Recessional Outwash (Qvr) sands and gravels. Ground water found in the Recent Alluvium (Qval) and the Recessional Outwash (Qvr) deposits is under unconfined conditions in and around the Pilchuck River. Recharge is generally from precipitation. Ground water flow within these deposits will generally be topographically controlled, following the general gradient of the adjacent streams and/or rivers. Shallow ground water will discharge into the Pilchuck River during periods of high precipitation and be recharged by the Pilchuck River during low periods of precipitation.
CRITICAL AQUIFER RECHARGE/WELLHEAD PROTECTION AREAS

Based on the Aquifer Recharge/Wellhead Protection Map the project site is located on the northwest side of the Newberg Sole Source Aquifer as well as within the wellhead protection area for the Lochaven Estates water well. According to the Aquifer Recharge/Wellhead Protection Map the project site is located within an area that has been classified as having moderate aquifer sensitivity. Aquifers with moderate sensitivity are aquifers located 40 to 100 feet below the ground surface where a moderate probability of being impacted from surficial contamination has been determined.

The project as proposed does not include any prohibited uses as defined in Section 330 Prohibited Uses of Snohomish County Critical Aquifer Recharge Area Ordinance Chapter 30.62C. The recommendations contained in the projects Geotechnical Report will be designed to protect the aquifer resource from any potential impacts caused by the project. Due to the depth of the aquifer below the ground surface, the thick sequence of low permeability soils overlying the aquifer, and the moderate sensitivity of the aquifer to contamination from surficial sources – the project will not require a project specific Hydrogeologic Report.

SITE SOIL PROFILES

A Soil Conservation Service (SCS) Soils Survey Map covering the project area is provided at the end of this memorandum. Mapped surficial soil units in the project area include Pilchuck Loamy Sand (50), Puget Silty Clay Loam (55), and Menzel Silt Loam (33). All soil types are formed on alluvial plains or terraces and will exhibit the same engineering characteristics as the underlying geologic unit from which it was derived.
GEOLOGIC HAZARDS

There are no landslide hazard areas, mine hazard areas, tsunami hazard areas or volcanic hazard areas located within 200 ft. of the project site. Based on the readily available information reviewed there are no other previously approved or documented critical areas within 200 ft. of the project site other than those listed under the Critical Aquifer Recharge/Wellhead Protection Areas section above.

The north bank of the Pilchuck River in the immediate vicinity of the project site is oversteepend. The bank may be subject to erosion from both the river and precipitation over the lifespan of the project. As discussed below, it may also be subject to sloughing caused by design level earthquakes. This potential impact will be mitigated by placing the north abutment of the new bridge on pile foundations and by increasing the length of the new bridge - moving the approach further back from the slope/bank than the existing bridge.

EARTHQUAKE HAZARDS

It is probable that the project site will experience the effects of a large earthquake during its lifespan. Earthquake induced impacts to project improvements could arise from soil movement, soil settlement or from soil liquefaction. Although project engineering is in the preliminary stages, it does appear that there will be no large, steep embankments or shallow founded engineered structures within the project area. It is AASHTO’s experience that medium dense to dense, granular embankment fills will be stable during all but the most serious seismic events. Some surficial sloughing may occur within any loose, saturated surficial soil or embankment fill within the project limits during a design level seismic event but this should not impact the overall stability of the proposed replacement bridge.

There are two-2) active fault systems located within 20 miles of the project site. The Darrington-Devils Mountain Fault Zone (DDMFZ) is located approximately 18 miles north of the project site and the South Whidbey Island Fault Zone (SWIFZ) is located approximately 18 mile south of the project site. Offsets along the DDMFZ are significant. Recent studies of the DDMFZ at locations just north of Snohomish County have resulted in data suggesting on-going Holocene (< 10,000 years) movements on the order of
0.5 mm/yr. Activity along the SWIFZ is not fully understood at this time and is subject to on-going investigations and interpretations. Current information suggests slip rates in the range of 0.2 to 0.6 mm/yr with a potential recurrence interval for larger design sized earthquakes on the order of 1000 years.

Other types of potential earthquake related hazards include soil rupture and liquefaction. Liquefaction refers to a phenomenon in which a saturated, loose, cohesionless soil loses strength during a seismic event resulting in vertical and/or lateral movement of the soil. Other than the shallow surficial soils (<16 ft. maximum depth), the observed and mapped soils found below the bridge abutments will not be susceptible to liquefaction or soil rupture due to their density and depositional gradation. If liquefaction or soil rupture were to occur within the shallow surficial soils, due to their shallow depth the resultant motion and impact to the project should be minimal. Given these observed conditions and the relative proximity of the project site to the closest known active fault zone, we conclude that the liquefaction/soil rupture potential of the subsurface soil during a design level seismic event is minimal. It should be noted that even though we believe that the overall potential for large scale soil liquefaction is minimal during a design level seismic event, small layers within the above described soil units may be more susceptible to liquefaction than the larger overall soil unit. This may be reflected at the ground surface by small, limited movements and/or settlements of embankment fills and other project improvements such as culverts, poles and underground utilities.

SEISMIC DESIGN CONSIDERATIONS

Structures along this project alignment will utilize earthquake designs performed in accordance with American Association of State Highway and Transportation Officials (AASHTO) LRFD procedures. AASHTO criteria requires that structure designs be based on earthquake ground motions with a 7% chance of exceedance in 75 years – with a 1000 year return period. AASHTO maps indicate a peak ground acceleration (PGA) between 0.20g and 0.30g for this return period in the Pacific Northwest area. The USGS has completed a more recent regional probabilistic ground motion study for the Pacific Northwest area. The USGS map indicates a site PGA of 0.30g for a recurrence interval of 1000 years in this area. Based on the surficial soil conditions observed during our site reconnaissance and investigations, we recommend that the USGS PGA of 0.30g be utilized for this project. Additional
required geologic inputs for seismic design considerations include: Horizontal Response Spectral Acceleration for a 0.2 and 1.0 second period, site class definition, site coefficient, and a seismic performance zone classification. These parameters will be provided in the site's geotechnical report.

FOUNDATION SUPPORT

Based on the observed subsurface soil characteristics and the geologic/seismic hazard considerations for the project site as described above, we recommend that the proposed bridge be supported upon driven pipe piles.

We trust that this information will meet your current needs. A detailed report discussing these and additional issues will follow once the driven pipe pile analysis has been completed for the project. If you have any questions concerning the geologic and geotechnical issues surrounding this project, please feel free to call.
<table>
<thead>
<tr>
<th>SAMPLE INTERVAL</th>
<th>SPT</th>
<th>STRATA</th>
<th>BLOWS/FT</th>
<th>DEPTH</th>
<th>SOIL DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/2/4</td>
<td></td>
<td></td>
<td>5</td>
<td>0.0 - 0.4' Asphaltic Concrete Pavement (ACP).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.4 - 5.0' Silty Sand; Brown, fine- to medium-grained, little gravel, loose, dry (Embayment Fill).</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4/8/6</td>
<td></td>
<td></td>
<td>10</td>
<td>5.0 - 14.5' Sand and Gravel; Brown, fine- to coarse-grained, trace silt, loose, wet (sp-gp, Recessional Outwash - Qvr).</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3/8/50-60</td>
<td></td>
<td></td>
<td>15</td>
<td>14.5 - 31.0' Silty Sand to Sandy Silt; Gray brown to blue gray, fine- to coarse-grained, little gravels, trace cobbles, very dense, dry (sm-ml, Glacial Till - Qvl).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.5 - 16.0' boulders</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50-5''</td>
<td></td>
<td></td>
<td>20</td>
<td>31.0 - 62.0' Sandy Silt; Blue gray, fine- to coarse-grained, little gravels, local lenses of very fine-grained sand, dense to very dense, damp (ml, Advance Outwash - Qva).</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50-3''</td>
<td></td>
<td></td>
<td>25</td>
<td></td>
<td>9.0' lost circulation</td>
</tr>
<tr>
<td>6</td>
<td>30/50-5</td>
<td></td>
<td></td>
<td>30</td>
<td></td>
<td>31.0' lost circulation</td>
</tr>
<tr>
<td>7</td>
<td>10/17/20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Boring log continued on next page.</td>
</tr>
</tbody>
</table>

NOTES: Soil samples were taken in accordance with ASTM D1586-84 standards and specifications. Soil classifications were developed in the field in accordance with ASTM D2488 and following the Unified Soil Classification system.
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>DEPTH</th>
<th>SOIL DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>40-</td>
<td>31.0 - 62.0' <strong>Sandy Silt</strong> continued from previous page.</td>
<td>11/14/2012 33.5'-115.0' continued drilling hole. Drill mud at 6.9 ft. bgs.</td>
</tr>
<tr>
<td>9</td>
<td>45-</td>
<td>31.0 - 32.5' boulders</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>55-</td>
<td>60.0' increased gravels</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>60-</td>
<td>62.0 - 65.5' <strong>Silt</strong>: Gray, very fine to fine-grained, trace sand, trace gravels, trace to little organics - wood chips and charcoal, medium dense to dense, damp to moist (mi, Transitional Bed-Qib).</td>
<td>Boring log continued on next page.</td>
</tr>
<tr>
<td>12</td>
<td>65-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:** Soil samples were taken in accordance with ASTM D1586-84 standards and specifications. Soil classifications were developed in the field in accordance with ASTM D2488 and following the Unified Soil Classification system.
<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>SAMPLE #</th>
<th>BLOWS/FT</th>
<th>STRATA</th>
<th>DEPTH</th>
<th>SOIL DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>10/11/19</td>
<td></td>
<td></td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>1/14/20</td>
<td></td>
<td></td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>5/13/24</td>
<td></td>
<td></td>
<td>85</td>
<td>85.5 - 109.5' Sand to Silty Sand: Blue gray, fine- to coarse-grained, locally micaceous, very dense, dry (sp-sm, Transitional Bed - Qtb).</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>14/24/20</td>
<td></td>
<td></td>
<td>90</td>
<td>85.5' hard drilling</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>30/40/50</td>
<td></td>
<td></td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>49/50/50</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>40/50-6</td>
<td></td>
<td></td>
<td>105</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:** Soil samples were taken in accordance with ASTM D1586-84 standards and specifications. Soil classifications were developed in the field in accordance with ASTM D2488 and following the Unified Soil Classification system.
<table>
<thead>
<tr>
<th>SAMPLE #</th>
<th>BLOW P/FT</th>
<th>STRATA</th>
<th>DEPTH</th>
<th>SOIL DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>110</td>
<td></td>
<td></td>
<td>85.5 - 109.5’ <strong>Sand to Silty Sand</strong>: continued from previous page.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>115</td>
<td></td>
<td></td>
<td>109.5 - 115.0’ Silt: Blue gray, fine-grained, dense, dry (ml, Transitional Bed - Qtb?).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Depth = 115.0 feet bgs</td>
<td></td>
<td>Boring backfilled with bentonite pellets upon completion. Surface was sealed with dry asphalt patch.</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
Soil samples were taken in accordance with ASTM D1586-84 standards and specifications. Soil classifications were developed in the field in accordance with ASTM D2488 and following the Unified Soil Classification system.
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>BORE STRATA</th>
<th>DEPTH</th>
<th>SOIL DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/1/11</td>
<td>5.2</td>
<td>0.0 - 0.3' Asphalitic Concrete Pavement (ACP).</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1/0/15</td>
<td>10.0</td>
<td>0.3 - 16.0' Silty Sand and Gravel to Sand and Gravel. Brown to gray brown, fine- to coarse-grained, trace cobbles, trace to little wood, loose, saturated (sp-gp, Recent Alluvium - Qty1).</td>
<td>11/19/2012 0.0 - 80.5' Hole advanced using HQ wire line and recirculating bentonite drill mud with good circulation. Surface casing set to approximately 5 ft. bgs.</td>
</tr>
<tr>
<td>3</td>
<td>3/26</td>
<td>15.0</td>
<td>16.0 - 37.0' Sandy Silt to Silty Sand with Gravel. Gray brown to blue gray, fine- to coarse-grained, dense to very dense, damp (sm-mls, Glacial Till - Qty).</td>
<td>SPT soil samples taken on 5 ft. intervals as indicated on log. Representative samples were collected and sealed in clear glass jars for later correlation and testing.</td>
</tr>
<tr>
<td>4</td>
<td>50.0</td>
<td>20.0</td>
<td>16.0' gravels</td>
<td>9.0' lost circulation</td>
</tr>
<tr>
<td>5</td>
<td>20/27/34</td>
<td>25.0</td>
<td>24.0' harder drilling</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>6/22/34</td>
<td>30.0</td>
<td>31.0' lost circulation</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>34/50-54</td>
<td>34.0</td>
<td>34.0' gravels</td>
<td>Boring log continued on next page.</td>
</tr>
</tbody>
</table>

NOTES: Soil samples were taken in accordance with ASTM D1588-84 standards and specifications. Soil classifications were developed in the field in accordance with ASTM D2488 and following the Unified Soil Classification system.
### Soil Description

- **37.0 - 64.0' Sandy Silt to Silt:** Gray to gray brown, fine-grained, little to some gravels, medium dense to dense, dry to damp (ml, Advance Outwash - Qva).

- **64.0 - 105.5' Silt:** Gray green, very fine- to fine-grained, trace to little organics - charcoal, local lenses of very fine-grained micaceous sand, medium dense to dense, damp (ml, Transitional Beds - Qtb).

### Notes

- Soil samples were taken in accordance with ASTM D1556-94 standards and specifications. Soil classifications were developed in the field in accordance with ASTM D2488 and following the Unified Soil Classification system.

---

**PROJECT:** Pilchuck River Bridge 681  
**64th St NE**  
**Lochside, Snohomish County**

**C.R.P. #:** RC1630-175-37  
**STATION:** SE Abutment  
**OFFSET:** 10ft. right  
**DATE:** 11/19/12  
**ELEV.:** el. 236

**GEO./ENGR.:** Kirk R. Bailey  
**BORING NO.:** B-02

**DRILLER:** WSDOT  
**DRILL TYPE:** Track CME 75  
**AUGER TYPE:** HQ Wireline  
**FLUID:** Quick-Gel Bentonite  
**TOTAL DEPTH:** 105.50
<table>
<thead>
<tr>
<th>SAMPLE NUMBER</th>
<th>SAMPLE DATE</th>
<th>DEPTH TO</th>
<th>SOIL DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>4/24/33</td>
<td>75</td>
<td>64.0 - 105.5' Silt</td>
<td>Continued from previous page.</td>
</tr>
<tr>
<td>16</td>
<td>4/20/12</td>
<td>60</td>
<td>74.5 - 75.5' very fine-grained sand</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>3/21/32</td>
<td>85</td>
<td></td>
<td>11/20/2012 80.5 - 105.5' continued drilling hole. Drill mud at 5.0 ft. bgs. 85.5' hard drilling</td>
</tr>
<tr>
<td>18</td>
<td>8/30/45</td>
<td>90</td>
<td></td>
<td>85.5' hard drilling</td>
</tr>
<tr>
<td>19</td>
<td>4/22/30</td>
<td>96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>4/21/32</td>
<td>100</td>
<td>99.0' discoloring similar to mottling</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>4/25/33</td>
<td></td>
<td></td>
<td>Boring log continued on next page.</td>
</tr>
</tbody>
</table>

NOTES: Soil samples were taken in accordance with ASTM D1556-84 standards and specifications. Soil classifications were developed in the field in accordance with ASTM D2488 and following the Unified Soil Classification system.
<table>
<thead>
<tr>
<th>SAMPLE INTERVAL</th>
<th>BLOW PUNCH</th>
<th>STRATA DEPTH</th>
<th>SOIL DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total Depth = 105.5 feet bgs</td>
<td>Boring backfilled with bentonite pellets upon completion. Surface was sealed with dry asphalt patch.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Doe Start Card: SE-46749 Driller: Danny Henderson #2742</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
Soil samples were taken in accordance with ASTM D1586-84 standards and specifications. Soil classifications were developed in the field in accordance with ASTM D2488 and following the Unified Soil Classification system.
MAJOR GEOLOGIC STRUCTURES MAP
Geologic Investigation and Geotechnical Engineering Report
RC1630-175-37
APPENDIX D

SOIL SURVEY MAP AND SOIL DESCRIPTIONS
MAP LEGEND

- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot

MAP INFORMATION

Map Scale: 1:15,700 if printed on A size (8.5" x 11") sheet.
The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 7, Jun 29, 2012

Date(s) aerial images were photographed: 7/24/2006

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.
# Map Unit Legend

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Everett gravelly sandy loam, 0 to 8 percent slopes</td>
<td>18.3</td>
<td>1.4%</td>
</tr>
<tr>
<td>27</td>
<td>Kitsap silt loam, 0 to 8 percent slopes</td>
<td>2.8</td>
<td>0.2%</td>
</tr>
<tr>
<td>33</td>
<td>Menzel silt loam, 0 to 3 percent slopes</td>
<td>322.1</td>
<td>24.8%</td>
</tr>
<tr>
<td>39</td>
<td>Norma loam</td>
<td>51.5</td>
<td>4.0%</td>
</tr>
<tr>
<td>47</td>
<td>Peslik silt loam, 0 to 8 percent slopes</td>
<td>137.1</td>
<td>10.5%</td>
</tr>
<tr>
<td>48</td>
<td>Peslik silt loam, 8 to 25 percent slopes</td>
<td>5.7</td>
<td>0.4%</td>
</tr>
<tr>
<td>50</td>
<td>Pilchuck loamy sand</td>
<td>103.5</td>
<td>8.0%</td>
</tr>
<tr>
<td>55</td>
<td>Puget silty clay loam</td>
<td>21.4</td>
<td>1.6%</td>
</tr>
<tr>
<td>56</td>
<td>Puyallup fine sandy loam</td>
<td>88.9</td>
<td>6.8%</td>
</tr>
<tr>
<td>57</td>
<td>Ragnar fine sandy loam, 0 to 8 percent slopes</td>
<td>35.7</td>
<td>2.7%</td>
</tr>
<tr>
<td>66</td>
<td>Sultan silt loam</td>
<td>11.2</td>
<td>0.9%</td>
</tr>
<tr>
<td>68</td>
<td>Sumas silt loam</td>
<td>24.7</td>
<td>1.9%</td>
</tr>
<tr>
<td>72</td>
<td>Tokul gravelly loam, 0 to 8 percent slopes</td>
<td>230.2</td>
<td>17.7%</td>
</tr>
<tr>
<td>73</td>
<td>Tokul gravelly loam, 8 to 15 percent slopes</td>
<td>54.3</td>
<td>4.2%</td>
</tr>
<tr>
<td>74</td>
<td>Tokul gravelly loam, 15 to 25 percent slopes</td>
<td>54.1</td>
<td>4.2%</td>
</tr>
<tr>
<td>77</td>
<td>Tokul-Winston gravelly loams, 25 to 65 percent slopes</td>
<td>103.3</td>
<td>7.9%</td>
</tr>
<tr>
<td>83</td>
<td>Water</td>
<td>35.9</td>
<td>2.8%</td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td><strong>1,300.5</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>
Snohomish County Area, Washington

39—Norma loam

Map Unit Setting
- Landscape: Outwash plains, till plains
- Elevation: 0 to 1,000 feet
- Mean annual precipitation: 35 to 60 inches
- Mean annual air temperature: 48 to 52 degrees F
- Frost-free period: 150 to 200 days

Map Unit Composition
- Norma and similar soils: 85 percent
- Minor components: 15 percent

Description of Norma

Setting
- Landform: Depressions, drainageways
- Parent material: Alluvium

Properties and qualities
- Slope: 0 to 3 percent
- Depth to restrictive feature: More than 80 inches
- Drainage class: Poorly drained
- Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
- Depth to water table: About 0 inches
- Frequency of flooding: None
- Frequency of ponding: Frequent
- Available water capacity: Moderate (about 9.0 inches)

Interpretive groups
- Farmland classification: Prime farmland if drained
- Land capability (nonirrigated): 3w
- Hydrologic Soil Group: B/D

Typical profile
- 0 to 10 inches: Ashy loam
- 10 to 28 inches: Sandy loam
- 28 to 60 inches: Sandy loam

Minor Components

Bellingham
- Percent of map unit: 5 percent
- Landform: Depressions

Custer
- Percent of map unit: 5 percent
- Landform: Depressions

Terric medisaprist
- Percent of map unit: 3 percent
- Landform: Depressions
Alderwood

Percent of map unit: 2 percent

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 7, Jun 29, 2012
Snohomish County Area, Washington

50—Pilchuck loamy sand

Map Unit Setting
Mean annual precipitation: 35 to 60 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 160 to 210 days

Map Unit Composition
Pilchuck and similar soils: 85 percent
Minor components: 4 percent

Description of Pilchuck

Setting
Landform: Flood plains
Parent material: Alluvium

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 24 to 48 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water capacity: Low (about 3.6 inches)

Interpretive groups
Farmland classification: Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season
Land capability (nonirrigated): 4w
Hydrologic Soil Group: A

Typical profile
0 to 31 inches: Loamy sand
31 to 50 inches: Fine sand
50 to 60 inches: Gravelly sand

Minor Components
Puget
Percent of map unit: 4 percent
Landform: Flood plains

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 7, Jun 29, 2012
Snohomish County Area, Washington

55—Puget silty clay loam

Map Unit Setting
  Elevation: 10 to 650 feet
  Mean annual precipitation: 35 to 55 inches
  Mean annual air temperature: 48 to 50 degrees F
  Frost-free period: 160 to 180 days

Map Unit Composition
  Puget, drained, and similar soils: 85 percent
  Minor components: 9 percent

Description of Puget, Drained

Setting
  Landform: Flood plains
  Parent material: Alluvium

Properties and qualities
  Slope: 0 to 2 percent
  Depth to restrictive feature: More than 80 inches
  Drainage class: Poorly drained
  Capacity of the most limiting layer to transmit water
    (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
  Depth to water table: About 24 to 48 inches
  Frequency of flooding: Rare
  Frequency of ponding: None
  Available water capacity: High (about 12.0 inches)

Interpretive groups
  Farmland classification: Prime farmland if drained and either
    protected from flooding or not frequently flooded during the
    growing season
  Land capability classification (irrigated): 3w
  Land capability (nonirrigated): 3w
  Hydrologic Soil Group: C

Typical profile
  0 to 9 inches: Silty clay loam
  9 to 38 inches: Silty clay loam
  38 to 60 inches: Silty clay loam

Minor Components

Snohomish
  Percent of map unit: 3 percent
  Landform: Flood plains

Sumas
  Percent of map unit: 3 percent
  Landform: Flood plains
Sultan

Percent of map unit: 3 percent

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 7, Jun 29, 2012
Snohomish County Area, Washington

56—Puyallup fine sandy loam

Map Unit Setting
Mean annual precipitation: 35 to 60 inches
Mean annual air temperature: 50 degrees F
Frost-free period: 170 to 200 days

Map Unit Composition
Puyallup and similar soils: 85 percent
Minor components: 6 percent

Description of Puyallup

Setting
Landform: Terraces
Parent material: Alluvium

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: 20 to 40 inches to strongly contrasting textural stratification
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water capacity: Low (about 4.2 inches)

Interpretive groups
Farmland classification: All areas are prime farmland
Land capability classification (irrigated): 2w
Land capability (nonirrigated): 2s
Hydrologic Soil Group: A

Typical profile
0 to 10 inches: Ashy fine sandy loam
10 to 30 inches: Fine sandy loam
30 to 60 inches: Sand

Minor Components
Puget
Percent of map unit: 3 percent
Landform: Flood plains

Sumas
Percent of map unit: 3 percent
Landform: Flood plains

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 7, Jun 29, 2012
Snohomish County Area, Washington

66—Sultan silt loam

Map Unit Setting
Mean annual precipitation: 35 to 55 inches
Mean annual air temperature: 50 degrees F
Frost-free period: 150 to 200 days

Map Unit Composition
Sultan and similar soils: 85 percent
Minor components: 4 percent

Description of Sultan

Setting
Landform: Flood plains
Parent material: Alluvium

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 24 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 10.7 inches)

Interpretive groups
Farmland classification: All areas are prime farmland
Land capability (nonirrigated): 3w
Hydrologic Soil Group: C

Typical profile
0 to 12 inches: Ashy silt loam
12 to 42 inches: Silty clay loam
42 to 60 inches: Stratified sand to silt loam

Minor Components
Puget
Percent of map unit: 4 percent
Landform: Flood plains

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 7, Jun 29, 2012
Snohomish County Area, Washington

68—Sumas silt loam

Map Unit Setting
Elevation: 20 to 200 feet
Mean annual precipitation: 35 to 60 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 150 to 210 days

Map Unit Composition
Sumas, drained, and similar soils: 85 percent
Minor components: 7 percent

Description of Sumas, Drained
Setting
Landform: Flood plains
Parent material: Alluvium

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: 20 to 40 inches to strongly contrasting
textural stratification
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.7 inches)

Interpretive groups
Farmland classification: Prime farmland if drained
Land capability classification (irrigated): 3w
Land capability (nonirrigated): 3w
Hydrologic Soil Group: C

Typical profile
0 to 14 inches: Silt loam
14 to 24 inches: Silt loam
24 to 60 inches: Sand

Minor Components
Mukiltto
Percent of map unit: 2 percent
Landform: Depressions

Puget
Percent of map unit: 2 percent
Landform: Flood plains

Terric medisaprist
Percent of map unit: 2 percent
Landform: Depressions

Snohomish
Percent of map unit: 1 percent
Landform: Flood plains

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 7, Jun 29, 2012
APPENDIX E

ALTERNATE ROUTE SUMMARY
Pilchuck River Bridge 581 Replacement Project
RC1630, UPI 11-0001-1
Alternate Route Assessment

Summary
An alternate route was analyzed to determine if it was feasible to abandon Bridge 581 and access the property from the Newberg Road. It was found that the alternate route was not viable.

The alternative route accesses the property from the Newberg Road through the privately owned Pilchuck Tree Farm development. The estimated cost of this alternative is $5.4 million (including PE, RW, CE & CN). The estimated cost of the bridge is $4.5 million.

This route would require about 1 ½ miles of gravel road to be widened, and about ½ mile of new gravel road to be constructed. The environmental impacts of this route are much higher than the bridge project and the environmental permit process would take longer.

There are an estimated 35 properties that would require acquisition for the land route. It is very likely that some acquisitions would need to go to condemnation if this route was pursued. We would not be able to justify condemnation because the bridge is a feasible alternative with lower costs, lesser environmental impacts, and only two property owners would be impacted.

The alternate route is through a private community. The red line is existing gravel road that would need to be upgraded and the white line is forest and pasture that has no existing road. The gravel road (red line) is approximately 1.6 miles and the proposed road (white) is approximately 0.6 miles.
Length of Routes to Farm

The current route via Bridge #581 is 8.9 miles from the east end of the trestle to the farm.

The route from trestle to Pilchuck Tree Farm via Machias is 10.1 miles; the private road is 2.2 miles. The total length of this route is 12.3 miles.

From end of trestle to Pilchuck Tree Farm, via Granite Falls, is 17.1 miles and the private road is 2.2 miles, for a total of 19.3 miles.