

SKAGIT COUNTY HIGH PRIORITY CULVERT REPLACEMENTS FOR FISH PASSAGE

Prepared for:

Jeff McGowan, Salmon Habitat Specialist
Skagit County Public Works
1800 Continental Place
Mount Vernon, WA 98273

Prepared on behalf of:

The Watershed Company
750 6th St South
Kirkland, WA, 98033

Prepared by:



750 Sixth Street South
Kirkland . WA 98033

p 425.822.5242
f 425.827.8136
watershedco.com

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SKAGIT COUNTY HIGH PRIORITY CULVERT REPLACEMENTS FOR FISH PASSAGE

1 PROJECT DESCRIPTION

1.1 Purpose and Objectives

The Watershed Company (TWC) is assisting Skagit County with evaluation, prioritization, and conceptual design of culvert replacement projects to improve fish passage. This report includes the identification and assessment of ten culverts at County road crossings that currently limit fish passage.

TWC first reviewed project background materials, including the identification, assessment, and prioritization by Washington State Department of Fish and Wildlife (WDFW) of nine culverts on Skagit River tributaries with respect to fish passage, primarily at County road crossings. TWC mapped these culverts and prepared an itinerary for field assessment and scheduled and conducted a meeting with representatives of the County, WDFW, Skagit River System Cooperative and Skagit Fisheries Enhancement Group to gain additional information about the prospective culvert replacement locations and projects as they may affect prioritization, ranking, and recommendations for implementation. Conceptual designs were developed by conducting field visits at each of the identified culvert crossing locations, noting length, size, type, estimated slope, channel geometry, and site-specific constraints. Field sketches of alternative concepts were made during each visit for future discussion and development.

For each of the prospective culvert replacement projects, TWC:

- estimated flows (hydrology) by applying regional regression equations;
- obtained a site topographic survey if available (from County sources);
- prepared alternative design concepts and identified preferred alternatives, evaluated hydraulic performance for the preferred alternative;
- prepared preliminary cost estimates for the preferred alternative;
- and evaluated cost effectiveness based on fish passage benefits (as provided by WDFW methodology) compared to costs and other feasibility issues such as, but not limited to, presence of utilities and

other to-be-protected infrastructure, site access, and/or requirements that downstream passage barriers also be improved to ensure success.

TWC then separated the prospective Culvert Replacement Projects into two categories:

- 1) Projects which are simple, straightforward, and inexpensive enough for County crews to implement on their own with relatively streamlined design and permitting and
- 2) Projects which are larger-scale in terms of cost such that assistance from outside funding sources would be needed for implementation.

A higher level of design detail and analysis may be required for later projects, including more detailed hydrologic and/or hydraulic modeling. TWC also used the WDFW Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual (WDFW 2009) to rank each list according to benefits and feasibility, establishing a scoring system as needed, implying a recommended order of implementation. After the scoring was done, conceptual designs were completed at each site, including likely culvert material, sizing, slope and length. Based upon these estimates (most without survey topography) preliminary specifications and preliminary cost estimates were developed. Per the contract scope of work, and upon receipt of county-supplied topographic survey information, nine sites were advanced to 30% design. Permit document applications and/or grant application documents to be prepared are outside of the scope of this agreement.

The culvert assessments and conceptual designs were based on Washington Department of Fish and Wildlife's (WDFW) Culvert Design Guidelines for Fish Passage (WDFW 2013). The hydrology of each site was analyzed using the USGS StreamStats Regression Equation method. Results provide an assessment of the 2-year design flow through 500-year design flow discharge. Topographic survey information was obtained from surveyed data from Skagit County at Bulson Road, Dairy Tributary, Sauk City Road, and English Road. Depending on the slope and conditions of the project area, either the No Slope Design or the Stream Simulation Design was used to create conceptual designs for each culvert. The site conditions and design criteria for each approach are described below.

1.2 No Slope Design

The no slope designs are characterized by a culvert that is countersunk and installed at a flat gradient, and is wide enough to allow for the natural movement of bed load to form a stable bed inside the culvert. The No-Slope Design tends to be cost effective because no special design expertise or

survey information is required. If velocities are sufficiently low to allow a bed to deposit in the culvert, it is assumed that a broad range of fish species and sizes will be able to move through the culvert.

The following standards were incorporated into the No Slope Designs:

- No-slope culverts are appropriate for:
 - Small channels generally < 10 ft BFW
 - Low gradient channels generally < 3% but higher gradients may be acceptable (see footnote 3, page 20)
 - Culvert length generally < 75 ft
- The no-slope design option is based on Washington Administrative Code provisions:
 - The culvert is installed at zero gradient
 - The width of the bed in the culvert is equal to the bankfull width (BFW is preferred to ordinary high water width as explained in Appendix C)
 - The bottom of the culvert is set below the downstream bed 20% of its rise
- An additional criterion limits the inlet countersink to 40% of the rise.
- A bed should be placed in the culvert that is composed of material similar to the bed of the adjacent stream.
- Adequate clearance between the culvert bed and crown should be provided to pass expected debris during flooding events.

Any culvert shape can be used (round, pipe-arch or elliptical), provided it meets the above criteria.

Using a round pipe provides sufficient width and additional vertical clearance. No-Slope Designs with culvert diameters of less than 12 feet will use a circular corrugated metal pipe since it provides a cost effective approach in terms of materials and installation. The figure below shows the no slope option from WDFW Culver Design Guidelines for Fish Passage (2013).

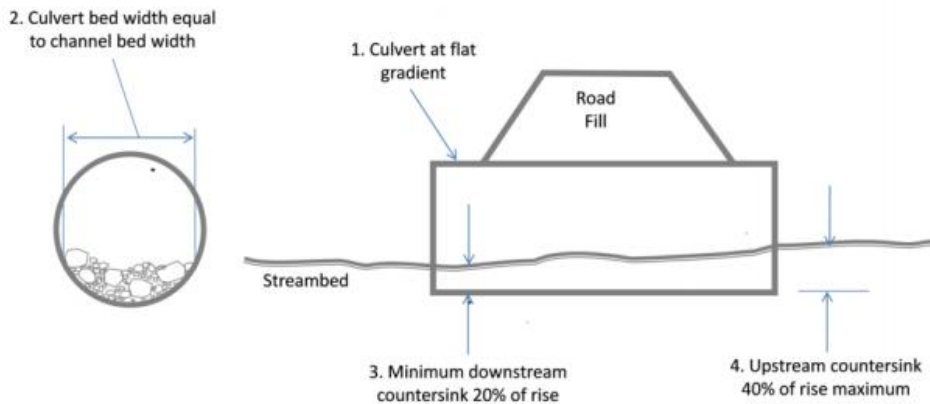


Figure 1. No Slope Design

1.3 Stream Simulation Design

The Stream Simulation is a design process to create natural stream processes within a culvert. Sediment transport, fish passage, floods and debris conveyance within the culvert are intended to function as they would in a natural channel. Culverts designed for stream simulation are sized substantially wider than the channel width and the bed inside the culvert is sloped at a similar or greater gradient than the adjacent stream reach. These culverts are filled with boulder/cobble mix that resists erosion and is unlikely to change grade unless specifically designed to do so. This fill material is placed to mimic a stream channel and allowed to adjust in minor ways to changing conditions.

Stream Simulation Design culverts are the preferred alternative for steep channels and long culverts. The Stream Simulation Design option was applied to sites with a slope over 3 percent and sites that did not meet the slope to length criteria for the No-Slope Design.

For projects designed using the Stream Simulation approach, a multi-plate steel or aluminum structural plate pipe arch or arch culvert were generally recommended to minimize the amount of rise and backfill materials above the culvert.

The following standards were incorporated into Stream Simulation Design:

- Stream simulation application:
 - Moderately confined channels
 - Bankfull width less than 15 ft, with exceptions
 - Any equilibrium stream slope

- Stream simulation culverts with a length-to-width ratio > 10 are considered long and need special design consideration and an increase in recommended width
- Suitability of the site
 - Design requires geomorphic assessment of stream reach
 - Method tolerates little or no lateral channel movement
 - Method tolerates moderate vertical instability
 - Culvert bed slope should not be greater than $1.25 \times$ upstream channel slope
- Culvert type and size
 - Any culvert type may be used for stream simulation
 - Width of bed inside culvert = $1.2 \times \text{BFW} + 2$ feet
- Scenario 1, channel slope less than 4%
 - Countersunk culvert 30-50% of its rise
 - Culvert bed should have a pool-riffle morphology
 - Bed may deform, scour, reform as the natural channel does
 - Coarse bands used to control channel shape, initiate stream structure
- Scenario 2, channel slope greater than 4%
 - Countersunk culvert 30-50% of its rise
 - Culvert bed should have a cascade or step-pool morphology
 - Bed tends to be stable over time
 - Bed structure is built-in at the time of construction
- Bed material design and specification
 - Stream simulation culvert bed material is similar to the natural channel, although there are several reasons why it should be coarser to increase stability
 - Sediment distribution should be well-graded, non-porous, with 5-10% fines
 - Sediment size can be determined by measuring the adjacent channel sediment size and/or using sediment stability analysis
 - Stream simulation bed materials are generally rounded, but there are exceptions
 - WDOT streambed sediment specifications are suitable for culverts

The figure below shows the low slope and high slope stream simulation options from WDFW Culvert Design Guidelines for Fish Passage (2013).

Water Crossing Design Guidelines

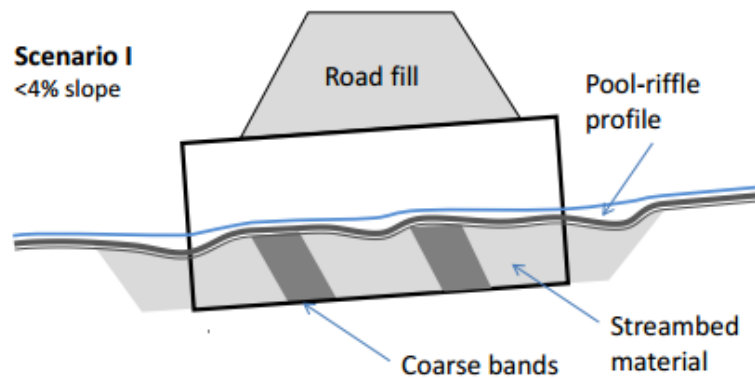


Figure 2. Low Slope Stream Simulation

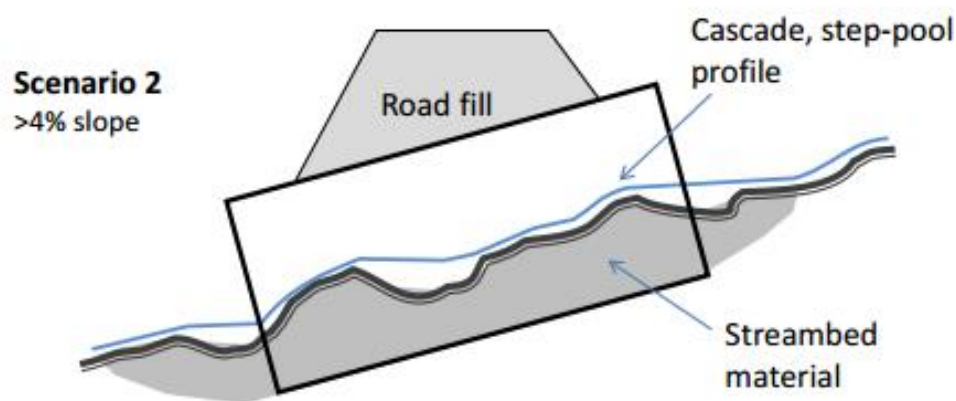


Figure 3. High Slope Stream Simulation

2 COST ESTIMATES AND PRIORITIZATION

Preliminary cost estimates were prepared for each of the culvert designs. These cost estimates include engineering design and construction cost for each culvert.

Projects were prioritized based on the WDFW's Fish Passage Inventory to help ensure projects that have the greatest benefits to fish are constructed first (See Appendix A for the prioritization details and methods). It provides the ability to compare similar projects in different watersheds and takes into account the benefits to fish as well as other pertinent factors like project cost and stock status. The Priority Index (PI) for each barrier is calculated as follows:

$$PI = \sum_{\text{all species}} \sqrt[4]{[(BPH) \times MDC]}$$

Where

- PI = Fish Passage Priority Index
- B = Proportion of passage improvement
- P = Annual adult equivalent production potential
- H = Habitat gain
- M = Mobility modifier
- D = Species condition modifier
- C = Cost modifier

The result of the priority index is:

1. Kelleher Road Culvert = 37.9
2. Old Highway 99 North Culvert = 20.7
3. Bulson Road Culvert = 15.6
4. Mountain View Culvert = 11.7
5. Lake Cavanaugh Culvert = 9.4
6. English Road Culvert = 7.7
7. Christian Camp Culvert = 5.6
8. Sauk City Culvert = 5.1
9. Dairy Tributary Culvert = 4.7

Priority Index Rank	Culvert Name	Passage Improvement	Parameters	Channel Width	Upstream Length	Estimate upstream area	Species Present	Priority Index
1	Kelleher Road	0.33	Length< 60FT, low slope	7.5	5,822	43662	Coho, Chum, Steelhead	37.9
2	OH 99	0.67	Length> 60FT, moderate slope	16	30,660	490554	Coho, Steelhead	20.7
3	Bulson Road	0.67	Length< 60FT, moderate slope	10	29,522	295220	Coho	15.6
4	Mountain View Road	0.67	Length> 60FT, moderate slope	11	12,845	141299	Coho	11.7
5	Lake Cavanaugh	0.67	Length> 60FT, moderate slope	6	6,381	38289	Coho	9.4
6	English Road	0.67	Length> 60FT, moderate slope	8	3,315	26521	Coho	7.7
7	Christian Camp Road	1	Length< 60FT, steep slope	4	1,207	4828	Coho	5.6
8	Sauk City Road	0.67	Length< 60FT, moderate slope	6	1,724	10342	Coho	5.1
9	Dairy Trib	0.33	Length< 60FT, low slope	6.5	748	4863	Coho	4.7

Based on the result, Kelleher Road, OH 99, Bulson Road, and Mountain View Road are the top four culverts that have greatest benefits to fish. Projects that County crews could implement on their own include smaller scale projects such as the Kelleher Road, Bulson Road, Dairy Tributary, and Mountain View. The larger scale projects that may require additional funding sources, and bid/award to outside contractors for implementation include Old Highway 99 North, Christian Camp Road, Sauk City Road, Lake Cavanaugh Culvert, and English Road Culvert. The list of both smaller and larger projects are shown below

Smaller Projects with Priority and Costs:

- | | |
|---------------------|---------------|
| 1. Kelleher Culvert | : \$60,430.92 |
| 2. Bulson Culvert | : \$64,098.08 |
| 3. Dairy Tributary | : \$48,939.58 |

Larger Projects with Priority and Costs:

- | | |
|---------------------------------|----------------|
| 1. Christian Camp Road Culvert | : \$116,289.97 |
| 2. Old Highway 99 North Culvert | : \$231,892.02 |
| 3. Mountain View Culvert | : \$147,983.01 |
| 4. Lake Cavanaugh Culvert | : \$107,652.31 |
| 5. English Road Culvert | : \$171,004.10 |
| 6. Sauk City | : \$208,452.68 |

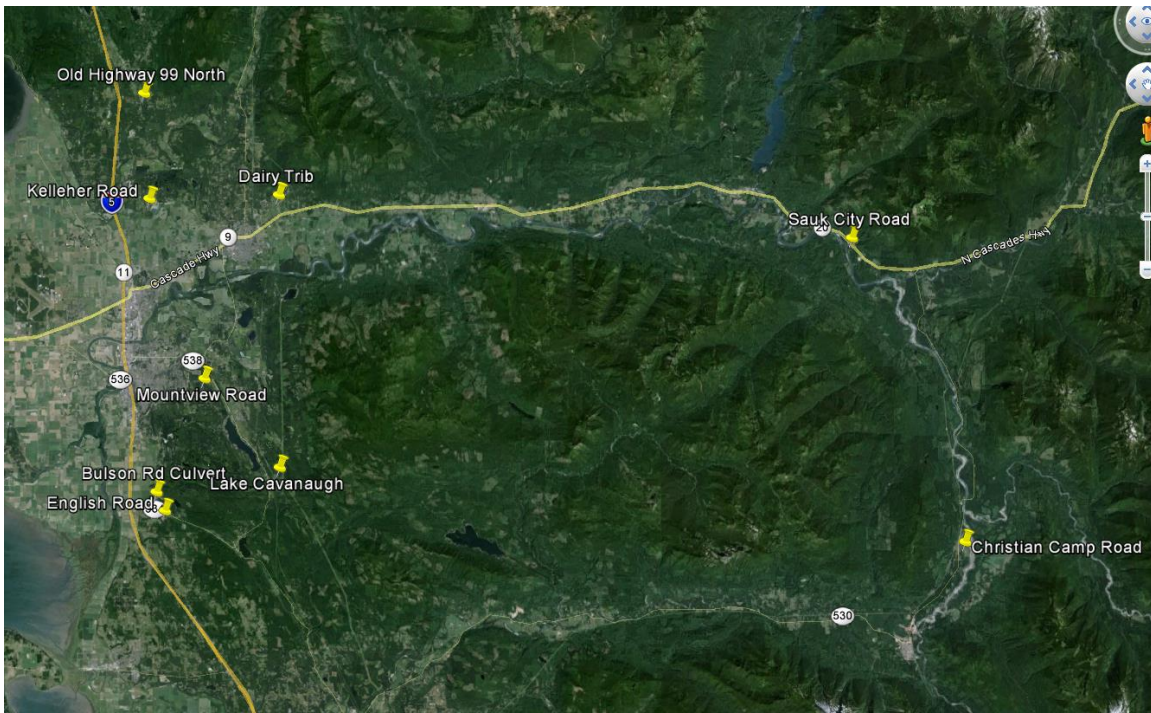


Figure 4. Vicinity Map by Google Map

3 CULVERTS

3.1 Kelleher Road Culvert

The Kelleher Road culvert is tributary to Thomas Creek. The existing crossing consists of an undersized 3 ft diameter concrete round culvert at a 0-percent slope. The average of the width of the channel upstream and downstream is approximately 7.5 feet. With the existing topographic information, the culvert will be placed on zero slope (flat) using the stream simulation method. The preferred alternative for the proposed culvert crossing is an 11'-10" wide X 7'-7" rise x 35' long multiplate pipe arch culvert. The preferred alternative's culvert is proposed at a 0-percent slope with the upstream and downstream invert elevation set at the same elevation. The culvert will be filled with fish-friendly gravel/cobble mix per WDFW Stream Simulation Design. The minimum cover above the preferred alternative culvert is 1.5 feet. The existing corrugated metal armoring at the outlet of the culvert will be removed and riprap armoring with one man rock material will be installed to direct flow. This culvert is in the smaller project list that can be done by Skagit County Crew. This culvert is in the top four based on the WDFW's priority index.

Preferred Alternative Culvert Description

Size	: 11'-10" wide X 7'-7" rise
Length	: 35 ft long
Min. Cover	: 1.5 ft
Culvert Slope	: 0% (flat)
Shape	: Pipe Arch
Material	: Multiplate Steel
Footings	: None
Substrate	: Fish-friendly gravel/cobble mix
Cost	: \$60,430.92

Recommendations

Replace culvert using county crews and equipment or include in a grant proposal for fish habitat improvement.

EXISTING CONDITION DATA SHEET

Culvert : Kelleher Road Culvert
 Stream Name : Unnamed
 Lat. /Long. : 48.528333, -122.319167
 Tributary to : Thomas Creek
 WRIA : 3
 OHWM : 5 ft Downstream / 9.5 ft Upstream

Channel

Width	7.5 ft
-------	--------

Stream

Pool Riffle Glide	Pool then turn into riffle
Substrate	Gravelly
Vegetation	Upstream – narrow vegetated channel between fields – RCG, HBB, alder, willow. Downstream similar.
LWD	NA
Other	Plunge at inlet due to debris

Existing Culvert

Size	3 ft diameter
Material	Concrete
Shape	Round
Length	35 ft
Slope	0%

Fish Habitat

Mapped Species	Coho, Fall Chum, Winter Steelhead
----------------	-----------------------------------

Barrier Assessment

% Passability	67%
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Table 1. Kelleher Road Data Sheet

EXISTING CONDITION PHOTOS



Stream Stats USGS Website Output

Streamstats Ungaged Site Report

Date: Wed Jan 30 2013 13:17:35 Mountain Standard Time

Site Location: Washington

NAD27 Latitude: 48.5284 (48 31 42)

NAD27 Longitude: -122.3179 (-122 19 05)

NAD83 Latitude: 48.5282 (48 31 42)

NAD83 Longitude: -122.3192 (-122 19 09)

Drainage Area: 0.73 mi²

Peak-Flow Basin Characteristics

100% Region 2 (0.73 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.73	0.08	3020
Mean Annual Precipitation (inches)	37.4	23	170

Peak-Flow Streamflow Statistics

Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	16.2	56	1		
PK10	28.9	53	1		
PK25	35.7	53	2		
PK50	41.8	53	2		
PK100	46.9	54	3		
PK500	61.3				

ENGINEERS OPINION OF PROBABLE COST					
Location	Kelleher Road				
Client	Skagit County Public Work				
Project	Skagit Culverts				
Phase	Conceptual Design				
ITEM NO.	ITEM	UNIT	QTY	UNIT PRICE	SUBTOTAL
1-10	Traffic Control	DAY	2	\$900.00	\$1,800.00
1-09	Mobilization	LS	1	\$5,000.00	\$5,000.00
2-02	Removal of Structure and Obstruction	LS	1	\$4,000.00	\$4,000.00
2-02	Temporary Stream Bypass System	LS	1	\$3,000.00	\$3,000.00
2-03	Excavation and Grading	CY	275	\$8.00	\$2,200.00
2-03	Excavation, Haul, Disposal	CY	123	\$30.00	\$3,690.00
4-04	Crushed Surfacing Top Course	TON	7	\$40.00	\$290.00
4-04	Crushed Surfacing Base Course	TON	6	\$50.00	\$300.00
5-04	Ashpalt Conc. For Pavement Repair	TON	7	\$150.00	\$1,050.00
7-03	Embankment Fill	CY	152	\$14.00	\$2,128.00
7-03	Multiplate Round Pipe 11-10 FT SPAN X 7-7 FT X 35 FT LONG	LS	1	\$10,000.00	\$10,000.00
8-01	Temporary Erosion and Sediment Control	LS	1	\$2,000.00	\$2,000.00
8-02	Roadside Protection and Property Restoration	LS	1	\$5,000.00	\$5,000.00
8-26	One man boulder armoring	LS	1	\$5,000.00	\$5,000.00
8-26	Streambed Gravel	CY	42	\$40.00	\$1,680.00
Subtotal					\$47,138.00
Construction Contingency (20%)					\$9,427.60
Sales Tax (8.2%)					\$3,865.32
Project Construction Total					\$60,430.92

Table 2. Kelleher Road Cost Estimate

3.2 Old Highway 99 Culvert

The Old Highway 99 culvert is located at the crossing of Old Highway 99 North and Butler creek and is tributary to Friday Creek. The existing crossing consists of an undersized 5 feet concrete round culvert at a 1-percent slope. The width of the channel is approximately 16 feet wide. With the existing topographic information, the stream simulation method is used. The proposed culvert crossing is a 22 ft multiplate steel round culvert. The total length of the structure is 124 linear feet. The culvert is proposed at a 0-percent slope, with the upstream and downstream invert elevation set at 206 feet. The culvert will be filled with fish-friendly gravel/cobble mix per WDFW stream simulation design. The minimum cover above the culvert is 3 feet and the maximum cover is 28 feet.

Preferred Alternative Culvert Description

Size	: 22 ft diameter
Length	: 124 ft long
Min. Cover	: 3 ft
Culvert Slope	: 0% (flat)
Shape	: Round
Material	: Multiplate Steel Plate
Footings	: None
Substrate	: Fish-friendly gravel/cobble mix
Cost	: \$231,892.02

Recommendations

Apply for Salmon Habitat restoration grant funds to complete construction.

EXISTING CONDITION DATA SHEET

Culvert : Old Highway 99 North Culvert
 Stream Name : Butler Creek
 Lat./Long. : 48.594167, -122.32889
 Tributary to : Friday Creek
 WRIA : 3
 OHWM : 20 ft

Channel

Width	16 ft
Velocity	Steep slope, big velocity

Stream

Pool Riffle Glide	Glide; Very large scour pool at outlet then riffles, glides w/ few shallow pools downstream
Substrate	7 inch diameter of cobbles, 12 inch cobbles; Medium, clean gravel; large in places with cobbles
Vegetation	Cottonwood, alder, cedar, salmonberry
Other	Steep slope

Existing Culvert

Size	5 ft
Material	Reinforced concrete
Shape	Round
Length	124 ft
Slope	Steep slope

Structures : Plunge in the outfall of the culvert, 20 ft-25 ft of fill

Fish Habitat

Mapped Species	Coho, Winter Steelhead
----------------	------------------------

Barrier Assessment

Parameter	Slope \geq 1 %
Range	1%-2%
% Passability	33%

Table 3. Old Highway Data Sheet

EXISTING CONDITION PHOTOS



STREAM STATS USGS WEBSITE OUTPUT

Old Highway 99

Streamstats Ungaged Site Report

Date: Wed Jan 30 2013 13:24:12 Mountain Standard Time
Site Location: Washington
NAD27 Latitude: 48.5947 (48 35 41)
NAD27 Longitude: -122.3227 (-122 19 22)
NAD83 Latitude: 48.5945 (48 35 40)
NAD83 Longitude: -122.3240 (-122 19 26)
Drainage Area: 3.35 mi²

Peak-Flow Basin Characteristics			
100% Region 2 (3.35 mi ²)			
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	3.35	0.08	3020
Mean Annual Precipitation (inches)	47.4	23	170

Peak-Flow Streamflow Statistics					
Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	88.1	56	1		
PK10	158	53	1		
PK25	194	53	2		
PK50	228	53	2		
PK100	255	54	3		
PK500	334				

ENGINEERS OPINION OF PROBABLE COST					
Location	Old Highway 99 North				
Client	Skagit County Public Work				
Project	Skagit Culverts				
Phase	Conceptual Design				
ITEM NO.	ITEM	UNIT	QTY	UNIT PRICE	SUBTOTAL
1-09	Mobilization	LS	1	\$5,000.00	\$5,000.00
1-10	Traffic Control	DAY	2	\$900.00	\$1,800.00
2-02	Removal of Structure and Obstruction	LS	1	\$5,000.00	\$5,000.00
2-02	Temporary Stream Bypass System	LS	1	\$3,000.00	\$3,000.00
2-03	Excavation, Haul, Disposal	CY	1744.90963	\$10.00	\$17,449.10
2-03	Excavation and Grading	CY	6457.18519	\$4.00	\$25,828.74
4-04	Crushed Surfacing Top Course	TON	22	\$40.00	\$870.00
4-04	Crushed Surfacing Base Course	TON	21	\$50.00	\$1,050.00
5-04	Ashpalt Conc. For Pavement Repair	TON	22	\$150.00	\$3,300.00
7-03	Embankment Fill	CY	4712	\$7.00	\$32,985.93
7-03	CMP 22 FT x 124 FT	LS	1	\$67,000.00	\$67,000.00
8-01	Temporary Erosion and Sediment Control	LS	1	\$5,000.00	\$5,000.00
8-02	Roadside Protection and Property Restoration	LS	1	\$2,000.00	\$2,000.00
8-26	Streambed Gravel	CY	353.308148	\$30.00	\$10,599.24
Subtotal					\$180,883.01
Construction Contingency (20%)					\$36,176.60
Sales Tax (8.2%)					\$14,832.41
Project Construction Total					\$231,892.02

Table 4. Old Highway 99 Cost Estimate

3.3 Bulson Road Culvert

The Bulson Road culvert is located at the crossing of Bulson Road and Bulson Creek and is tributary to Carpenter Creek. The existing crossing consists of two undersized 3 feet diameter round culverts at a 2.6-percent slope. The width of the channel is approximately 10 feet wide. With the existing topographic information, the stream simulation method is used to minimize the rise above the culvert and excavation along the channel. The proposed crossing consists of a 14' X 9.8' pipe arch culvert. The total length of the structure is 40 linear feet. The culvert is proposed at a 0-percent slope with the upstream and downstream invert elevation set at 176.6 feet. The culvert will be filled with fish-friendly gravel/cobble mix between 30-50% of the culvert's rise. The minimum cover above the culvert is 2 feet. Topographic survey information is available for this site. This culvert is in the top four priority list and is in the small project category list that can be done by Skagit County Crews.

Preferred Alternative Culvert Description

Size	: 14 ft span x 9.8 ft rise
Length	: 40 ft long
Min. Cover	: 2 ft
Culvert Slope	: 0% (flat)
Shape	: Pipe Arch Culvert
Material	: CMP Steel
Footings	: None
Substrate	: Fish-friendly gravel/cobble mix
Cost	: \$64,098.08

Recommendations

Replace culvert using county crews and equipment or include in a grant proposal for fish habitat improvement.

EXISTING CONDITION DATA SHEET

Culvert : Bulson Road Culvert
 Stream Name : Bulson Creek
 Lat. /Long. : 48.345, -122.3125
 Tributary to : Carpenter Creek
 WRIA : 3
 OHWM : 10 ft Upstream / 18 ft Downstream

Channel

Width	10 ft
-------	-------

Stream

Pool Riffle Glide	Scour pool in the outfall, then a little riffle
Substrate	Very small sandy gravel
Vegetation	Upstream – HBB, RCG, salmonberry, willow, alder, cedar, spruce, big leaf maple Downstream – cottonwood, big leaf maple, Salmonberry, sword fern
LWD	1

Existing Culvert

Size	Two at 3 ft diameter, 4 inch wall thickness
Material	Concrete
Shape	Round
Length	40 ft
Slope	2.6%
Other	2 culverts will be turned into one big culvert

Fish Habitat

Mapped Species	Coho
----------------	------

Barrier Assessment

% Passability	33%
---------------	-----

Table 5. Bulson Road Data Sheet

EXISTING CONDITION PHOTOS

Bulson Road



STREAM STATS USGS WEBSITE OUTPUT

Bulson Road

Streamstats Ungaged Site Report

Date: Wed Jan 30 2013 12:59:31 Mountain Standard Time

Site Location: Washington

NAD27 Latitude: 48.3450 (48 20 42)

NAD27 Longitude: -122.3113 (-122 18 41)

NAD83 Latitude: 48.3448 (48 20 41)

NAD83 Longitude: -122.3125 (-122 18 45)

Drainage Area: 5.39 mi²

Peak-Flow Basin Characteristics

100% Region 2 (5.39 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	5.39	0.08	3020
Mean Annual Precipitation (inches)	38.4	23	170

Peak-Flow Streamflow Statistics

Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	97.3	56	1		
PK10	171	53	1		
PK25	210	53	2		
PK50	244	53	2		
PK100	274	54	3		
PK500	355				

ENGINEERS OPINION OF PROBABLE COST					
Location	Bulson Road SS				
Client	Skagit County Public Work				
Project	Skagit Culverts				
Phase	30% Preliminary Design				
ITEM NO.	ITEM	UNIT	QTY	UNIT PRICE	SUBTOTAL
1-09	Mobilization	LS	1	\$5,000.00	\$5,000.00
1-10	Traffic Control	DAY	2	\$900.00	\$1,800.00
2-02	Removal of Structure and Obstruction	LS	1	\$5,000.00	\$5,000.00
2-02	Temporary Stream Bypass System	LS	1	\$3,000.00	\$3,000.00
2-03	Excavation and Grading	CY	311	\$8.00	\$2,488.00
2-03	Excavation, Haul, Disposal	CY	114	\$30.00	\$3,420.00
4-04	Crushed Surfacing Top Course	TON	9	\$40.00	\$362.50
4-04	Crushed Surfacing Base Course	TON	8	\$50.00	\$400.00
5-04	Ashpalt Conc. For Pavement Repair	TON	9	\$150.00	\$1,350.00
7-03	Embankment Fill	CY	197	\$14.00	\$2,758.00
7-03	Multiplate Arch 14'SPAN x 9-8' RISE X 40' LONG	LS	1	\$14,500.00	\$14,500.00
8-01	Temporary Erosion and Sediment Control	LS	1	\$5,000.00	\$5,000.00
8-02	Roadside Protection and Property Restoration	LS	1	\$2,000.00	\$2,000.00
8-26	Streambed Gravel	CY	73	\$40.00	\$2,920.00
Subtotal					\$49,998.50
Construction Contingency (20%)					\$9,999.70
Sales Tax (8.2%)					\$4,099.88
Project Construction Total					\$64,098.08

Table 6. Bulson Road Cost Estimate

3.4 Mountain View Road Culvert

The Mountain View Road culvert is tributary to WF Nookachamps. The existing crossing consists of an undersized 3 ft diameter CMP culvert at a 1-percent slope. The width of the channel is approximately 11 feet wide. With the existing topographic information, the width of the stream will be determined by the stream simulation method. The culvert will be placed on zero slope due to the flatness of the channel. The preferred alternative for the proposed culvert crossing is a 16 ft multiplate steel culvert. The total length of the structure is 93 linear feet. The preferred alternative's culvert is proposed at a 0-percent slope with the upstream and downstream invert elevation set at the same elevation. The culvert will be filled with fish-friendly gravel/cobble mix. The minimum cover above the preferred alternative culvert is 2 feet. This culvert is in the larger project list that can be done by Contractor bid.

Preferred Alternative Culvert Description

Size	: 16 ft diameter
Length	: 93 long
Min. Cover	: 2 ft
Culvert Slope	: 0% (flat)
Shape	: Round
Material	: Multiplate Structural Plate
Footings	: None
Substrate	: Fish-friendly gravel/cobble mix
Cost	: \$147,983.01

Recommendations

Replace culvert using county crews and equipment or include in a grant proposal for fish habitat improvement.

EXISTING CONDITION DATA SHEET

Culvert : Mountain view Road Culvert
 Stream Name : Unnamed
 Lat. /Long. : 48.415833, -122.266944
 Tributary to : WF Nookachamps
 WRIA : 3
 OHWM : 11 ft

Channel

Width	11 ft
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Stream

Pool Riffle Glide	Glide; Moderate pool/riffle definition with some glides
Substrate	Small sandy gravel
Vegetation	Salmonberry, sword fern, cedar, cottonwood, alder, fir
LWD	Small woody debris present
Other	Larger gravel and more wood downstream, flatter gradient and finer substrate upstream

Existing Culvert

Size	36 inch
Material	CMP
Shape	Round
Length	93
Slope	1%
Other	Backwatered all the way through

Roadway

Surface Material	Asphalt chip seal
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Fish Habitat

Mapped Species	Coho
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Barrier Assessment

% Passability	33%
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Table 7. Mountain View Data Sheet

EXISTING CONDITION PHOTOS



STREAM STATS USGS WEBSITE OUTPUT

Mountain View

Streamstats Ungaged Site Report

Date: Wed Jan 30 2013 13:21:24 Mountain Standard Time

Site Location: Washington

NAD27 Latitude: 48.4160 (48 24 58)

NAD27 Longitude: -122.2659 (-122 15 57)

NAD83 Latitude: 48.4159 (48 24 57)

NAD83 Longitude: -122.2672 (-122 16 02)

Drainage Area: 0.2 mi²

Peak-Flow Basin Characteristics

100% Region 2 (0.2 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.2	0.08	3020
Mean Annual Precipitation (inches)	38.9	23	170

Peak-Flow Streamflow Statistics

Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	5.52	56	1		
PK10	10	53	1		
PK25	12.4	53	2		
PK50	14.6	53	2		
PK100	16.4	54	3		
PK500	21.5				

ENGINEERS OPINION OF PROBABLE COST					
Location	Mountain View				
Client	Skagit County Public Work				
Project	Skagit Culverts				
Phase	Conceptual Design				
ITEM NO.	ITEM	UNIT	QTY	UNIT PRICE	SUBTOTAL
1-09	Mobilization	LS	1	\$10,000.00	\$10,000.00
1-10	Traffic Control	DAY	2	\$900.00	\$1,800.00
2-02	Removal of Structure and Obstruction	LS	1	\$5,000.00	\$5,000.00
2-02	Temporary Stream Bypass System	LS	1	\$3,000.00	\$3,000.00
2-03	Excavation, Haul, Disposal	CY	692	\$15.00	\$10,382.93
2-03	Excavation and Grading	CY	3534	\$4.00	\$14,136.00
4-04	Crushed Surfacing Top Course	TON	12	\$40.00	\$469.80
4-04	Crushed Surfacing Base Course	TON	11	\$50.00	\$550.00
5-04	Ashpalt Conc. For Pavement Repair	TON	12	\$150.00	\$1,800.00
7-03	Embankment Fill	CY	2842	\$7.00	\$19,892.63
7-03	Aluminum Structural Plate 16 FT SPAN X 93 FT LONG	LS	1	\$36,000.00	\$36,000.00
8-01	Temporary Erosion and Sediment Control	LS	1	\$5,000.00	\$5,000.00
8-02	Roadside Protection and Property Restoration	LS	1	\$2,000.00	\$2,000.00
8-26	Streambed Gravel	CY	135	\$40.00	\$5,400.00
Subtotal					\$115,431.36
Construction Contingency (20%)					\$23,086.27
Sales Tax (8.2%)					\$9,465.37
Project Construction Total					\$147,983.01

Table 8. Mountain View Cost Estimate

3.5 Lake Cavanaugh

The Lake Cavanaugh Road culvert is tributary to Lake Creek. The existing crossing consists of an undersized 3 ft diameter concrete round culvert at a 1-percent slope. The width of the channel is approximately 10 feet wide. With the existing topographic information, the culvert will be placed on a zero slope using the stream simulation method. The preferred alternative for the proposed culvert crossing is a 14 ft Aluminum structural plate culvert. The total length of the structure is 97 linear feet. The preferred alternative's culvert is proposed at a 0-percent slope with the upstream and downstream invert elevation set at the same elevation. The culvert will be filled with fish-friendly gravel/cobble mix. The fill above the culvert is approximately 18 feet. The maximum cover above the preferred alternative culvert is 29 feet. This culvert is in the bigger project list that can be done by Contractor bid.

Preferred Alternative Culvert Description

Size	: 14 ft diameter
Length	: 100 ft long
Min. Cover	: 1.5 ft
Culvert Slope	: 0%
Shape	: Round
Material	: Aluminum Structural Plate
Footings	: None
Substrate	: Fish-friendly gravel/cobble mix
Cost	: \$107,652.31

EXISTING CONDITION DATA SHEET

Culvert : Lake Cavanaugh Culvert
 Stream Name : Unnamed
 Lat./Long. : 48.360278, -122.196111
 Tributary to : Lake Creek
 WRIA : 3
 OHWM : 11 ft

Channel

Width	10 ft
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Stream

Pool Riffle Glide	Mostly glide, with moderate pool/riffle formation
Substrate	Upstream – very small, sandy gravel with some cobbles and small boulders; Small gravelly sandy
Vegetation	Sword fern, salmonberry, alder, big cedars
LWD	None

Existing Culvert

Size	3 ft diameter
Material	Concrete
Shape	Round
Length	97 ft
Other	1 ft drop, backwatered slightly at outlet. Steeper near inlet then flattens out

Roadway

Surface Material	Asphalt
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Fish Habitat

Mapped Species	Coho
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Barrier Assessment

% Passability	33%
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Table 9. Lake Cavanaugh Data Sheet

EXISTING CONDITION PHOTOS



STREAM STATS USGS WEBSITE OUTPUT

Lake Cavanaugh

Streamstats Ungaged Site Report

Date: Wed Jan 30 2013 13:27:27 Mountain Standard Time

Site Location: Washington

IAD27 Latitude: 48.3606 (48 21 38)

IAD27 Longitude: -122.1949 (-122 11 42)

IAD83 Latitude: 48.3604 (48 21 38)

IAD83 Longitude: -122.1961 (-122 11 46)

Drainage Area: 0.49 mi²

Peak-Flow Basin Characteristics

100% Region 2 (0.49 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.49	0.08	3020
Mean Annual Precipitation (inches)	44.9	23	170

Peak-Flow Streamflow Statistics

Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	15	56	1		
PK10	27.3	53	1		
PK25	33.9	53	2		
PK50	39.8	53	2		
PK100	44.7	54	3		
PK500	58.8				

ENGINEERS OPINION OF PROBABLE COST					
Location	Lake Cavanaugh				
Client	Skagit County Public Work				
Project	Skagit Culverts				
Phase	Conceptual Design				
ITEM NO.	ITEM	UNIT	QTY	UNIT PRICE	SUBTOTAL
1-09	Mobilization	LS	1	\$5,000.00	\$5,000.00
1-10	Traffic Control	DAY	2	\$900.00	\$1,800.00
2-02	Removal of Structure and Obstruction	LS	1	\$5,000.00	\$5,000.00
2-02	Temporary Stream Bypass System	LS	1	\$3,000.00	\$3,000.00
2-03	Excavation and Grading	CY	2396.25926	\$4.00	\$9,585.04
2-03	Excavation, Haul, Disposal	CY	552.756296	\$15.00	\$8,291.34
4-04	Crushed Surfacing Top Course	TON	12	\$40.00	\$493.00
4-04	Crushed Surfacing Base Course	TON	11	\$50.00	\$550.00
5-04	Ashpalt Conc. For Pavement Repair	TON	12	\$150.00	\$1,800.00
7-03	Embankment Fill	CY	1844	\$7.00	\$12,904.52
7-03	Aluminum Structural Plate 10 FT SPAN X 100 FT LONG	LS	1	\$24,600.00	\$24,600.00
8-01	Temporary Erosion and Sediment Control	LS	1	\$5,000.00	\$5,000.00
8-02	Roadside Protection and Property Restoration	LS	1	\$2,000.00	\$2,000.00
8-26	Streambed Gravel	CY	98.7064815	\$40.00	\$3,948.26
Subtotal					\$83,972.16
Construction Contingency (20%)					\$16,794.43
Sales Tax (8.2%)					\$6,885.72
Project Construction Total					\$107,652.31

Table 10. Lake Cavanaugh Cost Estimate

3.6 English Road

The English Road culvert is located at the crossing of English Road and an unnamed creek and is tributary to Bulson Creek. The existing crossing consists of an undersized 3 ft diameter CMP culvert at a 0.6-percent channel slope. The width of the channel is approximately 8 feet long. With the existing topographic information, the culvert will be placed on zero slope using the stream simulation method. The proposed culvert crossing consists of a 12 ft CMP culvert. The total length of the structure is 150 linear feet. The culvert is proposed at a 0-percent slope with the upstream and downstream invert elevation set at 183 feet. The culvert will be filled with fish-friendly gravel/cobble mix at a 0.4-percent slope with the upstream part of the culvert embedded at 186 feet and the downstream at 185.4 feet. The minimum cover above the culvert is 1.25 feet.

Preferred Alternative Culvert Description

Size	: 12ft diameter
Length	: 150 ft long
Min. Cover	: 1.25 ft
Culvert Slope	: 0%
Shape	: Round
Material	: Aluminum Structural Plate
Footings	: None
Substrate	: Fish-friendly gravel/cobble mix
Cost	: \$171,004.10

EXISTING CONDITION DATA SHEET

Culvert : English Road Culvert
 Stream Name : Unnamed
 Lat./Long. : 48.333333, -122.304167
 Tributary to : Bulson Creek
 WRIA : 3
 OHWM : 8 ft up stream / 6 ft middle stream

Channel

Width	8.3 ft
Depth	0.2 ft
Velocity	0.4 ft/s, slope = 4%

Stream

Pool Riffle Glide	Riffle; few pools and shallow, but 1 good plunge pool with LWD 150 ft upstream
Substrate	Sandy small gravel
Vegetation	Upstream – sword fern, salmonberry, alder, cedar
LWD	No – some small wood

Existing Culvert

Size	3 ft
Material	CMP
Shape	Round
Length	150 ft estimate
Slope	0%

Roadway

Surface Material	Chip seal, tar, gravel
Other	No plunge in the outfall, pipe is submerged and there's a pool at the downstream end

Fish Habitat

Mapped Species	Coho
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Barrier Assessment

% Passability	33%
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Table 11. English Road Data Sheet

EXISTING CONDITION PHOTOS



Figure 7: English Road Culvert

STREAM STATS USGS WEBSITE OUTPUT

English Road

Date: Wed Jan 30 2013 10:34:34 Mountain Standard Time

Site Location: Washington

NAD27 Latitude: 48.3331 (48 19 59)

NAD27 Longitude: -122.3025 (-122 18 09)

NAD83 Latitude: 48.3329 (48 19 58)

NAD83 Longitude: -122.3038 (-122 18 14)

Drainage Area: 0.84 mi²

Peak-Flow Basin Characteristics

100% Region 2 (0.84 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.84	0.08	3020
Mean Annual Precipitation (inches)	36.5	23	170

Peak-Flow Streamflow Statistics

Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	17.7	56	1		
PK10	31.5	53	1		
PK25	38.8	53	2		
PK50	45.4	53	2		
PK100	50.8	54	3		
PK500	66.4				

ENGINEERS OPINION OF PROBABLE COST					
Location	English Road				
Client	Skagit County Public Work				
Project	Skagit Culverts				
Phase	30% Preliminary Design				
ITEM NO.	ITEM	UNIT	QTY	UNIT PRICE	SUBTOTAL
1-09	Mobilization	LS	1	\$10,000.00	\$10,000.00
1-10	Traffic Control	DAY	4	\$900.00	\$3,600.00
2-02	Removal of Structure and Obstruction	LS	1	\$5,000.00	\$5,000.00
2-02	Temporary Stream Bypass System	LS	1	\$5,000.00	\$5,000.00
2-03	Excavation and Grading	CY	4167	\$4.00	\$16,666.67
2-03	Excavation, Haul, Disposal	CY	628	\$15.00	\$9,420.00
7-03	Embankment Fill	CY	3539	\$7.00	\$24,770.67
4-04	Crushed Surfacing Top Course	TON	8	\$40.00	\$313.20
4-04	Crushed Surfacing Base Course	TON	7	\$50.00	\$350.00
5-04	Asphalt Conc. For Pavement Repair	TON	8	\$150.00	\$1,200.00
7-03	Aluminum Structural Plate 12 FT SPAN X 150 FT LONG	LS	1	\$44,300.00	\$44,300.00
8-01	Temporary Erosion and Sediment Control	LS	1	\$4,000.00	\$4,000.00
8-02	Roadside Protection and Property Restoration	LS	1	\$5,000.00	\$5,000.00
8-26	Streambed Gravel	CY	94	\$40.00	\$3,768.00
Subtotal					\$133,388.53
Construction Contingency (20%)					\$26,677.71
Sales Tax (8.2%)					\$10,937.86
Project Construction Total					\$171,004.10

Table 12. English Road Cost Estimate

3.7 Christian Camp Road

The Christian Camp Road is located at the crossing of Hatchery Creek and is tributary to Sauk River. The existing crossing consists of an undersized 5 ft diameter CMP round culvert at a 6-percent channel slope. There is significant gully erosion downstream of the culvert. The width of the channel is approximately 12.5 feet wide. With the existing topographic information, the stream simulation method is used to minimize the rise above the culvert and excavation along the channel. The preferred alternative for the proposed culvert crossing is a multiplate aluminum arch culvert with a 17 ft span x 11-2 ft rise. The total length of the structure is 40 linear feet. The preferred alternative's culvert is proposed at a 10% slope. The culvert will be filled with fish-friendly gravel/cobble mix between 30-50% of the culvert's rise. Boulder weirs will be placed to imitate natural steps and act as grade controls downstream of culvert. The minimum cover above the preferred alternative culvert is 2.5 feet. This culvert is in the larger project list that can be done by Contractor bid.

Preferred Alternative Culvert Description

Size	: 17 ft x 11-2 ft
Length	: 40 ft long
Min. Cover	: 2.5 ft
Culvert Slope	: 10%
Shape	: Pipe Arch Culvert
Material	: Aluminum Structural Plate
Footings	: None
Substrate	: Fish-friendly gravel/cobble mix
Cost	: \$116,289.97

Recommendations

Apply for Salmon Habitat restoration grant funds to complete final design, permitting, and construction.

EXISTING CONDITION DATA SHEET

Culvert : Christian Camp Road Culvert
 Stream Name : Hatchery Creek
 Lat./Long. : 48.244722, -121.551667
 Tributary to : Sauk River
 WRIA : 4
 OHWM : 15 ft Upstream

Channel

Width	12.5 ft
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Stream

Pool Riffle Glide	Riffle; no pools or glides, continuous riffle and cascades
Substrate	12 inch cobbles, gravel, boulders; lots of cobbles and small boulders but also large gravel and sand
Vegetation	Salmonberry, sword fern, alder, cottonwood, big leaf maple, cedar
LWD	Small Large Woody Debris

Existing Culvert

Size	5 ft
Material	CMP
Shape	Round
Length	40 feet
Slope	0%
Other	Plunge and boulder cascades at the outlet

Roadway

Surface Material	Chip seal
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Structures : Big boulders in the outfall
 Utilities : Phone utilities

Fish Habitat

Mapped Species	Coho
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Barrier Assessment

% Passability	0%
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Table 13. Christian Camp Data Sheet

EXISTING CONDITION PHOTOS



Figure 8 Christian Camp Road Culvert

STREAM STATS USGS WEBSITE OUTPUT

Christian Camp Road

Date: Wed Aug 15 2012 11:37:20 Mountain Daylight Time

Site Location: Washington

NAD27 Latitude: 48.3458 (48 20 45)

NAD27 Longitude: -121.5558 (-121 33 21)

NAD83 Latitude: 48.3457 (48 20 44)

NAD83 Longitude: -121.5570 (-121 33 25)

Drainage Area: 0.5 mi²

Peak-Flow Basin Characteristics

100% Region 2 (0.5 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.5	0.08	3020
Mean Annual Precipitation (inches)	80.2	23	170

Peak-Flow Streamflow Statistics

Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	36.8	56	1		
PK10	69	53	1		
PK25	86.7	53	2		
PK50	103	53	2		
PK100	116	54	3		
PK500	156				

ENGINEERS OPINION OF PROBABLE COST					
Location	Christian camp Road				
Client	Skagit County Public Work				
Project	Skagit Culverts				
Phase	Conceptual Design				
ITEM NO.	ITEM	UNIT	QTY	UNIT PRICE	SUBTOTAL
1-07	Utility Relocation	LS	1	\$10,000.00	\$10,000.00
1-09	Mobilization	LS	1	\$5,000.00	\$5,000.00
1-10	Traffic Control	DAY	2	\$900.00	\$1,800.00
2-02	Removal of Structure and Obstruction	LS	1	\$5,000.00	\$5,000.00
2-02	Temporary Stream Bypass System	LS	1	\$3,000.00	\$3,000.00
2-03	Excavation and Grading	CY	498	\$8.00	\$3,982.22
2-03	Excavation, Haul, Disposal	CY	168	\$45.00	\$7,562.17
4-04	Crushed Surfacing Top Course	TON	12	\$40.00	\$487.20
4-04	Crushed Surfacing Base Course	TON	11	\$50.00	\$550.00
5-04	Ashpalt Conc. For Pavement Repair	TON	12	\$150.00	\$1,800.00
7-03	Embankment Fill	CY	330	\$14.00	\$4,616.21
7-03	Multi-Plate Arch Culvert 17 FT SPAN X 11-2 FT RISE X 40 FT LONG	LS	1	\$16,312.00	\$16,312.00
8-01	Temporary Erosion and Sediment Control	LS	1	\$2,000.00	\$2,000.00
8-02	Downstream Grade Control	LS	1	\$25,000.00	\$25,000.00
8-02	Roadside Protection and Property Restoration	LS	1	\$2,000.00	\$2,000.00
8-26	Streambed Gravel	CY	40	\$40.00	\$1,600.00
Subtotal					\$90,709.80
Construction Contingency (20%)					\$18,141.96
Sales Tax (8.2%)					\$7,438.20
Project Construction Total					\$116,289.97

Table 14. Christian Camp Cost Estimate

3.8 Sauk City Road

The Sauk City Road culvert is tributary to Skagit River. The existing crossing consists of an undersized 3 ft diameter concrete round culvert at a 2.5-percent channel slope. There is significant gully erosion downstream of the culvert. The width of the channel is approximately 6.6 feet wide. With the existing topographic information, the culvert will be placed on a zero slope using the stream simulation method. The preferred alternative for the proposed culvert crossing is 10 ft CMP culvert. The total length of the structure is 40 linear feet. The preferred alternative's culvert is proposed at a 0-percent slope with the upstream and downstream invert elevation set at the same elevation. The culvert will be filled with fish-friendly gravel/cobble mix per WDFW Stream Simulation Design Mix. The minimum cover above the preferred alternative culvert is 1.5 feet. Topographic survey information is available for this site.

Preferred Alternative Culvert Description

Size	: 10 ft diameter
Length	: 40 ft long
Min. Cover	: 1.0 ft
Culvert Slope	: 0%
Shape	: Round
Material	: CMP Steel
Footings	: None
Substrate	: Fish-friendly gravel/cobble mix
Cost	: \$208,452.68

Recommendations

Apply for Salmon Habitat restoration grant funds to complete survey, final design, permitting, and construction.

Note

The area downstream of this site has experienced significant gully erosion. It is recommended that the design and stabilization project be completed along with the culvert replacement project.

EXISTING CONDITION DATA SHEET

Culvert : Sauk City Road Culvert
 Stream Name : Unnamed
 Lat./Long. : 48.501667, -121.655833
 Tributary to : Skagit River
 WRIA : 4
 OHWM : 8 FT

Channel

Width	6.6 ft
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Stream

Pool Riffle Glide	Riffle; long, steep riffles w/ little pool/glide
Substrate	Gravelly; Large, clean gravel w/ a few boulders
Vegetation	HBB, RCG, salmonberry, alder, cottonwood,
LWD	No

Culvert

Size	3 ft
Material	CMP
Shape	Round
Length	40 ft
Slope	2.5%
Other	High plunge at outlet (9 ft)

Roadway

Surface Material	Chip seal
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Fish Habitat

Mapped Species	Coho
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Barrier Assessment

% Passability	33%
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Table 15. Sauk City Data Sheet

EXISTING CONDITION PHOTOS



Figure 9 Sauk City Road

STREAM STATS USGS WEBSITE OUTPUT

Sauk City Road

NAD27 Latitude: 48.5014 (48 30 05)
NAD27 Longitude: -121.6548 (-121 39 17)
NAD83 Latitude: 48.5012 (48 30 04)
NAD83 Longitude: -121.6561 (-121 39 22)
Drainage Area: 0.68 mi²

Peak-Flow Basin Characteristics

100% Region 2 (0.68 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.68	0.08	3020
Mean Annual Precipitation (inches)	76.1	23	170

Peak-Flow Streamflow Statistics

Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	44.5	56	1		
PK10	83	53	1		
PK25	104	53	2		
PK50	123	53	2		
PK100	139	54	3		
PK500	186				

Skagit County Fish Passage Culverts 2014

Location	Sauk City Road				
Client	Skagit County Public Work				
Project	Skagit Culverts				
Phase	Conceptual Design				
ITEM NO.	ITEM	UNIT	QTY	UNIT PRICE	SUBTOTAL
1-09	Mobilization	LS	1	\$5,000.00	\$5,000.00
1-10	Traffic Control	DAY	2	\$900.00	\$1,800.00
2-02	Removal of Structure and Obstruction	LS	1	\$5,000.00	\$5,000.00
2-02	Temporary Stream Bypass System	LS	1	\$3,000.00	\$3,000.00
2-03	Excavation and Grading	CY	273.481481	\$8.00	\$2,187.85
2-03	Excavation, Haul, Disposal	CY	116	\$30.00	\$3,480.00
4-04	Crushed Surfacing Top Course	TON	9	\$40.00	\$377.00
4-04	Crushed Surfacing Base Course	TON	8	\$50.00	\$400.00
5-04	Ashpalt Conc. For Pavement Repair	TON	9	\$150.00	\$1,350.00
7-03	Embankment Fill	CY	157	\$14.00	\$2,204.74
7-03	Multiplate Round Pipe 10 FT SPAN X 40 FT LONG	LS	1	\$9,800.00	\$9,800.00
8-01	Temporary Erosion and Sediment Control	LS	1	\$5,000.00	\$5,000.00
8-01	High Visibility Fence	LF	64	\$5.00	\$320.00
8-02	Slope and Erosion Stabilization	LS	1	\$50,000.00	\$50,000.00
8-02	Streambed grade stabilization	LS	1	\$50,000.00	\$50,000.00
8-02	Native Riparian Planting	LS	1	\$20,000.00	\$20,000.00
8-02	Roadside Protection and Property Restoration	LS	1	\$2,000.00	\$2,000.00
8-26	Streambed Gravel	CY	17	\$40.00	\$680.00
Subtotal					\$162,599.59
Construction Contingency (20%)					\$32,519.92
Sales Tax (8.2%)					\$13,333.17
Project Construction Total					\$208,452.68

Table 16. Sauk City Road Cost Estimate

3.9 Dairy Tributary Culvert

The Dairy Tributary culvert is located at the crossing of Thompson Drive Road and Dairy Tributary creek and is tributary to Red Creek. The existing crossing consists of an undersized 3 feet x 2 feet concrete box culvert at a 0-percent channel slope. The width of the channel is approximately 6.6 feet wide. With the existing topographic information, the culvert will be placed on zero slope using the stream simulation method due to the flatness of the channel. The proposed culvert crossing is a 10.25 ft x 6.75 ft multiplate pipe arch culvert. The total length of the structure is 20 linear feet. The culvert is proposed at a 0-percent slope with the upstream and downstream invert elevation set at 79 feet. The culvert will be filled with fish-friendly gravel/cobble mix. The width of the road along the culvert alignment is 12 feet at an approximate elevation of 87 feet. The minimum cover above the culvert is 1.5 feet. Topographic survey information is available for this site. This culvert is in the top four priority list.

Preferred Alternative Culvert Description

Size	: 10.25 ft span x 6.75 ft rise
Length	: 20 ft long
Min. Cover	: 1.5 ft
Culvert Slope	: 0%
Shape	: Pipe Arch
Material	: CMP Steel
Footings	: None
Substrate	: Fish-friendly gravel/cobble mix
Cost	: \$48,939.58

Recommendations

Replace culvert using county crews and equipment or include in a grant proposal for fish habitat improvement.

Please refer to the attached 30% design drawings for more specific information.

EXISTING CONDITION DATA SHEET

Culvert : Dairy Tributary Culvert
 Stream Name : Dairy Tributary
 Lat./Long. : 48.530556, -122.196667
 Tributary to : Red Creek
 WRIA : 3
 OHWM : 11 ft Downstream

Channel

Width	6.6 ft
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Stream

Pool Riffle Glide	Pool
Substrate	Swampy sandy – fines w/ small gravel
Vegetation	HBB, RCG, willow, alder, cedars farther upstream
LWD	None

Existing Culvert

Size	3 ft span, 2 ft rise (from the bottom of the gravel to the ceiling)
Material	Concrete
Shape	Box culvert
Length	20 ft
Slope	0%

Roadway

Surface Material	Concrete
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Fish Habitat

Mapped Species	Dairy Tributary: Coho
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Barrier Assessment

% Passability	67%
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Table 17. Dairy Tributary Data Sheet

EXISTING CONDITION PHOTOS



Figure 10. Dairy Tributary Culvert

STREAM STATS USGS WEBSITE OUTPUT

Dairy Tributary

Streamstats Ungaged Site Report

Date: Wed Jan 30 2013 12:52:28 Mountain Standard Time

Site Location: Washington

IAD27 Latitude: 48.5308 (48 31 51)

IAD27 Longitude: -122.1949 (-122 11 42)

IAD83 Latitude: 48.5306 (48 31 50)

IAD83 Longitude: -122.1961 (-122 11 46)

Drainage Area: 0.14 mi²

Peak-Flow Basin Characteristics

100% Region 2 (0.14 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.14	0.08	3020
Mean Annual Precipitation (inches)	47	23	170

Peak-Flow Streamflow Statistics

Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	5.37	56	1		
PK10	9.88	53	1		
PK25	12.3	53	2		
PK50	14.6	53	2		
PK100	16.4	54	3		
PK500	21.7				

ENGINEERS OPINION OF PROBABLE COST					
Location Dairy Tributary Road Client Skagit County Public Work Project Skagit Culverts Phase 30% Preliminary Design					
ITEM NO.	ITEM	UNIT	QTY	UNIT PRICE	SUBTOTAL
1-07	Utility Relocation	LS	1	\$10,000.00	\$10,000.00
1-09	Mobilization	LS	1	\$5,000.00	\$5,000.00
2-02	Removal of Structure and Obstruction	LS	1	\$5,000.00	\$5,000.00
2-02	Temporary Stream Bypass System	LS	1	\$3,000.00	\$3,000.00
2-03	Excavation and Grading	CY	136	\$8.00	\$1,088.00
2-03	Excavation, Haul, Disposal	CY	31.4	\$30.00	\$942.00
4-04	Crushed Surfacing Top Course	TON	7	\$40.00	\$280.00
4-04	Crushed Surfacing Base Course	TON	6	\$50.00	\$300.00
7-03	Embankment Fill	CY	104.6	\$14.00	\$1,464.40
7-03	Multiplate Pipe Arch Culvert 10.25 FT SPAN X 6.75 FT RISE X 20 FT long	LS	1	\$5,500.00	\$5,500.00
8-01	Temporary Erosion and Sediment Control	LS	1	\$3,000.00	\$3,000.00
8-02	Roadside Protection and Property Restoration	LS	1	\$2,000.00	\$2,000.00
8-26	Streambed Gravel	CY	15	\$40.00	\$600.00
Subtotal					\$38,174.40
Construction Contingency (20%)					\$7,634.88
Sales Tax (8.2%)					\$3,130.30
Project Construction Total					\$48,939.58

Table 18. Dairy Tributary Cost Estimate

4 REFERENCES

Barnard, R.J.J. Johnson, and P. Brooks. "Water Crossing Design Guidelines." *WDFW*. Washington Department of Fish and Wildlife, 2013. Web. Jan.-Feb. 2013.

APPENDIX A

FISH PASSAGE BARRIER AND SURFACE WATER DIVERSION SCREENING ASSESSMENT AND PRIORITIZATION MANUAL

Fish Passage Priority Index

The variability in costs, amounts of habitat gain, and species utilizing potential project sites throughout Washington State can make the characterization and prioritization of corrections to fish passage barriers complex. The WDFW Fish Passage Inventory process uses a Priority Index model to consolidate several factors that affect a fish passage project's feasibility (expected passage improvement, production potential of the blocked stream, fish stock health, etc.) into a manageable framework for developing prioritized lists of projects. The result is a numeric indicator giving each project's relative priority that includes production benefits to both anadromous and resident salmonid species adjusted for sympatric species interactions (species complexes). The Priority Index (PI) for each barrier is calculated as follows:

$$PI = \sum_{\text{all species}} \sqrt[4]{[(BPH) \times MDC]}$$

PI = Fish Passage Priority Index

- Relative project benefit considering cost.
- The PI is actually the sum ($\sum_{\text{all species}}$) of individual PI values, one of which is calculated for each species present in a stream (e.g., PI Coho is added to PI chum to obtain PI all species).
- The quadratic root in the equation is used because it provides a more manageable number and represents a geometric mean of factors used.

B = Proportion of passage improvement

- Proportion of fish run expected to gain access due to the project; gives greater weight to projects providing a greater margin of improvement in passage.
- Derived from passability estimate:
0% passable = 1.00
33% passable = 0.67
67% passable = 0.33
- Refer to Table 3.3 in Chapter 3 for a discussion of judging percent passability.

P = Annual adult equivalent production potential per m²

- Estimated number of adult salmonids that can potentially be produced by each m² of

habitat annually.

- The values (adults/m²) are species specific; Chinook salmon = 0.016, chum salmon = 1.25, Coho salmon = 0.05, pink salmon = 1.25, sockeye/kokanee salmon = 3.00, steelhead = 0.0021, bull trout/Dolly Varden = 0.0007, searun cutthroat trout = 0.037, resident cutthroat/rainbow trout = 0.04.

H = Habitat gain in m²

- Measured/calculated from a habitat survey (described in Chapter 8); gives greater weight to projects that will make greater amounts of habitat available.
- Spawning area values used for species complexes normally limited by spawning habitat (sockeye, chum, and pink salmon) and rearing area values used for species complexes normally limited by rearing habitat (Coho salmon, searun cutthroat, Chinook salmon, and steelhead), (resident cutthroat/rainbow trout and bull trout/Dolly Varden).
- When more than one species within a species complex is present, H is modified to reflect sympatric interactions among species with similar freshwater life histories. The result is a reduction of single species' habitat area values when competing species coexist.

M = Mobility Modifier

- Accounts for benefits to each fish stock for increased mobility (access to habitat being evaluated); gives greater weight to projects that increase productivity of species that are highly mobile and subject to geographically diverse recreational and commercial fisheries by providing access to habitat currently limiting productivity.
- 2 = Highly mobile stock subject to geographically diverse recreational and commercial fisheries (anadromous species).
- 1 = Moderately mobile stock subject to local recreational fisheries (resident species).

D = Species Condition Modifier

- Representation of status of species present; gives greater weight to less healthy species as listed in the Washington State Salmonid Stock Inventory (SaSI) report (WDFW 2003). In the absence of a SSASI assignment, stock condition should be estimated using the best available information.
- 3 = Condition of species considered critical.
- 2 = Condition of species considered depressed or stock of concern.
- 1 = species not meeting the conditions for 2 or 3.

C = Cost Modifier

- Representation of projected cost of project; gives greater weight to less costly projects.
- 3 = incremental funds needed >\$100,000.
- 2 = incremental funds needed between >\$100,000 and \$500,000.
- 1 = incremental funds needed >\$500,000.
- All barriers receive a cost modifier value of 2 until engineering evaluations are Completed