APPENDIX B
Site Photographs

Cougar Creek Low Flow Conditions at Outlet

Cougar Creek Fish Passage Barrier Removal
Asotin County, Washington

GeoEngineers

Figure B-1

Roughened Channel Morphology
Approximately 30 Feet Upstream of Inlet

Cougar Creek Fish Passage Barrier Removal
Asotin County, Washington

GeoEngineers

Figure B-2

Step Pool Within Reference Reach Approximately 100 Feet Upstream of Inlet

Cougar Creek Fish Passage Barrier Removal
Asotin County, Washington

GeoEngineers

Figure B-3

Large Woody Material and 5-6 Foot Drop Over 25 Feet Approximately 165 Feet Upstream

Cougar Creek Fish Passage Barrier Removal
Asotin County, Washington

GeoEngineers

Figure B-4

Bankfull Width Measurement #1 Approximately 110 to 120 Feet Upstream of Inlet

Cougar Creek Fish Passage Barrier Removal
Asotin County, Washington

GeoEngineers

Figure B-5

22281-004-00 Date Exported: 01/21/22

Bankfull Width Measurement #2 Approximately 130 to 140 feet Upstream of Inlet

Cougar Creek Fish Passage Barrier Removal
Asotin County, Washington

GeoEngineers

Figure B-6

22281-004-00 Date Exported: 01/21/22

Perched Culvert Outlet with an Approximate 2-Foot-Deep Pool and 6-Inch Hydraulic Drop

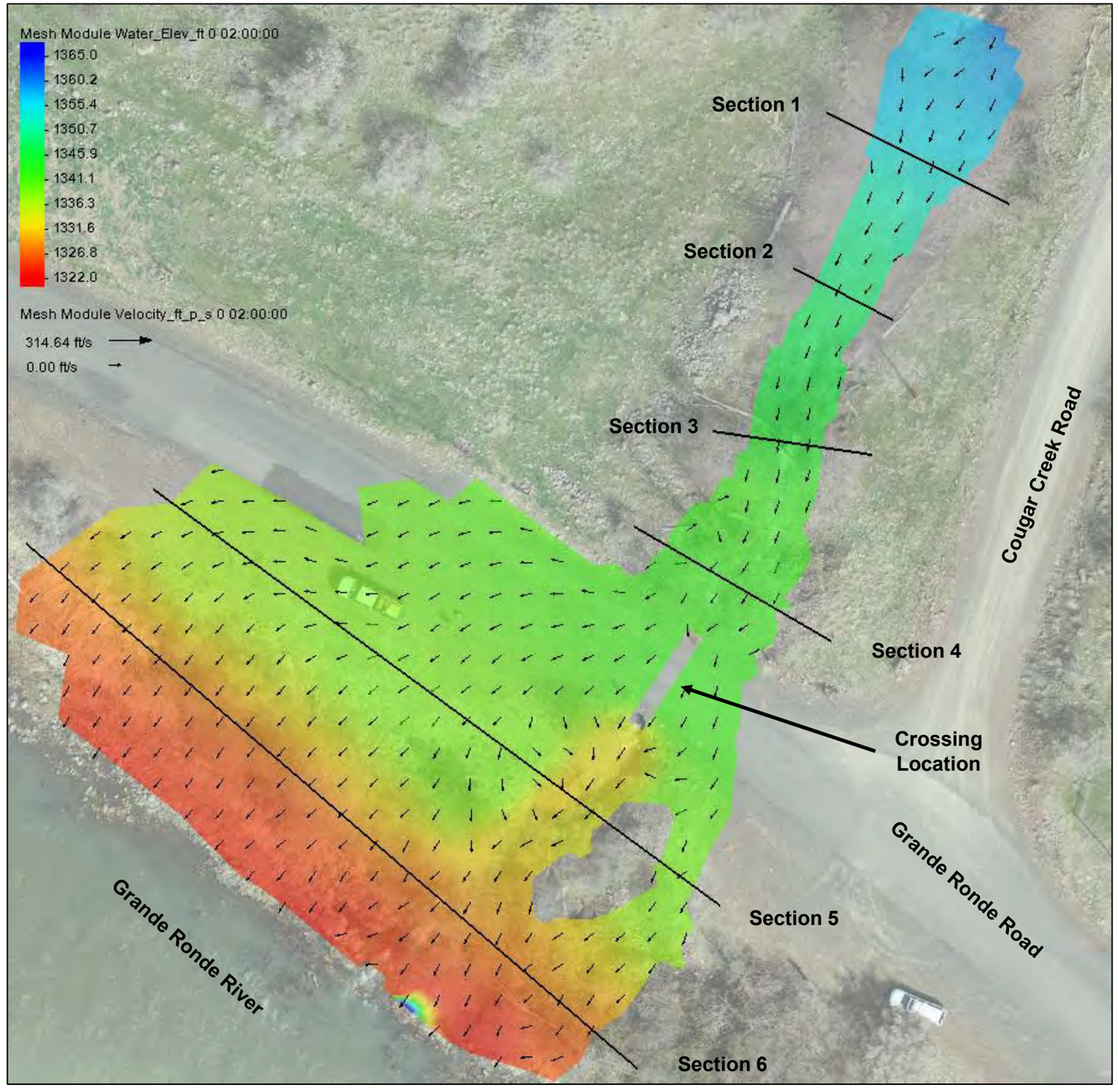
Cougar Creek Fish Passage Barrier Removal
Asotin County, Washington

GeoEngineers

Figure B-7

22281-004-00 Date Exported: 01/21/22

APPENDIX C
Hydrologic and Hydraulic Analysis



Existing and Proposed Conditions Cross Section Locations

Notes:

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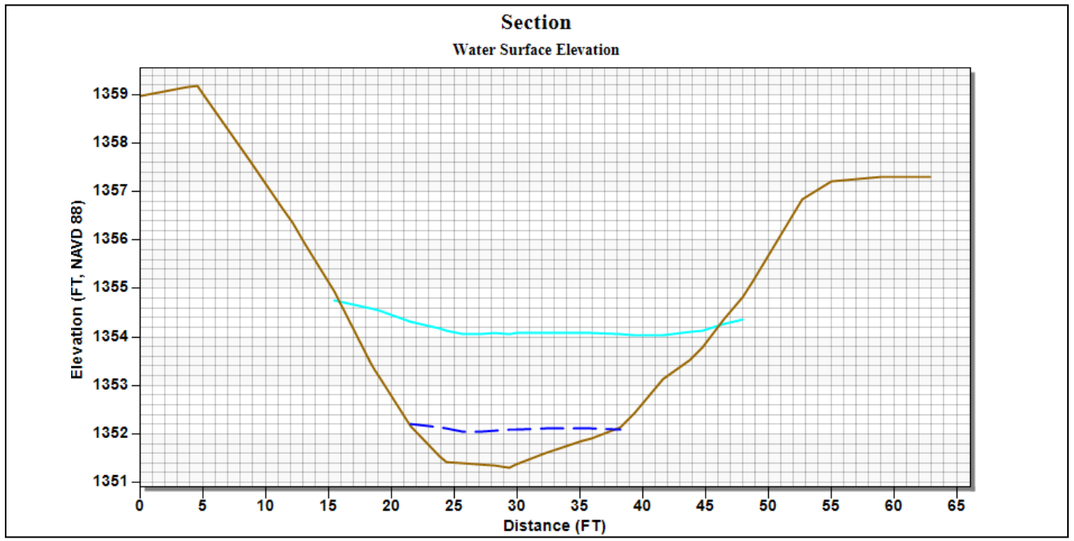
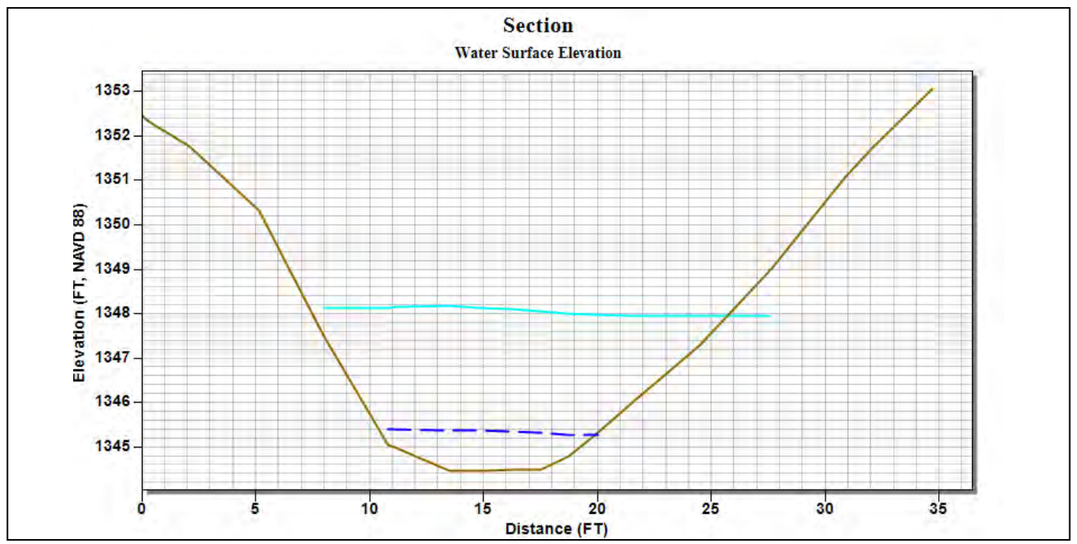
Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

Cross Section Locations	
Cougar Creek Fish Passage Barrier Asotin County, Washington	
GeoEngineers	Figure C-1

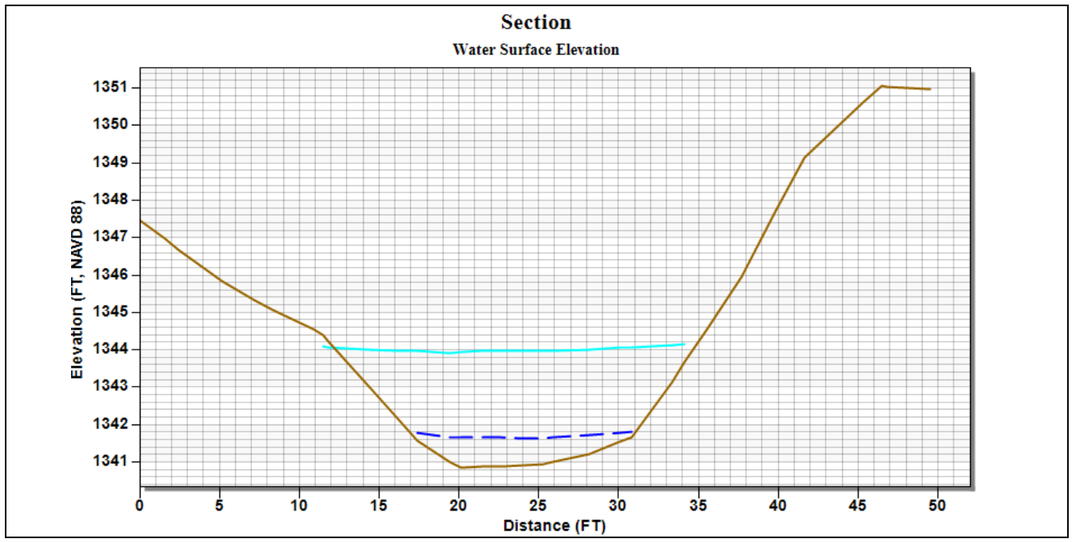
22281-004-00 Date Exported: 09/27/21



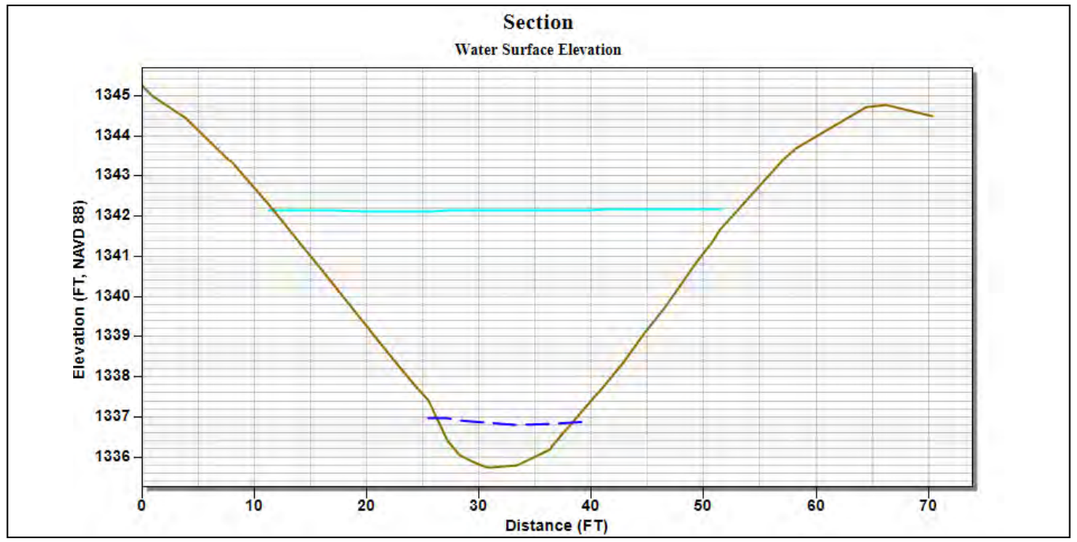
Cross Section 1



Cross Section 2



Cross Section 3



Cross Section 4

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3. All cross sections are looking downstream.

Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

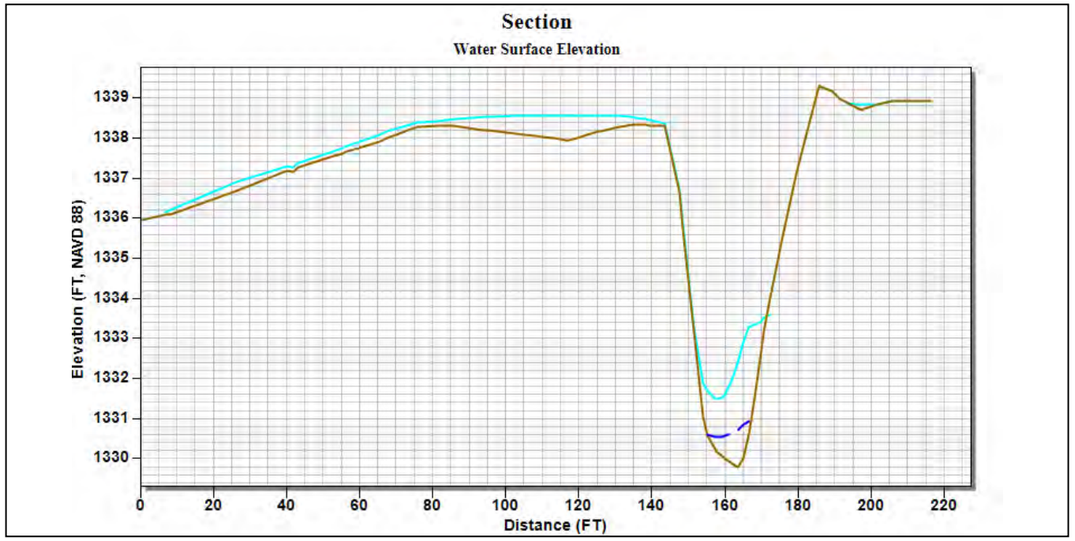
Existing Conditions 2-year and 100-year Water Surface Elevation at Upstream Cross Sections

Cougar Creek Fish Passage Barrier
Asotin County, Washington

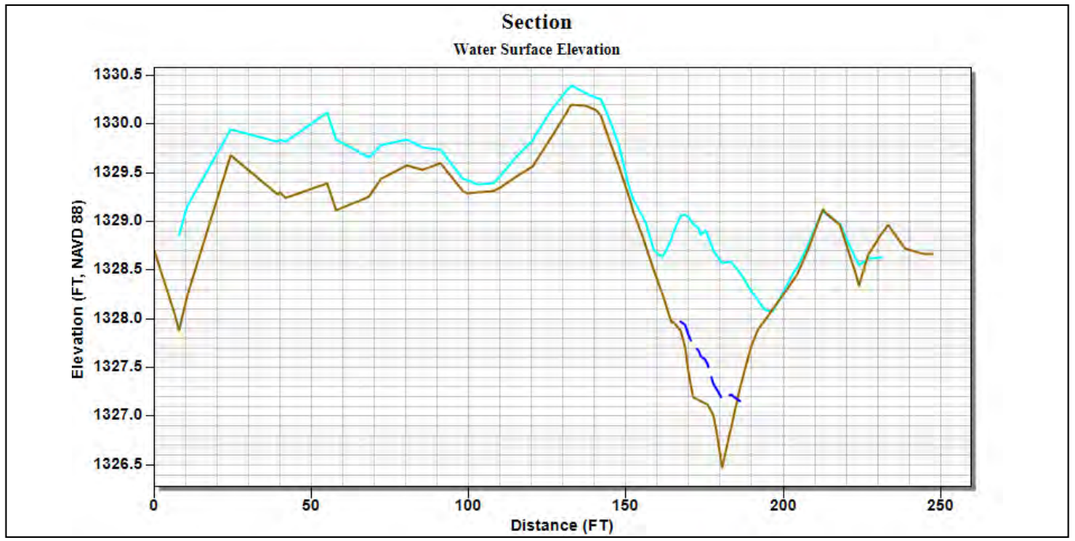
GeoEngineers

Figure C-2

22281-004-00 Date Exported: 09/27/21



Cross Section 5



Cross Section 6

Notes:

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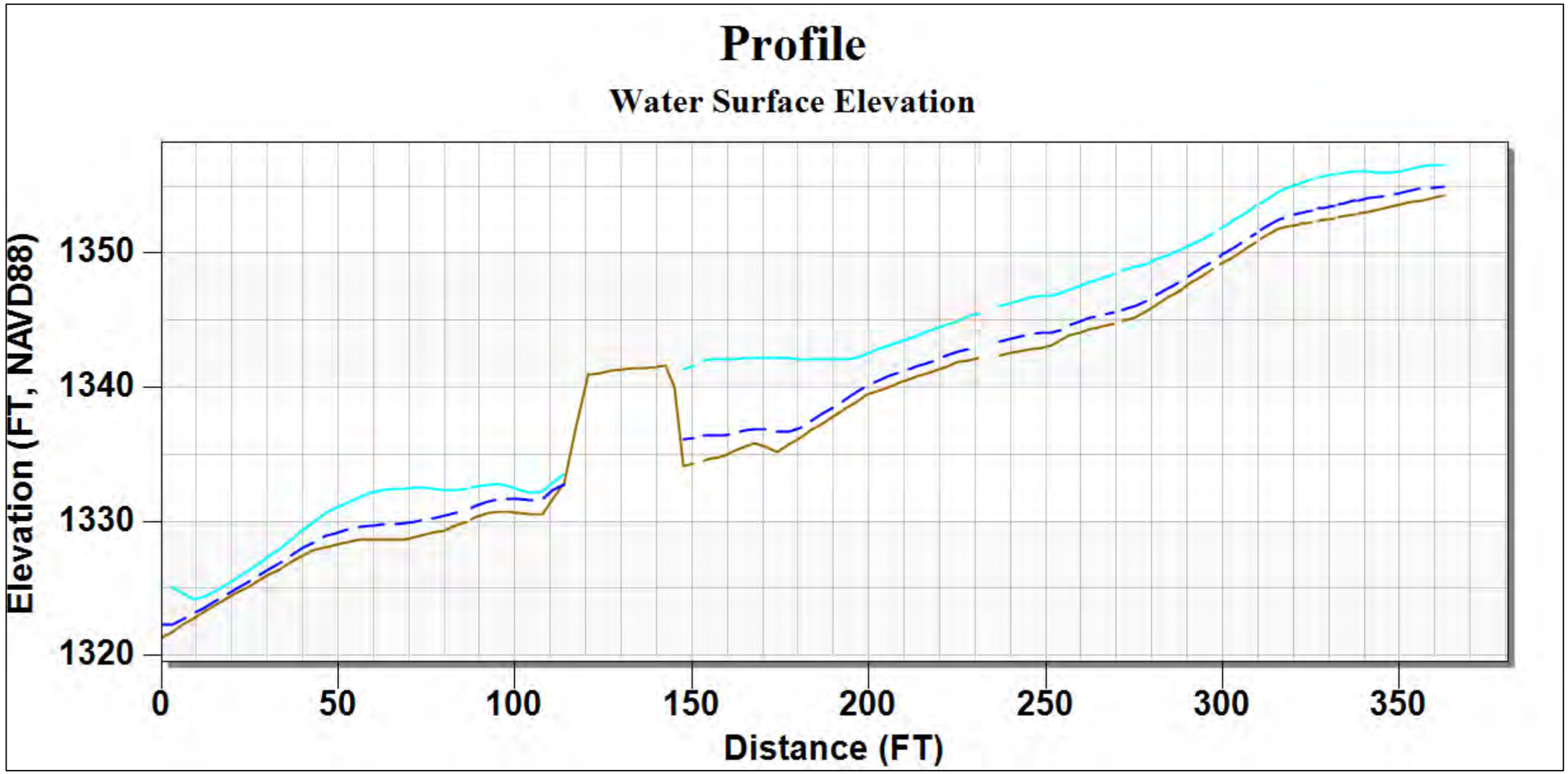
3. All cross sections are looking downstream.

Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

Existing Conditions 2-year and 100-year Water Surface Elevation at Downstream Cross Sections	
Cougar Creek Fish Passage Barrier Asotin County, Washington	
GeoEngineers	Figure C-3

22281-004-00 Date Exported: 09/27/21



Existing Conditions

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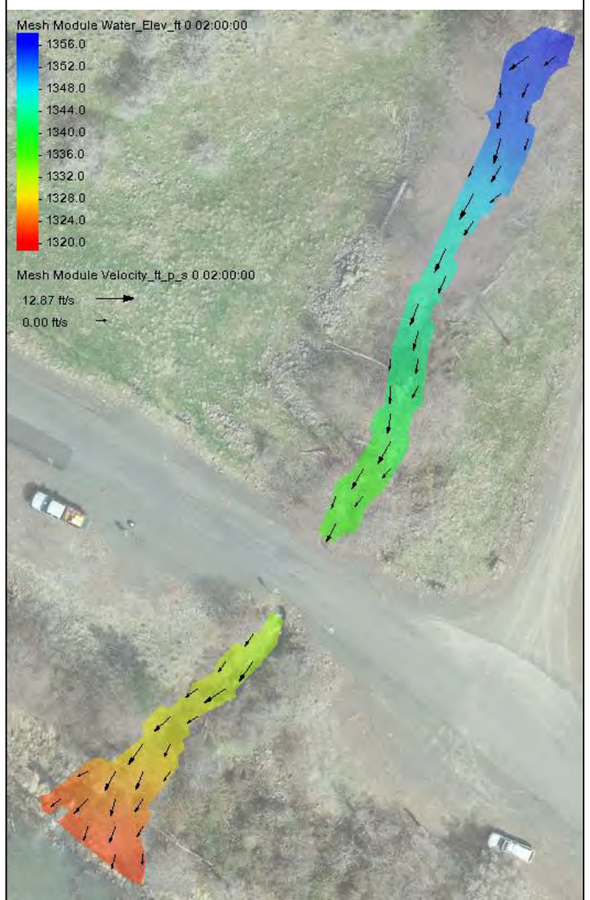
Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

Existing Conditions 2-year and 100-year Water Surface Elevation Profiles	
Cougar Creek Fish Passage Barrier Asotin County, Washington	
GeoEngineers	**Figure C-4**

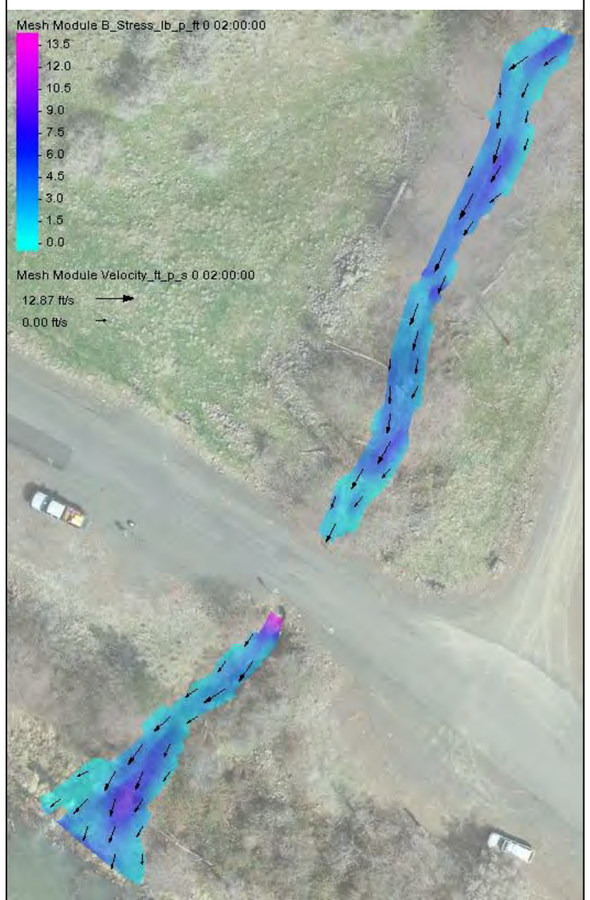
22281-004-00 Date Exported: 09/27/21



Water Surface Elevation
(FT NAVD88)

Velocity (FT/SEC)

Depth (FT)



Shear Stress (LB/SF)

Notes:

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Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

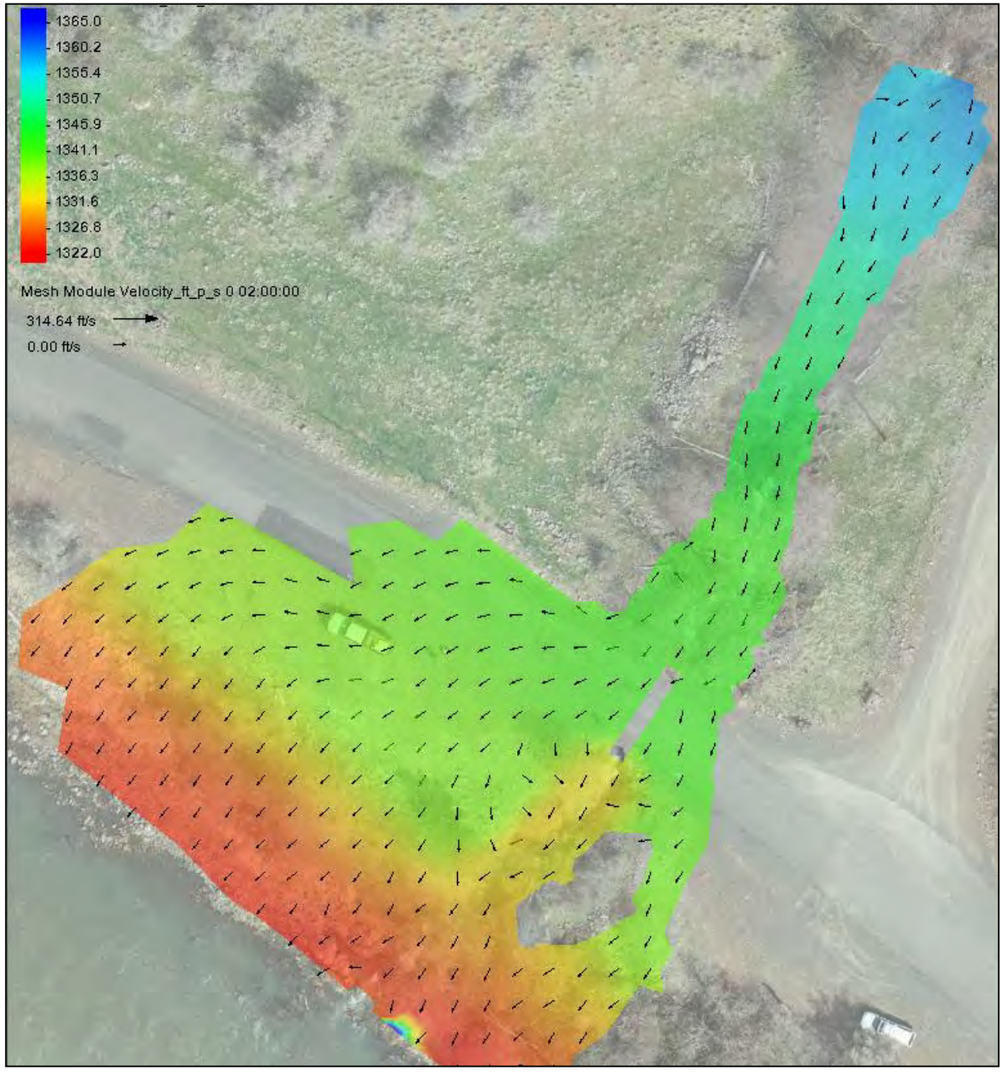
Existing Conditions Plan Views
2-year Flow (36 cfs)

Cougar Creek Fish Passage Barrier
Asotin County, Washington

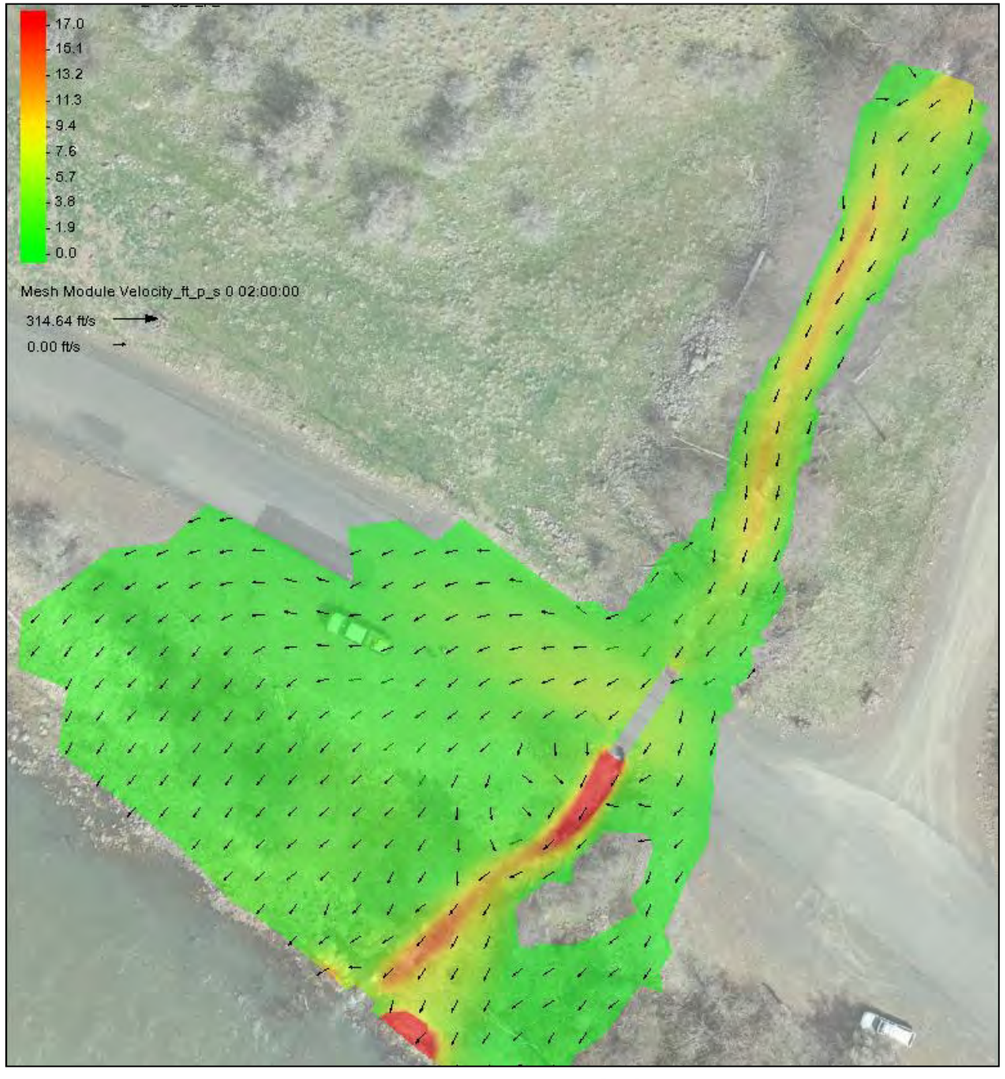
GeoEngineers

Figure C-5

22281-004-00 Date Exported: 09/27/21



Water Surface Elevation (FT NAVD88)



Velocity (FT/SEC)

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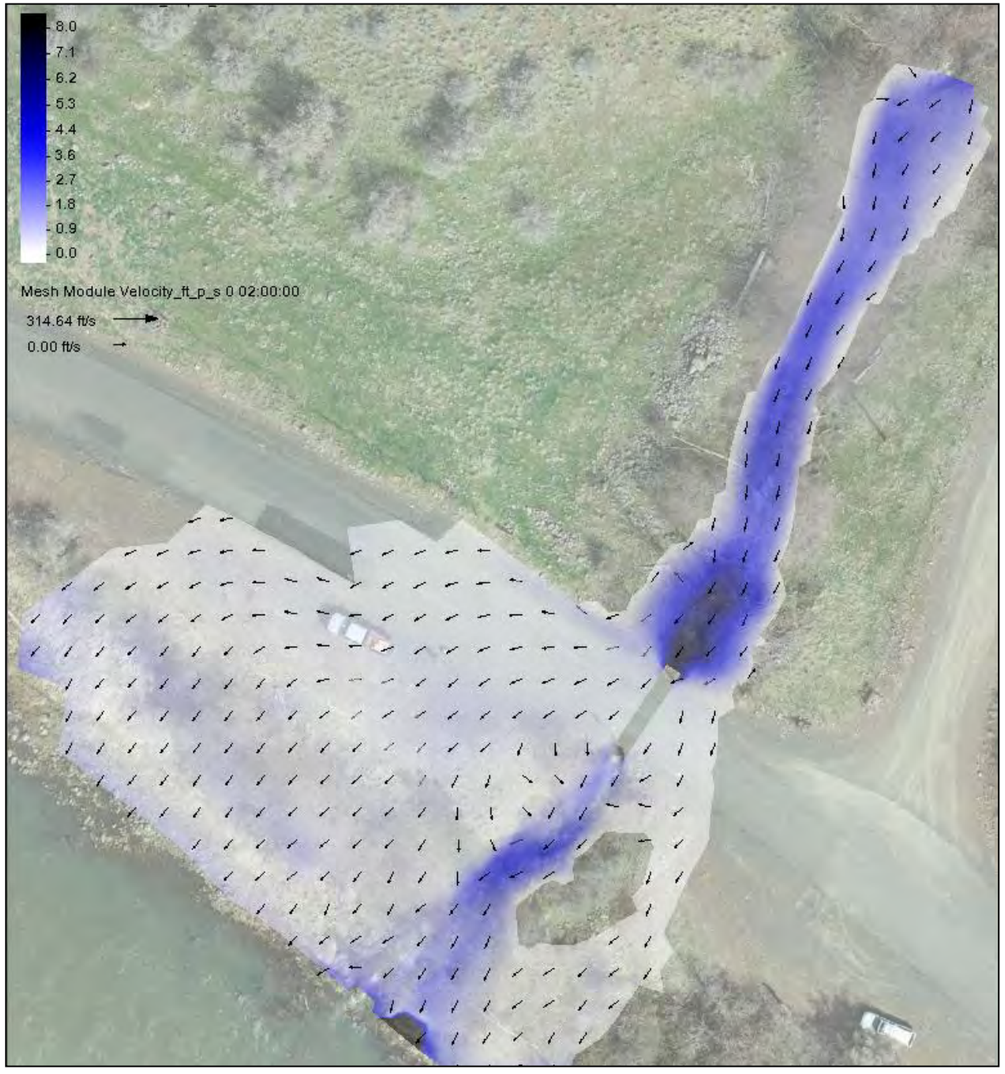
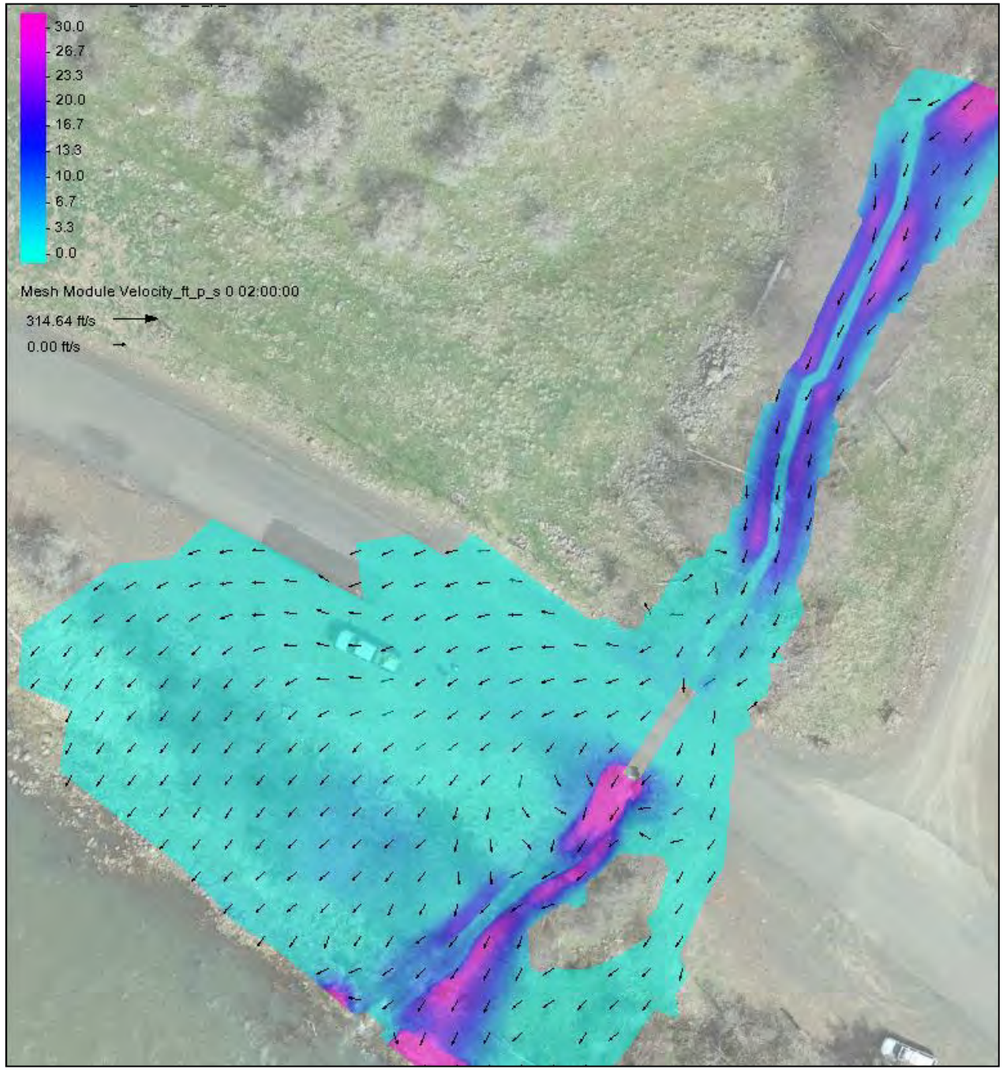
Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

Existing Conditions Plan Views 100-year Event (355 cfs)	
Cougar Creek Fish Passage Barrier Asotin County, Washington	
GeoEngineers	Figure C-6

22281-004-00 Date Exported: 09/27/21



Depth (FT)



Shear Stress (LB/SF)

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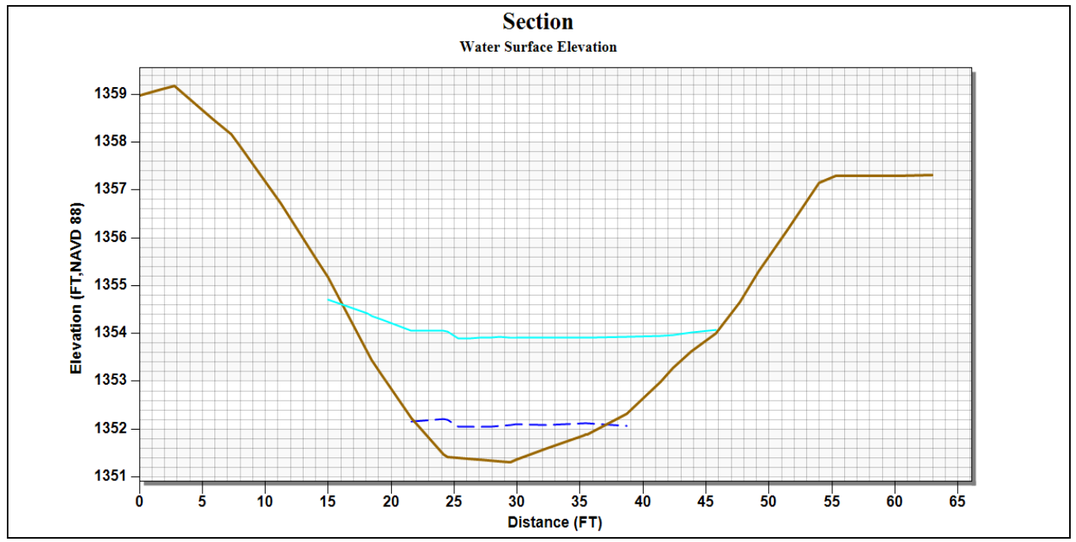
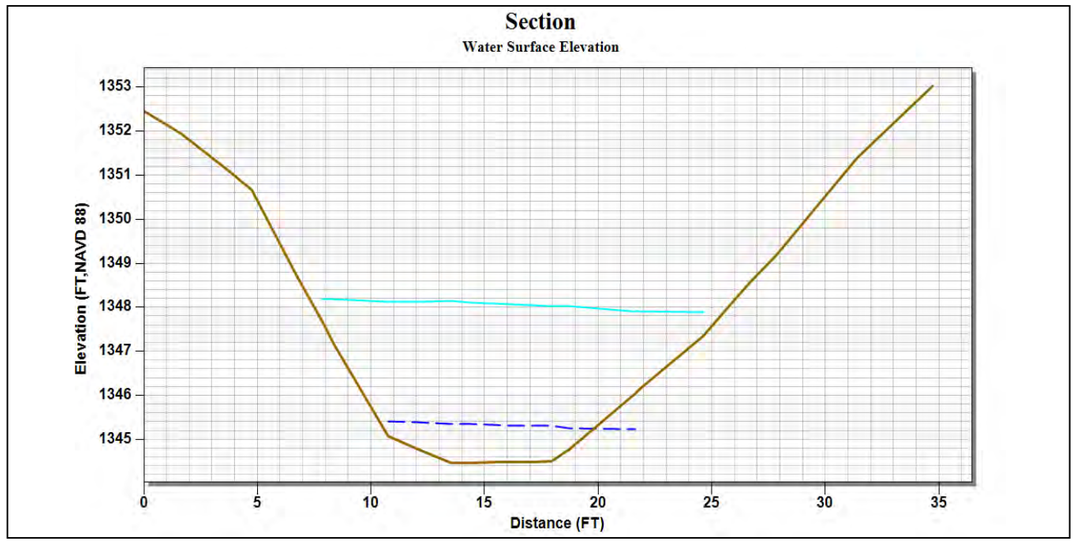
Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

Existing Conditions Plan Views 100-year Event (355 cfs)	
Cougar Creek Fish Passage Barrier Asotin County, Washington	
GeoEngineers	Figure C-7

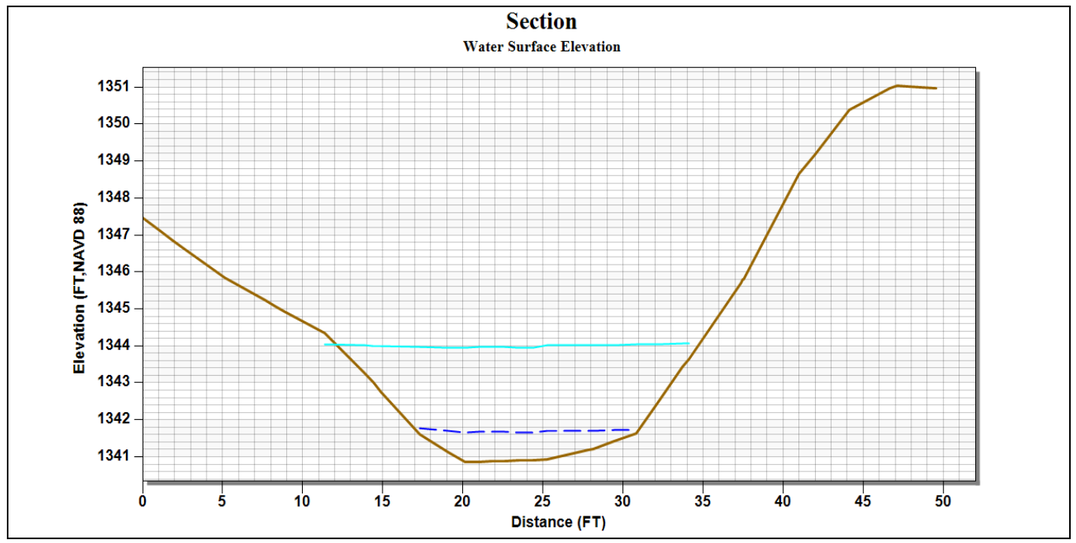
22281-004-00 Date Exported: 09/27/21



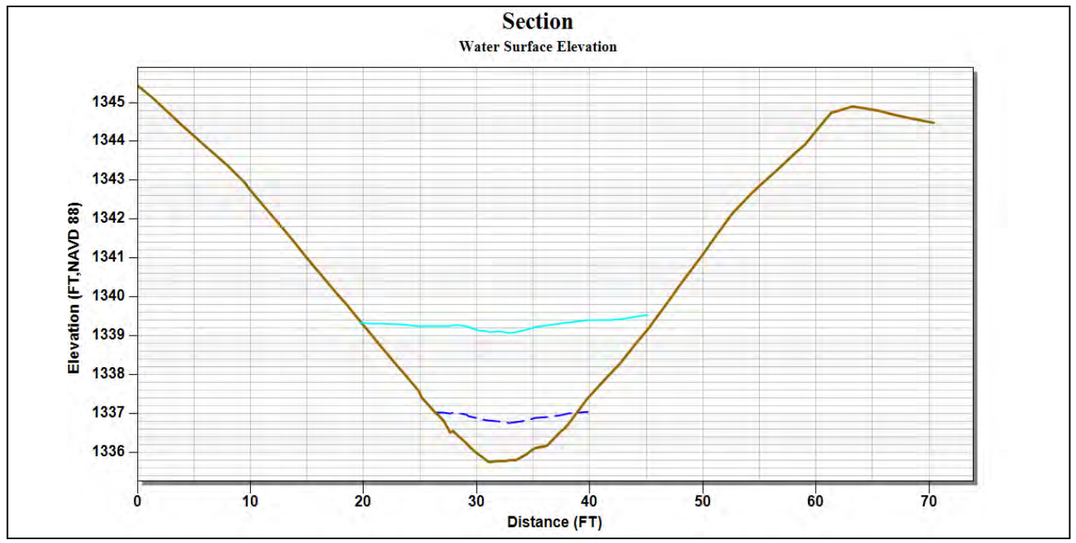
Cross Section 1



Cross Section 2



Cross Section 3



Cross Section 4

Notes:

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3. All cross sections are looking downstream.

Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

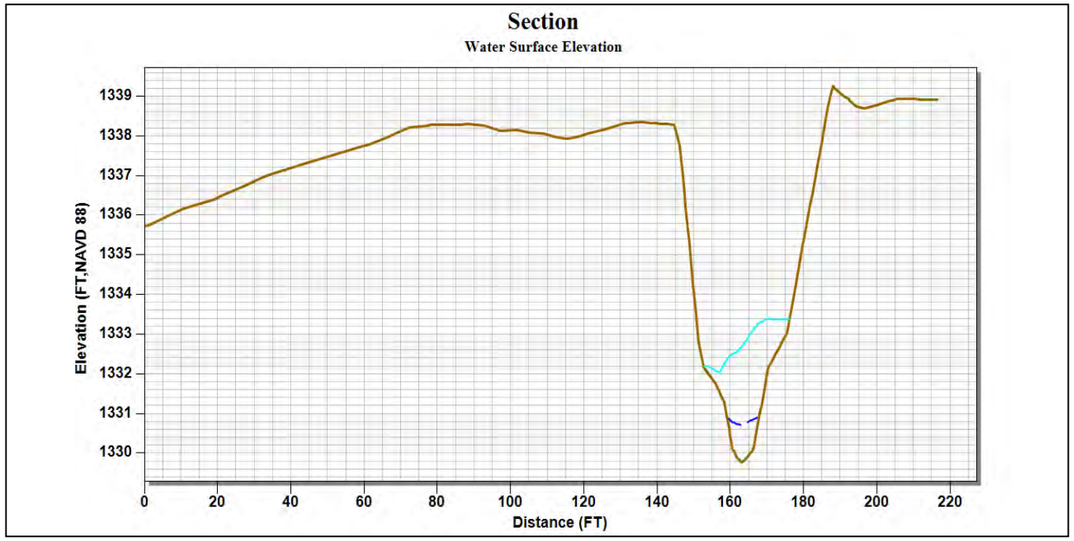
Proposed Conditions 2-year and 100-year Water Surface Elevations at Upstream Cross Sections

Cougar Creek Fish Passage Barrier
Asotin County, Washington

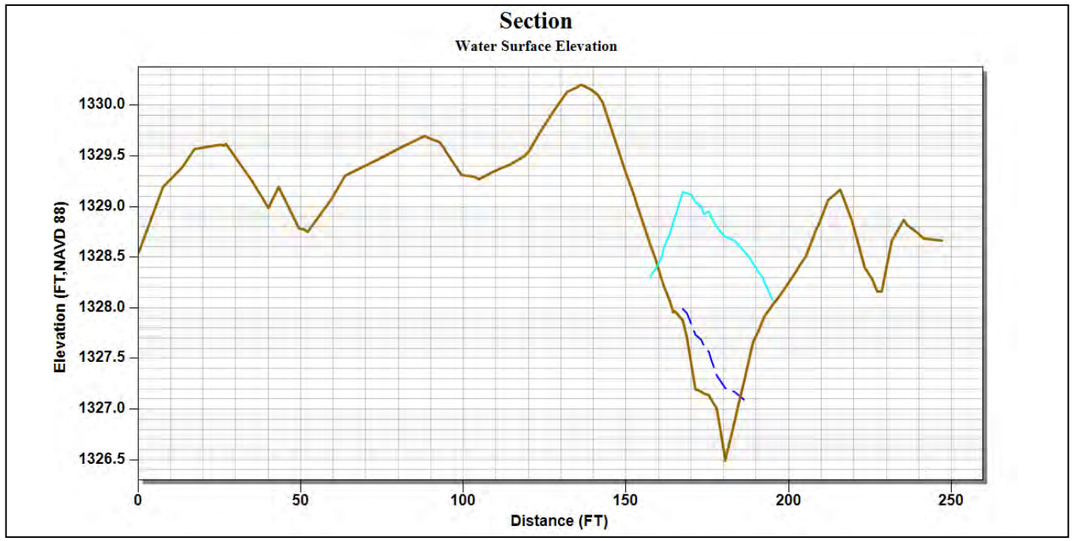
GeoEngineers

Figure C-8

22281-004-00 Date Exported: 09/27/21



Cross Section 5



Cross Section 6

Notes:

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Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

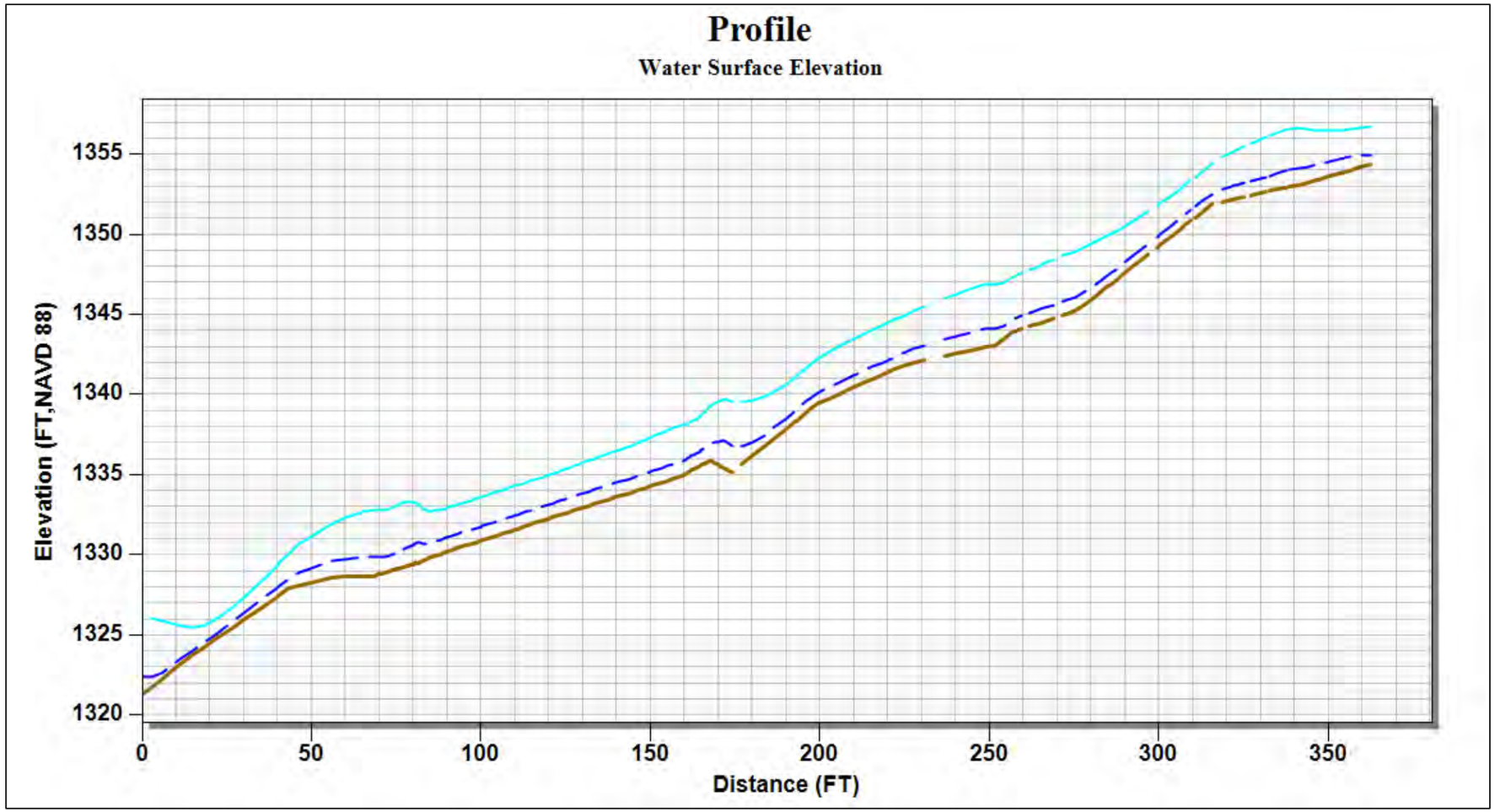
Proposed Conditions 2-year and 100-year Water Surface Elevation at Downstream Cross Sections

Cougar Creek Fish Passage Barrier
Asotin County, Washington

GeoEngineers

Figure C-9

22281-004-00 Date Exported: 09/27/21



Existing Conditions

Notes:
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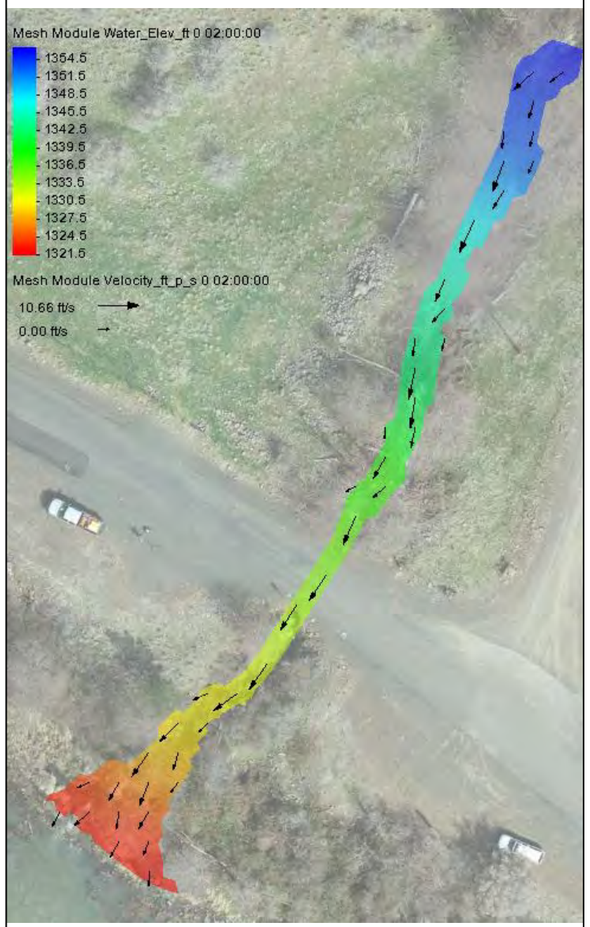
Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

Proposed Conditions 2-year and 100-year Water Surface Elevation Profiles	
Cougar Creek Fish Passage Barrier Asotin County, Washington	
GeoEngineers	**Figure C-10**

22281-004-00 Date Exported: 09/27/21



Water Surface Elevation (FT NAVD88)

Velocity (FT/SEC)

Depth (FT)

Shear Stress (LB/SF)

Notes:

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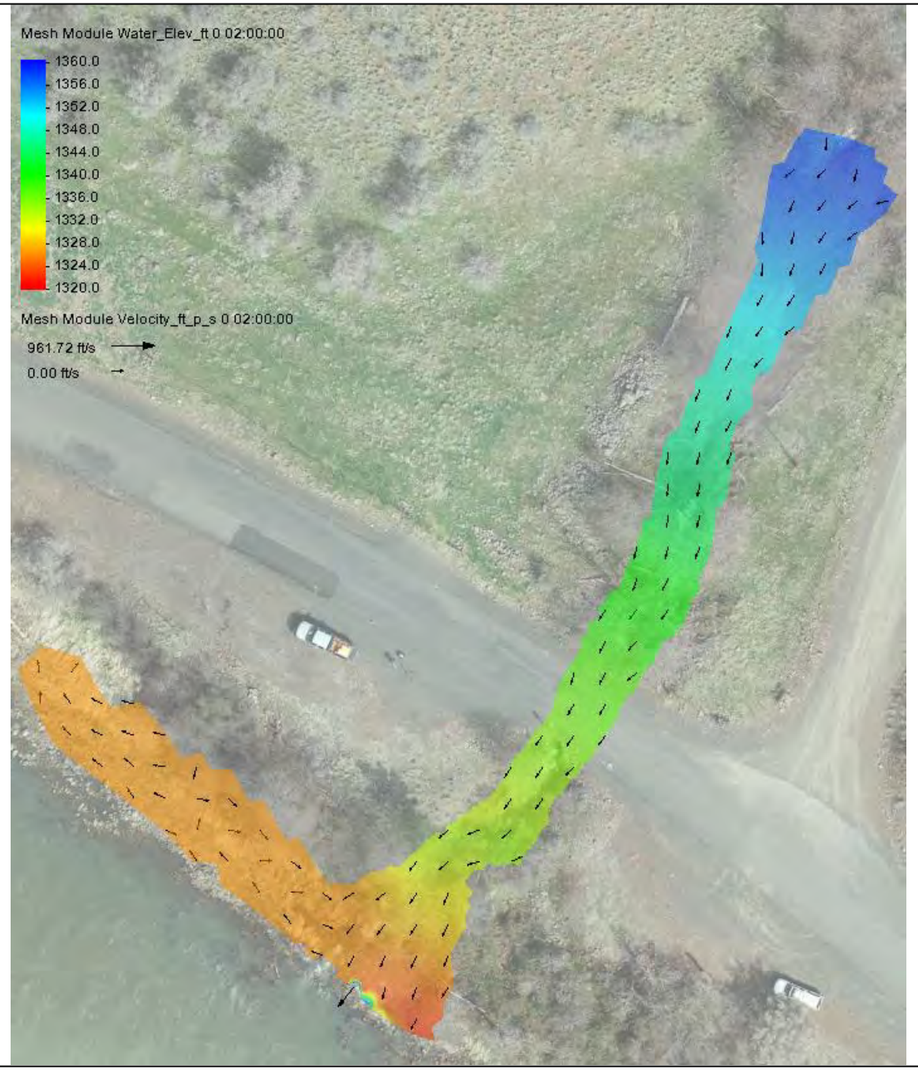
Proposed Conditions Plan Views
2-year Flow (36 cfs)

Cougar Creek Fish Passage Barrier
Asotin County, Washington

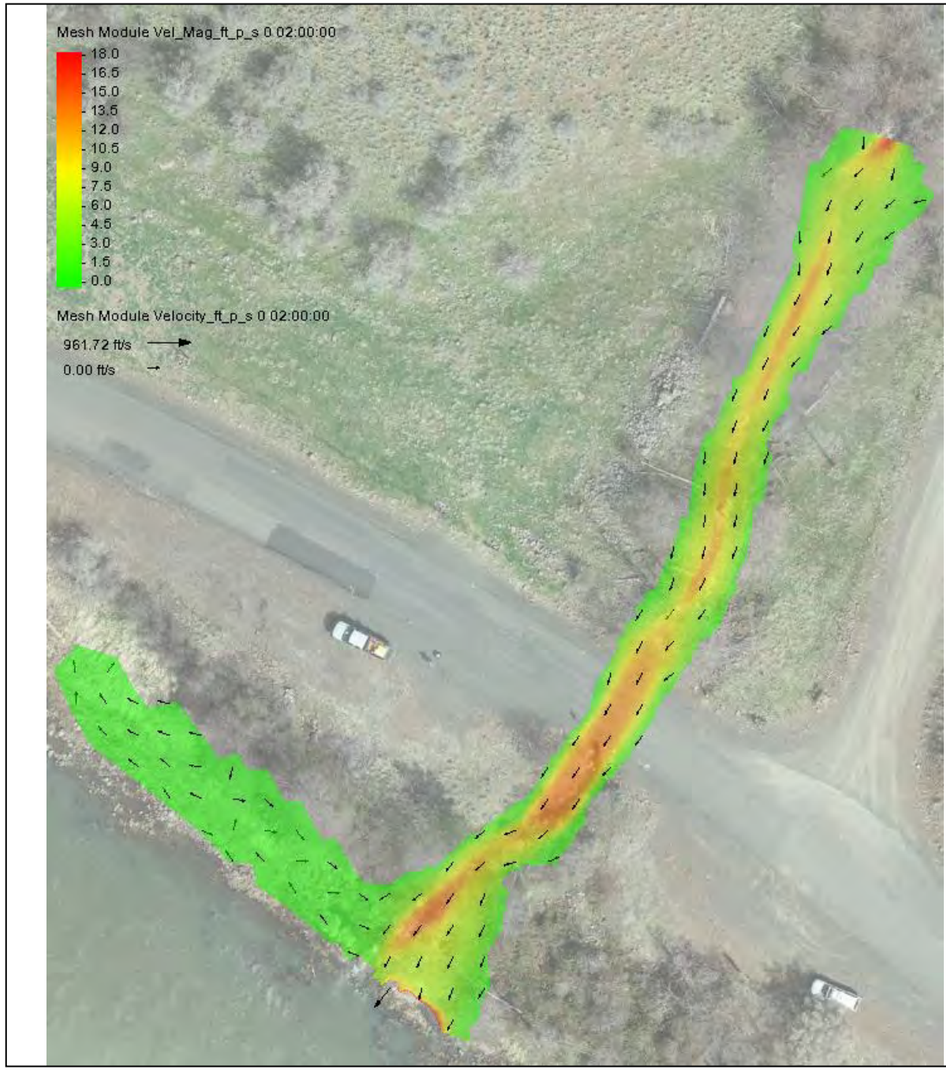
GeoEngineers

Figure C-11

22281-004-00 Date Exported: 09/27/21



Water Surface Elevation
(FT NAVD88)



Velocity (FT/SEC)

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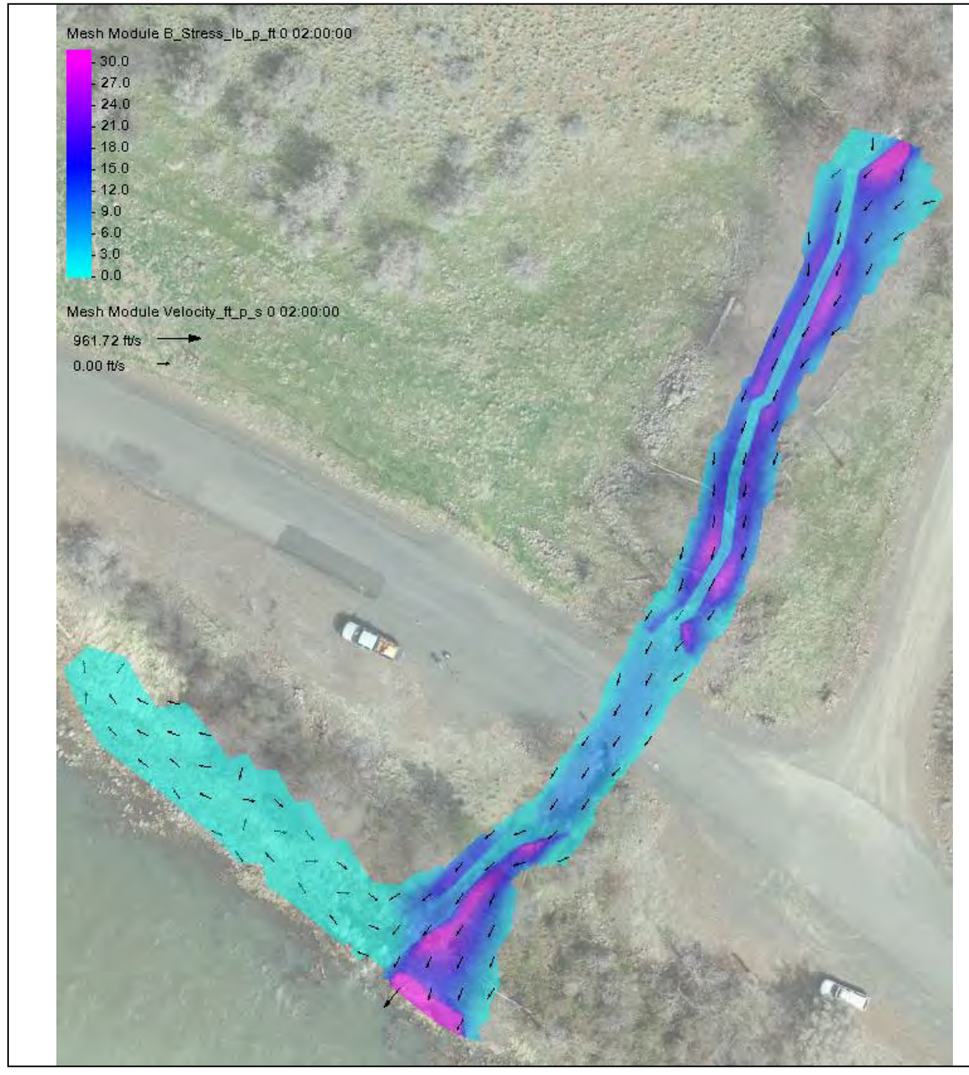
Proposed Conditions Plan Views 100-year Flow (355 cfs)	
Cougar Creek Fish Passage Barrier Asotin County, Washington	
GeoEngineers	Figure C-12

22281-004-00 Date Exported: 09/27/21

Depth (FT)



Shear Stress (LB/SF)

Notes:

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Data Source: SMS Version 13.1.9 and SRH-2D Version 3.3; Simulation Date: 04/21/21

Proposed Conditions Plan Views
100-year Event (355 cfs)

Cougar Creek Fish Passage Barrier
Asotin County, Washington

GeoEngineers

Figure C-13

22281-004-00 Date Exported: 09/27/21

Long-Term Degradation

Computation Method: Controlled by Equilibrium Slope

Parameter	Value	Units	Notes
Input Parameters			
Slope Equation	No Sediment Supply, Shields' Criterion		The methods req...
D90	242.999971	mm	
Shield's Parameter	0.0470		
Manning's n Value	0.0450		
Discharge Per Unit Width	3.10	cfs/ft	
Current Slope	0.0560	ft/ft	
Distance Upstream of Base Level Control	120.00	ft	
Results			
Equilibrium Slope	0.141774	ft/ft	
Ultimate Degradation Amount	-10.29	ft	

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Data Source: Hydraulic Toolbox Version 5.1

N W E S

Not to Scale

Long Term Scour Results

Cougar Creek Barrier Fish Passage Design
Asotin County, Washington

GeoEngineers

Figure C-14

022281-004-00 Date Exported: 11/22/21

Contraction Scour

Computation Method: Clear-Water and Live-Bed Scour

Parameter	Value	Units	Notes
Input Parameters			
Average Depth Upstream of Contraction	3.30	ft	
D50	64.000075	mm	0.2 mm is the lower limit for ...
Average Velocity Upstream	9.40	ft/s	
Results of Scour Condition			
Critical velocity above which bed material of size D and s...	8.10	ft/s	
Contraction Scour Condition	Live Bed		
Live Bed & Clear Water Input Parameters			
Temperature of Water	60.00	°F	
Slope of Energy Grade Line at Approach Section	0.069000	ft/ft	
Discharge in Contracted Section	603.00	cfs	
Discharge Upstream that is Transporting Sediment	603.00	cfs	
Width in Contracted Section	14.00	ft	Remove widths occupied by ...
Width Upstream that is Transporting Sediment	17.00	ft	
Depth Prior to Scour in Contracted Section	2.80	ft	
Unit Weight of Water	62.40	lb/ft^3	
Unit Weight of Sediment	165.00	lb/ft^3	
Results of Clear Water Method			
Diameter of the smallest nontransportable particle in the b...	80.000094	mm	
Average Depth in Contracted Section after Scour	4.58	ft	
Scour Depth	1.78	ft	Negative values imply 'zero' ...
Results of Live Bed Method			
k1	0.640000		
Shear Velocity	2.71	ft/s	
Fall Velocity	1.64	ft/s	
Average Depth in Contracted Section after Scour	3.74	ft	
Scour Depth	0.94	ft	Negative values imply 'zero' ...
Shear Applied to Bed by Live-Bed Scour	4.0032	lb/ft^2	
Shear Required for Movement of D50 Particle	0.8402	lb/ft^2	
Recommendations			
Recommended Scour Depth	0.94	ft	Negative values imply 'zero' ...

N W E S

Not to Scale

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Data Source: Hydraulic Toolbox Version 5.1

Contraction Scour Results

Cougar Creek Barrier Fish Passage Design
Asotin County, Washington

GeoEngineers

Figure C-15

022281-004-00 Date Exported: 11/22/21

Abutment Scour

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type b (Overbanks)		
Abutment Type	Vertical-wall abutmen...		
Unit Discharge, Upstream in Active, Approach Overbank A...	4.30	cfs/ft	
Unit Discharge in Constricted Area (q2)	8.12	cfs/ft	
D50	64.000075	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth	1.00	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour	0.80	ft	Depth at Abutment Toe
Results			
q2 / q1	1.89		
Average Velocity Upstream	4.30	ft/s	
Critical Velocity above which Bed Materal of Size D and Sm...	6.64	ft/s	
Scour Condition	Clear Water		
Scour Condition	b (Overbank)		
Amplification Factor	2.05		
Flow Depth including Contraction Scour	1.19	ft	
Maximum Flow Depth including Abutment Scour	2.44	ft	
Scour Hole Depth	1.64	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width	0.00	ft	
Scour Hole Top Width	1.70	ft	

OK Cancel

N W E S

Not to Scale

Notes:

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Data Source: Hydraulic Toolbox Version 5.1

Abutment Scour Results

Cougar Creek Barrier Fish Passage Design
Asotin County, Washington

GeoEngineers

Figure C-16

022281-004-00 Date Exported: 11/22/21

Scour Associated With Step Pools

Project:	Cougar Creek	Site:	Cougar Creek - Proposed Steps within Culvert
Watercourse:	Cougar Creek	Analyst:	GLS
Checked By:		Latest Revision:	11.23.2021

Description:

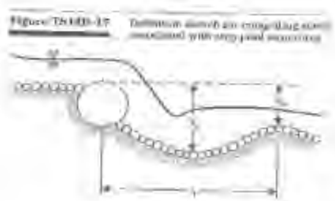
- The scour equations in this workbook apply to course grained mountain streams (8 streamd in study), originally studied in Colorado.
- Equations and methods are from TS14B, page 23.
- This workbook is intended for English units

$$\frac{z_s}{W} = -0.0118 + 1.394\left(\frac{h_d}{W}\right) + 5.514\left(\frac{S_{q_{25}}}{W^{\frac{3}{2}}\sqrt{g}}\right)$$

$$\frac{l_p}{W} = 0.409 + 4.211\left(\frac{h_d}{W}\right) + 87.341\left(\frac{S_{q_{25}}}{W^{\frac{3}{2}}\sqrt{g}}\right)$$

Input

Variable	Value	Definition
Q	603	Design discharge, cfs (500 Year Discharge)
W	24	Average active channel width (ft)
h_d	1	Height of step crest above controlling bed elevation at downstream end of pool, (ft)
S	0.069	Average channel bed slope
q	25.13	Flow per unit width over the sill at design discharge
g	32.2	Acceleration of gravity, 32.2 ft/s^2



Calculations

Z_s/W	0.06	
Z_s	**1.5**	Depth of scour downstream from structure, (ft), measured from crest of the structure to the lowest point within the scour pool
l_p/W	0.81	
l_p	**19.5**	Length of scour pool, (ft)

Notes:

1. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Hydraulic Toolbox Version 5.1

Not to Scale

Porous Weir Scour Results

Cougar Creek Barrier Fish Passage Design
Asotin County, Washington

GeoEngineers

Figure C-17

022281-004-00 Date Exported: 11/22/21

Bathurst Critical Unit Discharge

Cougar Creek - Asotin County, Washington

References:

Stream Simulation and Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings

Appenix E (USDA 2008)

$$q_{c-D50} = \frac{0.15 g^{0.5} {D_{50}}^{1.5}}{S^{1.12}} \qquad D_{50} = \left(\frac{S^{1.12} q_{c-D50}}{0.15 g^{0.5}}\right)^{\frac{2}{3}} \qquad cfs = \frac{ft^3}{s}$$

Input Data

Cross Section Name/Station:				
Flow Event:		*100*	yr	
Energy Slope (S) - ft/ft:	S =	**0.069**	ft/ft	Design slope
100-yr Flow in Main Channel (Q):	Q =	**355.0**	cfs	From hydrology analysis
Stream Width (W):	W =	**24.0**	ft	Average BFW from concurrence
Specific Discharge (q_c) - (cfs/ft):	q_c =	*14.8*	ft^{-}/s	

$$q_c = \frac{Q}{W}$$

D_{84} =	2.28 ft	
	27.34 in	

$$D_{16} = \frac{D_{84}}{8}$$

D_{16} =	0.28 ft	
	3.42 in	

$$D_{50} = \frac{D_{84}}{2.5}$$

D_{50} =	0.91 ft	
	10.94 in	

$$D_{100} = \frac{D_{84}}{0.4}$$

D_{100} =	5.70 ft	Limit to 3.0 feet
	68.35 in	

APPENDIX D
Construction Quantities and Estimate of Anticipated Costs

Final Cost Estimate

Project: Cougar Creek Fish Passage
Project Number: 22281-004-01

Analyst Ryan Carnie
Date 11/18/2022

Workbook Description

- This workbook contains spreadsheets that facilitate the analysis and/or design of this project.
- This spreadsheet lists the general project and workbook information that is consistent throughout the workbook.
- It also lists the titles of the spreadsheets contained in this workbook.
- This workbook is limited to the Construction Cost Estimate for modifications identified in the GeoEngineers Construction drawings and
  does **NOT** include the modifications proposed by others.
- This workbook is intended for use with ENGLISH UNITS.

Filename: *geoengineers.com*\

Sheet Titles:

Final Cost Estimate
Unit Costs
Engineers's Construction Cost Estimate
Bid Response Form

Unit Costs

Project: Cougar Creek Fish Passage **Analyst** Ryan Carnie

Project Number: 22281-004-01 **Latest Revision** 11/18/2022

- This spreadsheet calculates the costs associated with site preparation. Unit costs include materials, labor, equipment, overhead and contractor profit.
- Reference used for "unit costs" include:
  (1) WSDOT Bid Tabs Data Base
  (2) Engineering Experience & Recent Similar Projects
  (3) Contractor or Supplier
- Inflation adjustment is negligible.
- Additional adjustments are based on engineering judgement, experience and site-specific degree of difficulty.
- Blank rows are provided at the bottom for additional items. Add new items & unit costs on this sheet, if necessary. These will be used to calculate costs on subsequent sheets.
- General mark-up percentages are also provided at the bottom.
- Specification # References the 2022 version of WSDOT's Standard Specifications for Road, Bridge, and Municipal Construction as amended in December 2021. Project-specific special provisions are affixed with "SP."

Item No.	Specification Pay Item	Item Description	Unit Measure	Unit Cost
1	1-09	Mobilization	LS	$ 57,000.00
2	1-10	Other Temporary Traffic Control (Temp. Traffic Bypass Brg.)	LS	$ 14,000.00
3	1-10	Project Temporary Traffic Control	LS	$ 25,000.00
4	2-01	Clearing and Grubbing	LS	$ 20,000.00
5	2-01	Roadside Cleanup	FA	$ 3,000.00
6	2-02	Removal of Structures and Obstructions	LS	$ 8,000.00
7	2-03	Roadway Excavation Inc. Haul	CY	$ 30.00
8	2-03	Channel Excavation Incl. Haul	CY	$ 40.00
9	2-03	Select Borrow Inc. Haul (Grande Ronde Rd. Embankment)	CY	$ 45.00
10	2-09	Structure Excavation Class A Incl. Haul	CY	$ 35.00
11	2-09SP	Dewatering	LS	$ 2,800.00
12	2-12	Construction Geosynthetic for Separation	SY	$ 6.00
13	4-04	Crushed Surfacing Base Course (Grande Ronde Rd.)	CY	$ 350.00
14	5-04 SP	HMA Cl. 1/2-inch, PG 70-28	TON	$ 125.00
15	5-03	HMA Sawcut And Seal	LF	$ 7.00
16	6-10	Precast Concrete Barrier Type II	LF	$ 150.00
17	6-11	Conc. Class 4000 for Retaining Wall	CY	$ 800.00
18	6-11	Steel Reinforcement Bar for Retaining Wall	LB	$ 2.00
19	6-20	Contractor Design Buried Structure No. 1	LS	$ 170,000.00
20	7-06	Temporary Stream Diversion	LS	$ 12,000.00
21	8-01	Erosion Control and Water Pollution Control	LS	$ 10,000.00
22	8-02	Seeding and and Mulching	AC	$ 1,300.00
23	8-02	Live Pole	EA	$ 15.00
24	8-12	Chain Link Fence Type 4	LF	$ 100.00
25	8-19 SP	Streambed Sediment	TON	$ 75.00
26	8-19 SP	Native Streambed Material	TON	$ 60.00
27	8-19 SP	Streambed Boulders - Three Man	TON	$ 140.00
28	8-21	Permanent Signing	LS	$ 5,000.00
			Taxes	9%

Engineers's Construction Cost Estimate

Project: Cougar Creek Fish Passage
Project No: 22281-004-01

Analyst **Ryan Carnie**
Latest Revision **11/18/2022**

- This spreadsheet summarizes the costs for construction of the culvert, roadway, and channel restoration measures.

Item No.	Specification Pay Item	Item Description	Quantity	Unit Measure	Unit Cost	Estimated Cost
1	1-09	Mobilization	1.0	LS	$57,000.00	$57,000
2	1-10	Other Temporary Traffic Control (Temp. Traffic Bypass Brg.)	1.0	LS	$14,000.00	$14,000
3	1-10	Project Temporary Traffic Control	1.0	LS	$25,000.00	$25,000
4	2-01	Clearing and Grubbing	1.0	LS	$20,000.00	$20,000
5	2-01	Roadside Cleanup	1.0	FA	$3,000.00	$3,000
6	2-02	Removal of Structures and Obstructions	1.0	LS	$8,000.00	$8,000
7	2-03	Roadway Excavation Inc. Haul	960.0	CY	$30.00	$28,800
8	2-03	Channel Excavation Incl. Haul	67.0	CY	$40.00	$2,680
9	2-03	Select Borrow Inc. Haul (Grande Ronde Rd. Embankment)	800.0	CY	$45.00	$36,000
10	2-09	Structure Excavation Class A Incl. Haul	36.0	CY	$35.00	$1,260
11	2-09SP	Dewatering	1.0	LS	$2,800.00	$2,800
12	2-12	Construction Geosynthetic for Separation	106.0	SY	$6.00	$636
13	4-04	Crushed Surfacing Base Course (Grande Ronde Rd.)	90.0	CY	$350.00	$31,500
14	5-04 SP	HMA Cl. 1/2-inch, PG 70-28	65.0	TON	$125.00	$8,125
15	5-03	HMA Sawcut And Seal	52.0	LF	$7.00	$364
16	6-10	Precast Concrete Barrier Type II	108.0	LF	$150.00	$16,200
17	6-11	Conc. Class 4000 for Retaining Wall	116.0	CY	$800.00	$92,800
18	6-11	Steel Reinforcement Bar for Retaining Wall	18325.0	LB	$2.00	$36,650
19	6-20	Contractor Design Buried Structure No. 1	1.0	LS	$170,000.00	$170,000
20	7-06	Temporary Stream Diversion	1.0	LS	$12,000.00	$12,000
21	8-01	Erosion Control and Water Pollution Control	1.0	LS	$10,000.00	$10,000
22	8-02	Seeding and and Mulching	1.7	AC	$1,300.00	$2,210
23	8-02	Live Pole	106.0	EA	$15.00	$1,590
24	8-12	Chain Link Fence Type 4	25.0	LF	$100.00	$2,500
25	8-19 SP	Streambed Sediment	40.0	TON	$75.00	$3,000
26	8-19 SP	Native Streambed Material	200.0	TON	$60.00	$12,000
27	8-19 SP	Streambed Boulders - Three Man	56.0	TON	$140.00	$7,840
28	8-21	Permanent Signing	1.0	LS	$5,000.00	$5,000
SUBTOTAL CONSTRUCTION COST						**$610,955**
				Taxes		$54,986
				Construction Observation		$25,000
FINAL CONSTRUCTION COST						**$690,941**

Bid Response Form

Project: Cougar Creek Fish Passage
Project Number: 22281-004-01

Analyst **Ryan Carnie**
Date **11/18/2022**

- This spreadsheet provides an outline of the Bid Response Form for inclusion with the bid package and construction contract.

Item No.	Specification Pay Item	Item Description	Approx. Quantity	Unit Measure	Unit Cost
1	1-09	Mobilization	1.0	LS	
2	1-10	Other Temporary Traffic Control (Temp. Traffic Bypass Brg.)	1.0	LS	
3	1-10	Project Temporary Traffic Control	1.0	LS	
4	2-01	Clearing and Grubbing	1.0	LS	
5	2-01	Roadside Cleanup	1.0	FA	
6	2-02	Removal of Structures and Obstructions	1.0	LS	
7	2-03	Roadway Excavation Inc. Haul	960.0	CY	
8	2-03	Channel Excavation Incl. Haul	67.0	CY	
9	2-03	Select Borrow Inc. Haul (Grande Ronde Rd. Embankment)	800.0	CY	
10	2-09	Structure Excavation Class A Incl. Haul	36.0	CY	
11	2-09SP	Dewatering	1.0	LS	
12	2-12	Construction Geosynthetic for Separation	106.0	SY	
13	4-04	Crushed Surfacing Base Course (Grande Ronde Rd.)	90.0	CY	
14	5-04 SP	HMA Cl. 1/2-inch, PG 70-28	65.0	TON	
15	5-03	HMA Sawcut And Seal	52.0	LF	
16	6-10	Precast Concrete Barrier Type II	108.0	LF	
17	6-11	Conc. Class 4000 for Retaining Wall	116.0	CY	
18	6-11	Steel Reinforcement Bar for Retaining Wall	18325.0	LB	
19	6-20	Contractor Design Buried Structure No. 1	1.0	LS	
20	7-06	Temporary Stream Diversion	1.0	LS	
21	8-01	Erosion Control and Water Pollution Control	1.0	LS	
22	8-02	Seeding and and Mulching	1.7	AC	
23	8-02	Live Pole	106.0	EA	
24	8-12	Chain Link Fence Type 4	25.0	LF	
25	8-19 SP	Streambed Sediment	40.0	TON	
26	8-19 SP	Native Streambed Material	200.0	TON	
27	8-19 SP	Streambed Boulders - Three Man	56.0	TON	
28	8-21	Permanent Signing	1.0	LS	
		Construction Sub-Total			
		Taxes			
		Final Construction Cost			

APPENDIX E
Bonneville Power Comment Response

HIP Project Review
Comment Tracking

Project Information:

Project Name:	Cougar Creek Fish Passage Project
BPA Project #:	1994-018-05
Contract #:	85356
Sponsor:	Asotin County Conservation District
Designer:	GeoEngineers
Area Lead:	André L'Heureux, EWU, Lower Snake Lead
COR/PM:	Matthew Schwartz, EWU
HIP Program Lead:	Daniel A. Gambetta, ECF

HIP Review Team:

BPA EC Lead:	Catherine Clark, ECF
BPA Technical Lead:	Christopher J. Nygaard, P.E., EWL
NMFS Branch Chief:	Kenneth Troyer, NMFS, Northern Snake Branch Chief
NMFS Biologist:	NA
NMFS Engineer:	Not Required
USFWS Field Office:	Russ MacRae, USFWS (Eastern WA) Spokane Field Office
USFWS Reviewer:	NA

Documents Reviewed:

Cougar Creek Fish Passage Barrier Removal - Conceptual Alternative Analysis
Cougar Creek Fish Passage Barrier Removal, Asotin County, 30% Design
Cougar Creek Fish Passage Barrier Removal, Asotin County, 80% Design, 3 DEC 2021

Activity Categories:	**Risk Level:**
1f - Bridge and Culvert Removal or Replacement	Medium
1c - Headcut and Grade Stabilization	Medium
2b - Set-back or Removal of Berms, Dikes and Levees	NA
Overall Project Risk	**Medium**

Review Timeline:	**Date Completed**
• Conceptual Review (typically 15%)	
o Site visit, if needed	Not Required
o Sponsor to submit conceptual design to EC Lead and COR	5/5/2021
o EC Lead to submit concept to HIP Review Team to initiate review	6/9/2021
o EC Lead to compile comments and forward to Sponsor	6/11/2021
• Preliminary Design or Alternatives Analysis Review (typically 30%)	
o Sponsor to submit preliminary design to EC Lead and COR	10/4/2021
o EC Lead to compile comments and forward to Sponsor	10/11/2021
• Permit Level Design Review (typically 60% to 80%)	
o Sponsor to submit design package to EC lead and COR	12/8/2021
o EC Lead to submit design package to HIP Review Team	12/8/2021
o EC Lead to compile comments and forward to Sponsor	12/10/2021
o Sponsor to provide responses to EC Lead	12/10/2021
• Final Design Package (100%)	
o Sponsor to submit final designs to EC Lead and COR	Not Started
o EC Lead and BPA Technical Lead to verify no critical changes	Not Started

HIP Project Review
Comment Tracking

Comments:

#	Reviewer (Org.)	Date	Document	Page/ Section	Comment		Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
1	BPA	6/11/21	Design Package		The final project drawings shall be sealed by the Project Engineer per Revised Code of Washington 18.43.070. **Update 10/14/21:** Comment closed.		GeoEngineers	8/27/21	Final Design drawings will be stamped by an engineer licensed in the State of Washington	Closed
2	BPA	6/11/21	Design Package		Please review HIP activity Category 1f) Bridge and Culvert Removal or Replacement and ensure that the plan develops in a manner that meets the programmatic Conservation Measures. **Update 10/14/21:** Will fines be included in the weirs? How will subsurface flows be minimized to ensure passage at low flows? **Update 12/10/21:** Comment closed.		GeoEngineers	8/27/21	The design follows HIP IV Category 1f guidelines. **10/27/2021** The footer boulders that make up the lower half of the porous weirs will be backfilled with streambed material that will include fines. Similarly, the streambed material proposed between the porous weirs will be comprised of sufficient WSDOT streambed sediment, applied in two lifts with a maximum thickness of 12 inches, and washed in to minimize subsurface flows. We'll develop the gradation and boulder sizes with hydraulic model results and include that material specification in the 80%.	Closed
3	BPA	6/11/21	Design Package		Please provide with-project hydraulics and scour analysis of proposed alternative in the 30% design submittal. **Update 10/14/21:** Comment closed.		GeoEngineers	8/27/21	These data and analyses are included in the 30% report and incorporated into the design.	Closed
4	BPA	7/13/21	Design Package		If the culvert alternative is chosen "2b – Set-back or Removal of Berms, Dikes and Levees" would be removed under the Activity Categories. **Update 10/14/21:** Comment closed.		GeoEngineers	8/27/21	Only 1f (Bridge and culvert removal or replacement) is being implemented at this site.	Closed
5	BPA	7/13/21	Design Package		Timing of in-water work: Please include in the 30% design package. **Update 10/14/21:** Comment closed.		GeoEngineers	8/27/21	The in-water work window is July 15 to August 15 and is in the 30% package.	Closed

HIP Project Review
Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/ Section	Comment		Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
6	BPA	7/13/21	Design Package		Staging, storage, and stockpile areas: Staging areas must be 150 feet or more from any natural waterbody. Clearly noting equipment storage, vehicle storage, and fueling area. Please include in the 30% design package. **Update 10/14/21:** Comment closed.		GeoEngineers	8/27/21	30% design plans include a sheet for staging and stockpiling, maintain 150 feet offset from all water bodies.	Closed
7	BPA	7/13/21	Design Package		Turbidity monitoring: Incorporate turbidity monitoring protocols for adherence to CWA permitting and HIP reports. **Update 12/10/21:** Comment closed.		GeoEngineers	8/27/21	Turbidity monitoring requirements and CWA permitting will be at the next (80%) design step. They are also included in the HIP General Requirements.	Closed
8	BPA	7/13/21	Design Package		Planting plan: If planting is planned after implementation – Please provide a short planting plan (i.e. species, plant sizes vs. seeding, planting success, etc.). **Update 12/10/21:** Note: Crested wheatgrass is non-native. Ability to use in this project does not set precedence for future projects. Comment closed.		GeoEngineers	8/27/21	Planting plan is, in part, included in the 30% design drawings. However, it will be further refined in the 80% design step.	Closed

APPENDIX F
Monitoring and Adaptive Management Plan

APPENDIX F
MONITORING AND ADAPTIVE MANAGEMENT PLAN

INTRODUCTION

The Asotin County Conservation District (ACCD) proposes the removal of a fish passage barrier at the crossing of Cougar Creek and Grande Ronde Road. The fish passage barrier limits access to spawning and rearing habitat for anadromous salmonids, including Endangered Species Act-listed (ESA) Steelhead within Cougar Creek. To restore fish passage, this project proposes to replace the currently undersized culvert with a fish passable crossing structure and restoring the roadway.

Responsible Parties

The project sponsor is the ACCD, and the project manager is Megan Stewart 509.552.8100.

Project Goals and Objectives

The project goal is to restore fish passage under Grande Ronde Road with the replacement of the existing fish passage barrier culvert. To achieve the project goal, the project objectives included developing a set of construction-ready design drawings and special provisions adequately detailing a restoration action for replacing the culvert on Cougar Creek. The design drawings and special provisions were developed to restore natural channel morphology upstream and downstream of the crossing to the greatest extent practical while allowing for proper bed load transport. The design drawings and special provisions considered and accommodated passage of all life stages of steelhead and resident trout. Implementation of the crossing replacement was also identified as a project objective. A basis of design report, design drawings and design specifications were prepared by GeoEngineers (GeoEngineers 2022).

Monitoring Plan Period and Documentation

Monitoring will begin after the as-built (Year 0) report has been prepared. Monitoring will occur for either 5 years or the duration identified on the grant agreement, whichever is longer. The monitoring duration should start after the culvert and stream channel enhancement has been installed. Fish passage and culvert performance will be monitored for each year during the monitoring period. The site will be assessed after the minimum monitoring duration with reports prepared following each year. If the site is successful (meeting performance standards) a release letter will be requested from the Washington RCO by the project sponsor, ACCD (WDFW & RCO 2018).

A monitoring report should be prepared by the project sponsor's responsible party to document activities during the recommended monitoring activities. All observations and measurements shall be recorded in the job diary. Photographic documentation should be made of data collection and measurements. The reports will describe the condition of the areas. General maintenance requirements such as trash removal, vandalism and invasive species removal should also be noted in the monitoring report.

ASSESSMENT PROTOCOLS

The project objective to restore fish passage for all life stages of steelhead and resident trout. The recommended assessment protocols are intended to assess bankfull width, structural vertical clearance, hydraulic drop heights and longitudinal channel slope. The assessment methods described are intended to

be easily executed without significant financial investment in monitoring equipment by the project sponsor. The protocols are summarized in Table F-1 below.

The monitoring and adaptive management for the Cougar Creek Fish Passage Restoration project follow criteria identified in the following guidelines:

- The February 2018 WDFW/RCO Manual 22 provides implementation guidance for preliminary project design deliverables content and FBRB Grant Program funding. We prepared the Preliminary Basis of Design Report and attached appendices accordingly (WDFW & RCO 2018).
- The 2013 WDFW Stream Crossing Design Guidelines (guidelines) provide design guidelines for geomorphic condition documentation, channel design and minimum crossing structure span (R. Barnard, et al. 2013). We designed the proposed structure span using the confined bridge design criteria, which requires a complete span of the 100-year width to limit hydraulic influence on the stream
- Bonneville Power Habitat Improvement Program (HIP) Guidelines Version 5.2 (BPA 2021).
- National Marine Fisheries Service (NMFS) Anadromous Salmonid Passage Facility Design guidelines (NMFS 2011).

CATEGORIES OF ACTION AND ASSOCIATED THRESHOLDS

The proposed actions for the Cougar Creek Fish Passage Restoration project are compliant with BPA HIP Guidelines (BPA 2021). The project is within Category 1, fish passage restoration and specifically Category 1f, Bridge and Culvert Removal or Replacement. Within Category 1f, the project proposes two design elements that include channel reconstruction and culvert replacement. The categories of action and triggers are summarized below and included in Table 1.

Bridge and Culvert Replacement Thresholds

The project proposes to remove the existing corrugated metal pipe (CMP) crossing structure and replacing it with a concrete open bottom culvert.

The proposed culvert has a 24-foot span to accommodate the minimum hydraulic opening width. The proposed span was designed to exceed the bankfull width times a factor of 1.5 based on BPA HIP guidelines (BPA 2021). The reference reach bankfull width was measured as 13.9 feet. Therefore, culvert replacement triggers are specific to the measured bankfull width upstream and downstream of the culvert. The measured bankfull width should remain less than 24 feet divided by a factor of 1.5 feet, or 16 feet to provide a clear and unobstructed opening (BPA 2021).

Monitoring protocols regarding bankfull width are described in Bankfull Width Monitoring below and summarized in Table F-1 below.

Bankfull Width Monitoring

- Method: Measure the bankfull width at the upstream and downstream limits of the culvert using channel grade break, vegetative and sediment indicators. Stake each bankfull location and measure the distance using a standard tape. Document measurements.
- Timing and Frequency: Shall be performed annually.

- Special Equipment Needed: Wood stakes, measuring tape, notebook and camera.
- Maintenance: In-channel equipment grading may be required to revise the channel dimensions and streambed boulders may require replacement. In channel grading may be performed as a maintenance project so long as it is in compliance with local, state, and federal laws and regulations. If the maintenance activity occurs after the maintenance grace period identified in the permits, federal, state and local permits may be required.

Vertical clearance between the channel thalweg and the low chord of the proposed concrete culvert is important to provide hydraulic and debris passage (BPA 2021) and to and limit the risk of overtopping. The design vertical clearance is 4.5 feet between thalweg and low chord.

Monitoring protocols regarding vertical clearance are described in Vertical Clearance Monitoring and summarized in Table F-1 below.

Vertical Clearance Monitoring

- Method: Measure the vertical distance between the culvert low chord and the channel thalweg using staff gages. Document vertical measurements at each location.
- Timing and Frequency: Shall be performed annually.
- Special Equipment Needed: Staff gage, notebook, and camera.
- Maintenance: In-channel equipment grading may be required to revise the channel thalweg elevation and streambed boulders may require replacement. In-channel grading may be performed as a maintenance project. If the maintenance activity occurs after the maintenance grace period identified in the permits, federal, state and local permits may be required.

Channel Reconstruction Thresholds

The proposed reconstructed channel will consist of channel-spanning porous weirs. Porous weirs are proposed with a longitudinal spacing of approximately twice the bankfull width to approximately match conditions observed in the reference reach. Hydraulic drop heights are limited to 0.5 feet to provide fish passage (NMFS 2011).

Monitoring protocols regarding drop height related to fish passage are described in Hydraulic Drop Heights and summarized in Table F-1 below.

Hydraulic Drop Heights

- Method: If channel spanning drops are observed, drop height should be measured to ensure they do not exceed 0.5-feet (NMFS 2011), to maintain juvenile fish passage. Measurements should be taken at drop locations visually observed within the monitoring area during annual monitoring. A drop is defined as a vertical change in elevation extending across the full width of the channel. A laser level (or equivalent) will be used to measure drop heights. The drop should be documented with photographs and recorded in the monitoring report.
- Timing and Frequency: Will be performed annually during low flow conditions.
- Special Equipment Needed: laser level, staff gage, notebook and camera.

- Maintenance: In-channel equipment grading may be required to reduce the drop height at the porous weirs. Grading activities include reconstruction of the streambed upstream and downstream of the porous weirs or adjusting the streambed boulders that comprise the porous weirs. In channel grading may be performed as a maintenance project. If the maintenance activity occurs after the maintenance grace period identified in the permits, federal, state and local permits may be required.

The longitudinal slope through the culvert was designed to be 6.9 percent to mimic the reference reach slope upstream of the culvert and maintain fish passage and material passage through the crossing (BPA 2021). Maintaining a channel slope within 25 percent of the reference channel slope is recommended to maintain geomorphic processes through the crossing (R. Barnard, et al. 2013). Based on those criteria, the minimum allowable slope is 5.2 percent, and the maximum allowable slope is 8.6 percent. Because the culvert slope is equal to 6.9 percent, the measurements will indicate variations from the baseline condition. To calculate the variation in longitudinal slope, use the vertical clearance monitoring measurements and divide the difference by the culvert length of 50 feet. The slope calculated by dividing the difference the upstream and downstream measurements shall be either added or subtracted from 6.9 percent to document longitudinal slope.

Monitoring protocols regarding longitudinal slope are described in Longitudinal Slope Monitoring and summarized in Table F-1 below.

Longitudinal Slope Monitoring

- Method: Measure the vertical distance between the culvert low chord and the channel thalweg using staff gages. Calculate the slope through the culvert by dividing the difference between the upstream and the downstream vertical measurement by the 50-foot culvert length. Document vertical measurements at each location.
- Timing and Frequency: Shall be performed annually.
- Special Equipment Needed: Staff gage, notebook and camera.
- Maintenance: In-channel equipment grading may be required to revise the channel dimensions and streambed boulders may require replacement. In-channel grading may be performed as a maintenance project. If the maintenance activity occurs after the maintenance grace period identified in the permits, federal, state and local permits may be required.

TABLE F-1. MONITORING TECHNIQUE, MONITORING METRICS, DESIGN VALUE, THRESHOLD VALUE AND MONITORING FREQUENCY

Objectives	Monitoring Technique	Monitoring Metrics	Design Value	Threshold Values	Monitoring Frequency
Bankfull width (BFW)	Tape measure reading	Measure the BFW at the culvert inlet and at the culvert outlet	Design BFW = 14.0 ft	BFW > 16 feet	Annually
Vertical clearance	Staff gage reading	Measure vertical distance from culvert low chord to channel grade at inlet and outlet of culvert.	4.5 feet	Clearance < 4 feet	Annually
Drop height at porous weir	Staff gage reading	Measure the difference in WSEL upstream and downstream of the porous weir	0.5 foot during low design flow	Drop height > 0.5 foot	Annually during low flow (July, August, September)
Longitudinal slope through structure	Staff gage reading	Divide vertical clearance measurement difference by 50 and add or subtract to 6.9%	6.9%	5.2% < slope < 8.6%	Annually

9.0 REFERENCES

Barnard, R. J., J. Johnson, P. Brooks, K. M. Bates, B. Heiner, J. P. Klavas, D. C. Ponder, P. D. Smith, and P.D. Powers. 2013. "Water Crossing Design Guidelines." Olympia, WA: Washington State Department of Fish and Wildlife.

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NMFS. 2011. Anadromous Salmonid Passage Facility Design. Portland, Oregon: National Marine Fisheries Service, Northwest Region, July.

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APPENDIX G
Report Limitations and Guidelines for Use

APPENDIX G
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that stream and river engineering analysis and design practices are less exact than other engineering and natural science disciplines. Such misunderstanding can create unrealistic expectations, sometimes leading to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

STREAM AND RIVER DESIGN ENGINEERING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the Asotin County Conservation District and their authorized agents and regulatory agencies for use on the Project(s) specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the Asotin County Conservation District may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project(s), and its (their) schedule and budget, our services have been executed in accordance with our Agreement with the Asotin County Conservation District dated February 11, 2021 and generally accepted practices in this area at the time this report was prepared. We do not authorize and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A STREAM OR RIVER DESIGN ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the Cougar Creek Fish Passage Barrier Removal project, in Asotin County, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site, or
- Completed before project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

- The function of the proposed design and/or structure;
- Elevation, configuration, location, orientation or weight of the proposed structures;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations in the context of such changes. Based on that review, we can provide written modifications or confirmation, as appropriate.

CONDITIONS CAN CHANGE

This report is based on conditions that existed at the time the study/design was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability, stream flow fluctuations or stream channel fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

REPORT RECOMMENDATIONS AND DESIGNS ARE NOT FINAL

The recommendations included in this report are preliminary and should not be considered final. The designs depicted herein are approximate and are intended to express the overall design intent of the Project and need to be adjusted in the field during construction in order to meet the specific site conditions and intended function. GeoEngineers' recommendations can be finalized only by observing actual site-specific conditions revealed during construction.

We recommend that you allow sufficient monitoring and consultation by GeoEngineers during construction to confirm that the conditions encountered are consistent with those indicated in the report, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated and to evaluate whether construction activities are completed in accordance with our recommendations. GeoEngineers cannot assume responsibility for the recommendations in this report if we do not perform construction observation.

REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

To help reduce the risk of problems, we recommend giving contractors the complete report, including these "Report Limitations and Guidelines for Use." When providing the report, you preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

HAZARDS OF INSTREAM HABITAT STRUCTURES

Instream habitat structures ("Structures") create potential hazards, including, but not limited to:

- Persons falling from the Structures and associated injury or death;
- Collisions of recreational users' and their watercraft with the Structures, and associated risk of injury, and damage of the watercraft;
- Mobilization of a portion or all of the Structures during high water flow conditions and related damage to downstream persons and property;
- Flooding;
- Erosion; and
- Channel avulsion.

In some cases, instream habitat structures are only intended to be temporary, providing temporary stabilization while stream/river processes stabilize. This gradual deterioration with age and vulnerability to major flood events make the risks with temporary Structures inherently greater with their increasing age.

GeoEngineers strongly recommends that the Client appropriately address safety concerns, including but not limited to warning construction workers of hazards associated with working in or near deep and fast-moving water and on steep, slippery and unstable slopes. In addition, signs should be placed along the enhanced stream reaches in prominent locations to warn third parties, such as nearby residents and recreational users, of the potential hazards noted above.

INCREASED FLOOD ELEVATIONS AND WETLAND EXPANSION ARE POSSIBLE

The proposed stream enhancements may result in increased flood elevations and expansion of wetlands. These impacts are generally considered advantageous for aquatic and riparian habitat in the project locations of these stream systems, but the analysis, consideration and quantification of these impacts is beyond the scope of this report, unless expressly included within GeoEngineers' scope of services.

CHANNEL EROSION AND MIGRATION ARE POSSIBLE

In general, river and stream enhancements result in more stable streambeds, banks and floodplains. In some cases, stream enhancement and channel stability include reestablishing the natural balance of sediment erosion, distribution and deposition, which in some cases may induce channel meandering and migration. Therefore, channel erosion, channel migration and/or avulsions can occur over time.

IMPORTANCE OF MONITORING AND MAINTENANCE

In some instances, GeoEngineers may have purposely excluded piles, anchors, chains, cables, reinforcing bars, bolts and similar fasteners from structures with the intent of mimicking naturally-occurring instream structures. In other instances, GeoEngineers may have purposely included such fasteners, if considered

appropriate. While GeoEngineers designs Structures to be relatively stable during flood events, some movement of these Structures is expected. We recommend that the Client implement appropriate monitoring and maintenance procedures to minimize potential adverse impacts at or near areas of concern, such as at downstream road, bridge and/or culvert crossings, including replacing, adjusting and removing damaged, malfunctioning or deteriorated components of Structures, particularly after a major storm event.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our recommendations are not intended to direct the contractor's procedures, means, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

GeoEngineers