Fish Passage Construction

Update to Fish Passage and Stream Restoration Training
2021 Fish Passage Construction Season

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Fish Passage Design Manager
HQ Hydraulics

February 9, 2022

River Restoration Northwest

This will be record

Purpose

*To **inform** Fish Passage practitioners on the **challenges** associated with fish passage construction and implementing the **designs and specification** to **meet the project intent** and provide a water crossing that is **sustainable to fish passage** for the life of the crossing.*

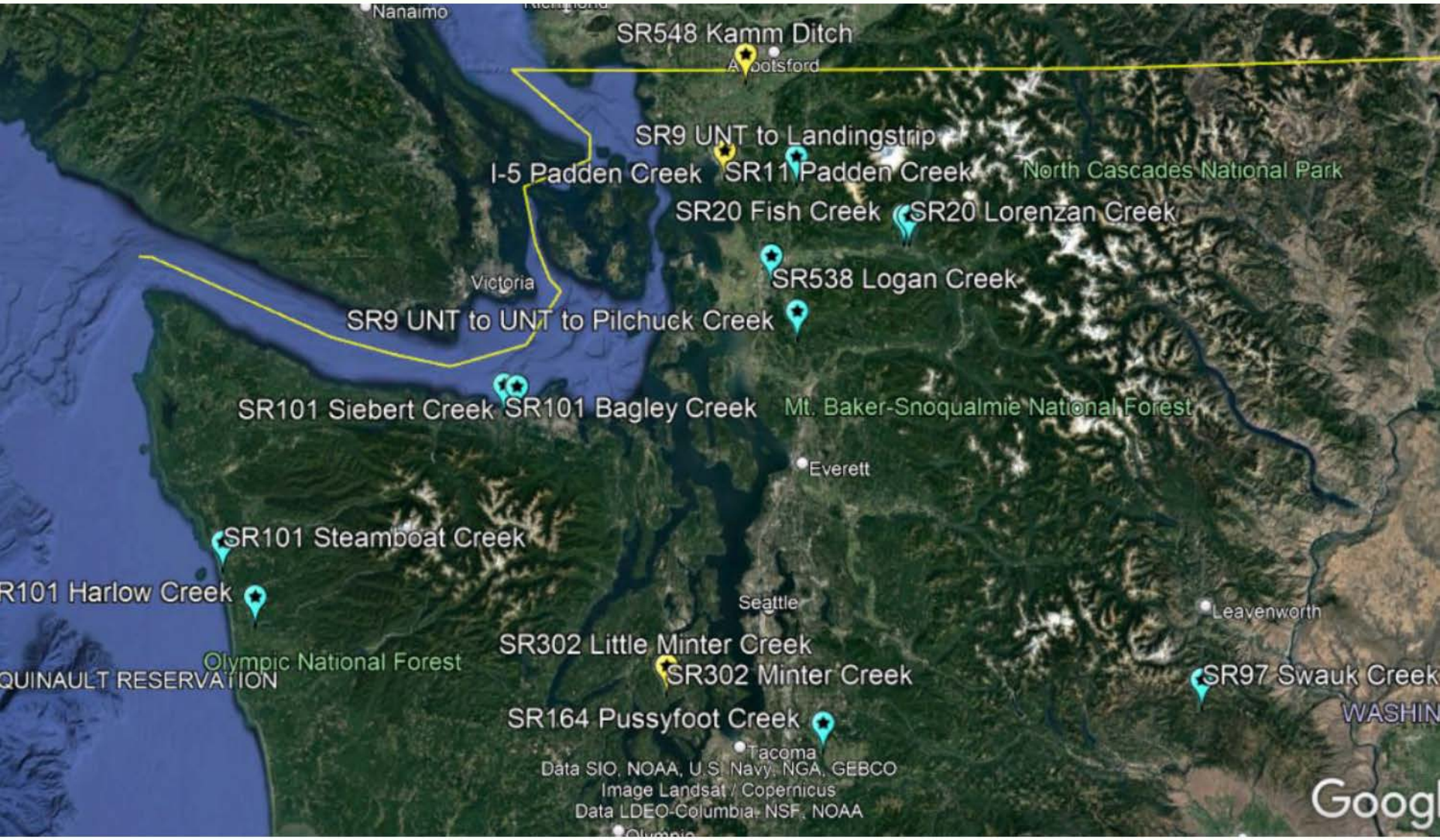
Water is the driving force of all nature.

Leonardo da Vinci

Learning Objectives

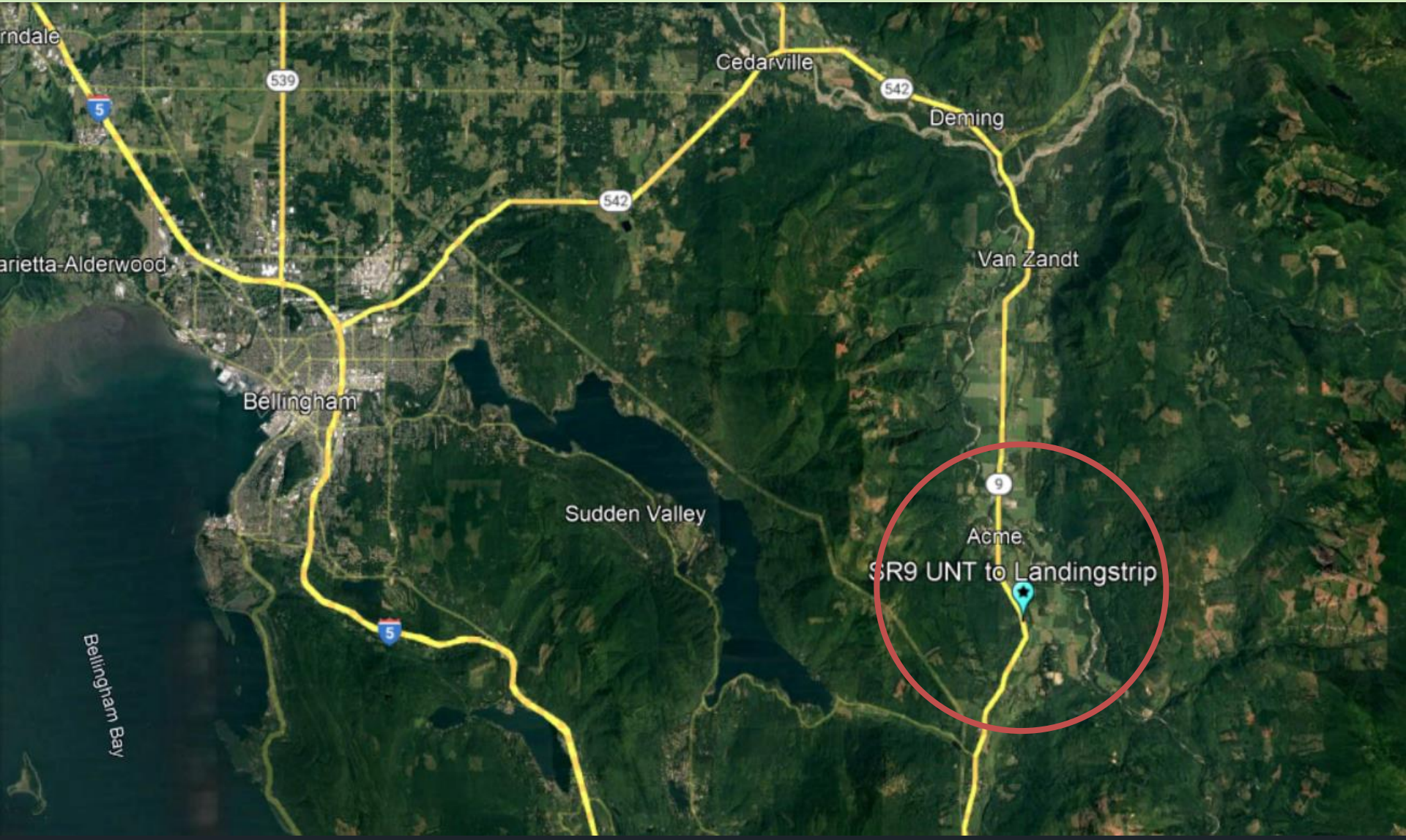
- Understanding high risk items and how to avoid them
- Seeking opportunities for improvements
- Interpreting and understand the designs & specifications pertaining to;
  - Streambed alignment/geometry
  - Streambed materials,
  - Channel complexities,
  - Large woody material,
  - Design plans & details

Project Examples

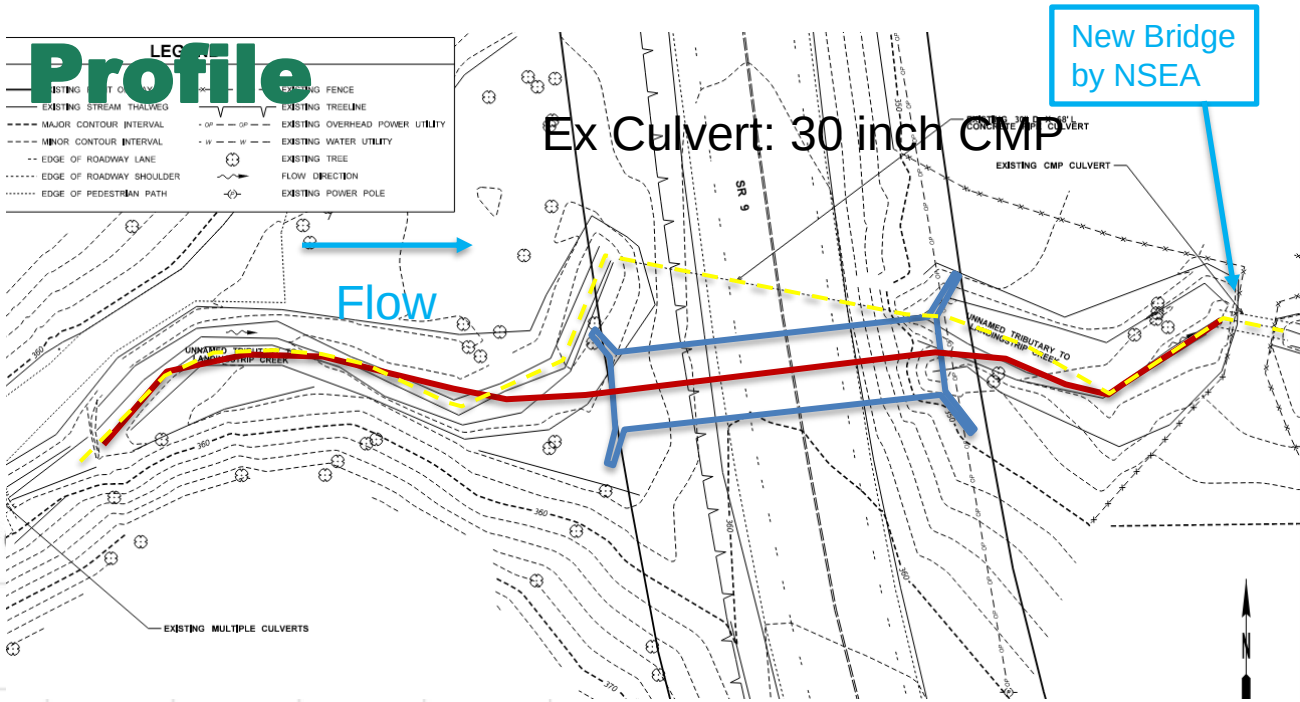


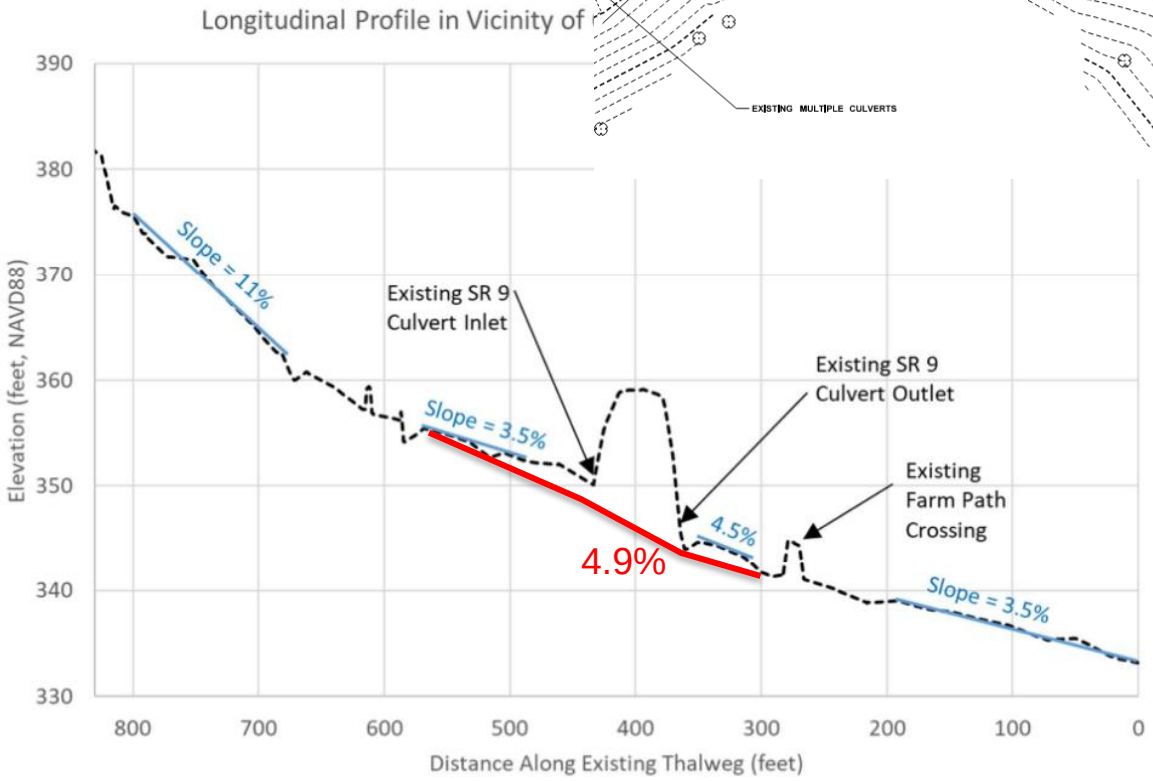
SR 9 MP 70.60
UNT to Landingstrip Creek #991106

WSDOT



Alignment & Profile





Reference Reach

Streambed Material

- Reuse of existing streambed material?

Streambed Sediment and/or Streambed Cobbles may be available from the existing streambed excavation limits as shown in the Plans. Components of the excavated streambed which meet the criteria for the specific material may be used to supplement the Streambed Sediment and/or Streambed Cobbles and will be based upon visual acceptance by the Engineer.

Streambed Material matching the design streambed gradation may be available from unprocessed pit run sources. Pit run sources to be reviewed for use, shall require a submittal of a sieve analysis completed within the same calendar year of placement. If the material is confirmed as a potential source, the material will be sampled and tested by the Engineer for final acceptance. Submittal of these materials for use shall be submitted before the first working day.

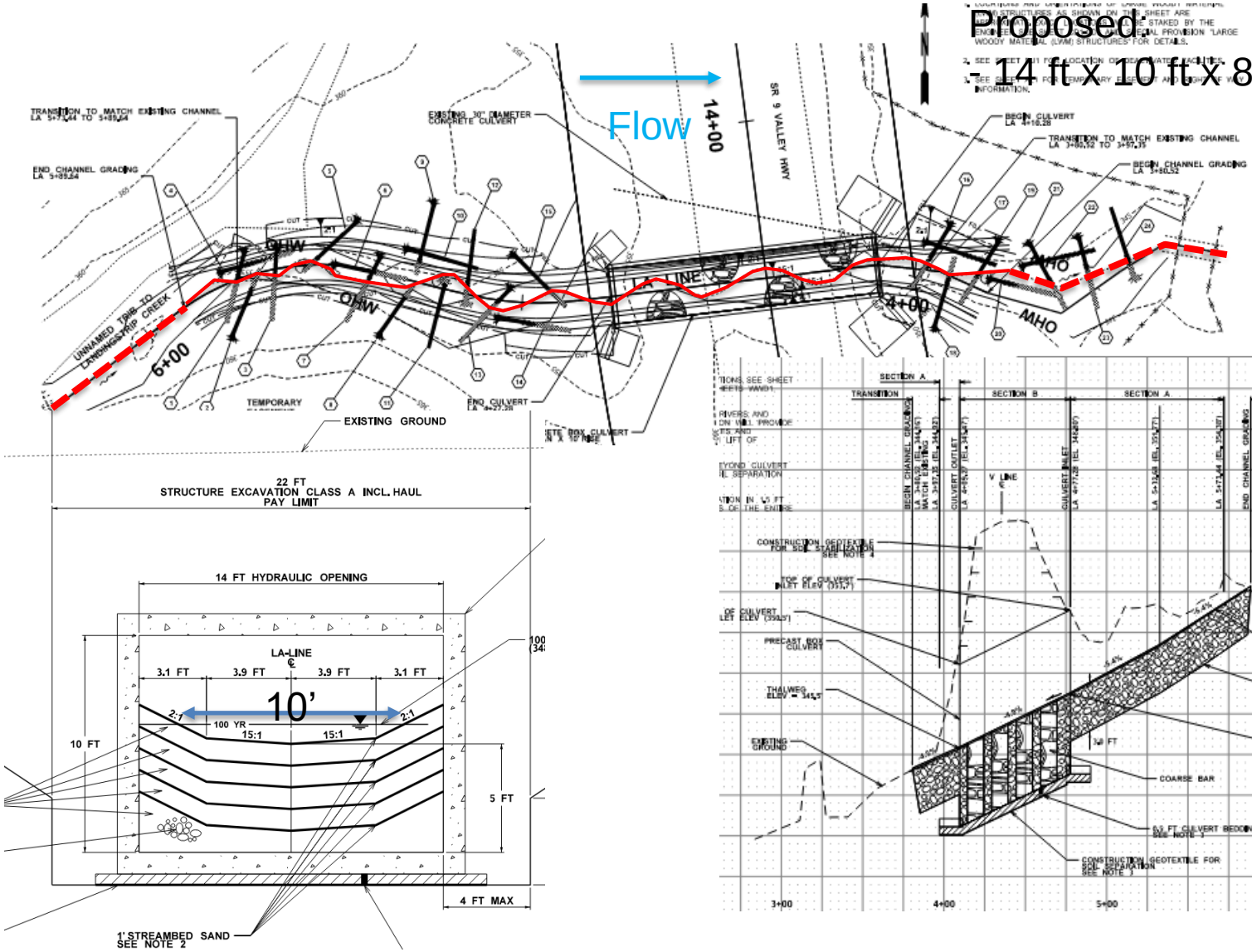
Imported Sediment

Native Alluvium

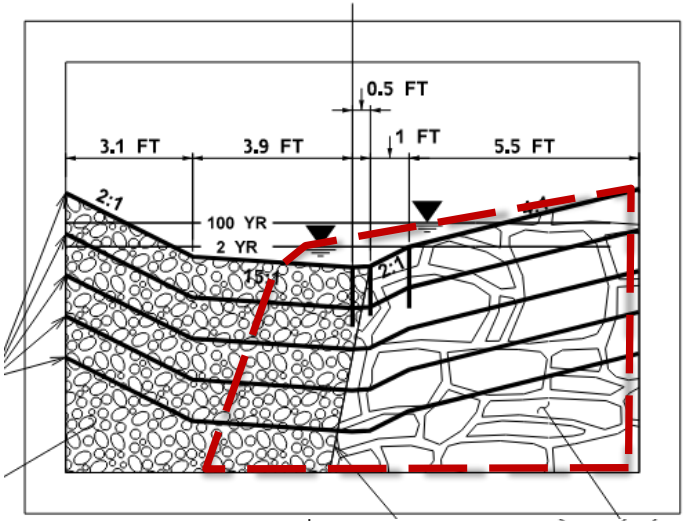
Samples:				
Work within the wetted perimeter may only occur during the time periods authorized in the APP ID 21036 entitled "Allowable Freshwater Work Times May 2018". Work outside of the wetted perimeter may occur year-round. APPS website: https://www.govonlinesaas.com/WA/WDFW/Public/Client/WA_WDFW/Shared/Pages/Main/Login.aspx				
Were any sample(s) collected from below the OHWM?	*No ☐ If no, then stop here.*			
	Yes ☐ If yes, then fill out the proceeding section for each sample.			
Sample #:	Work Start:	Work End:	Latitude:	Longitude:
Summary/description of location:				
Summarize/describe the sample location.				
Description of work below the OHWL:				
Describe the work below the OHWL, including equipment used and quantity of sediment sampled.				
Description of problems encountered:				
Describe any problems encountered, such as provision violations, notification, corrective action, and impacts to fish life and water quality from problems that arose.				

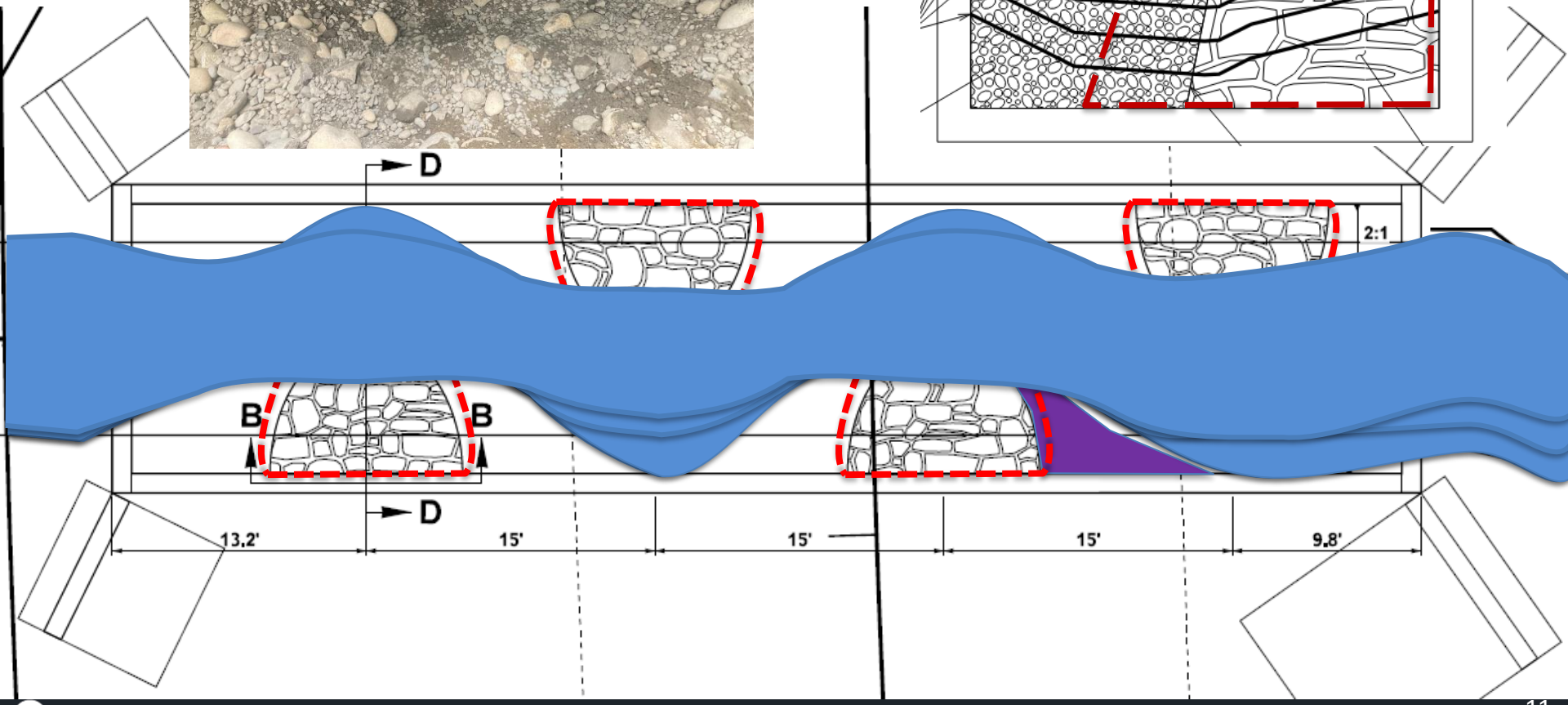
Proposed Alignment/Profile/Section

Proposed:
- 14 ft x 10 ft x 80 ft



Streambed Geometry & Meander Bar





Minimum Hydraulic Opening

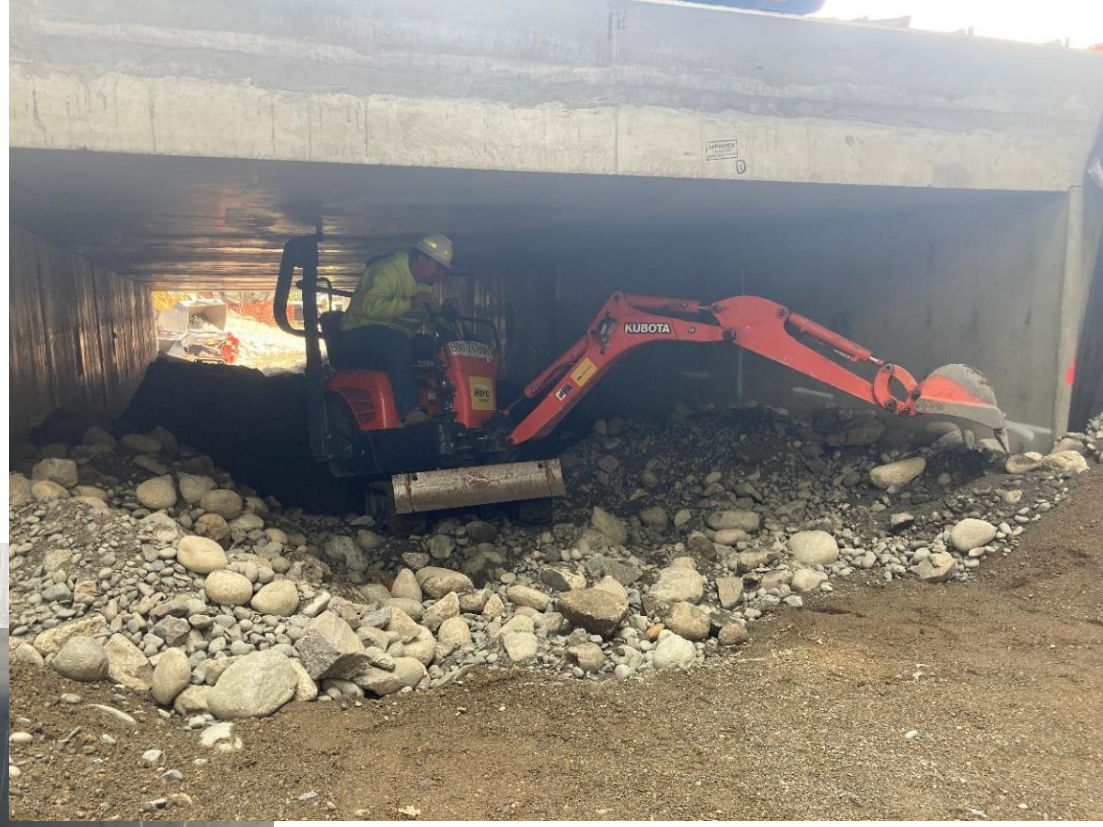
What drives MHO?

1. **BFW – (stream simulation/confined bridge)**
2. **Velocity Ratio 1.1 – (unconfined bridge)**
3. Floodplain Connectivity
4. Lateral Migration
5. Flood Prone Width
6. Valley Width
7. Aggradation/Degradation
8. Hydraulic Backwater
9. 100yr WSE
10. Stream Sinuosity
11. Meander Amplitude
12. Channel Complexities (Boulders/LWM)
13. Model Comparison of Widths Smaller/Larger (sensitivity analysis)

Structure Size

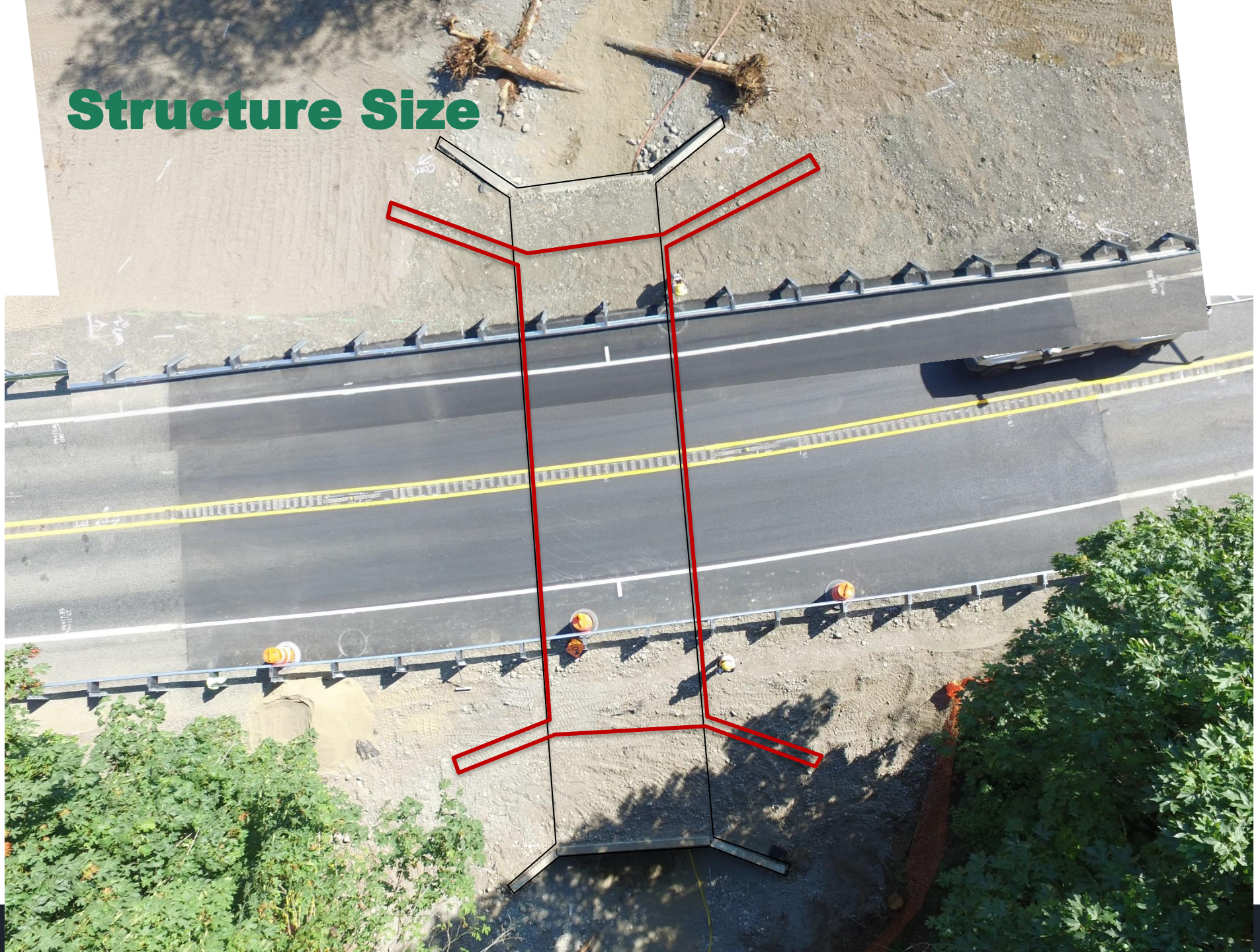
Structure Size

Dingos



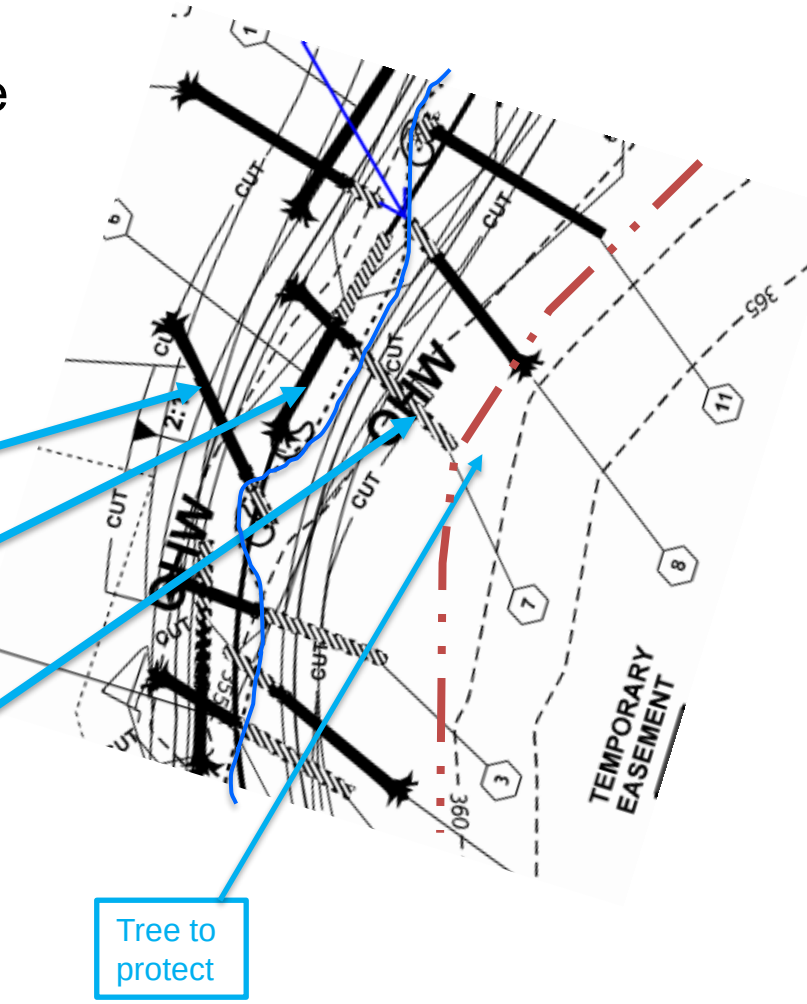
“Micro” Excavator

Structure Size



LWM Installation

- LWM not drawn to scale
- LWM typical details didn't work all the time
- Consider clearing & grubbing limits



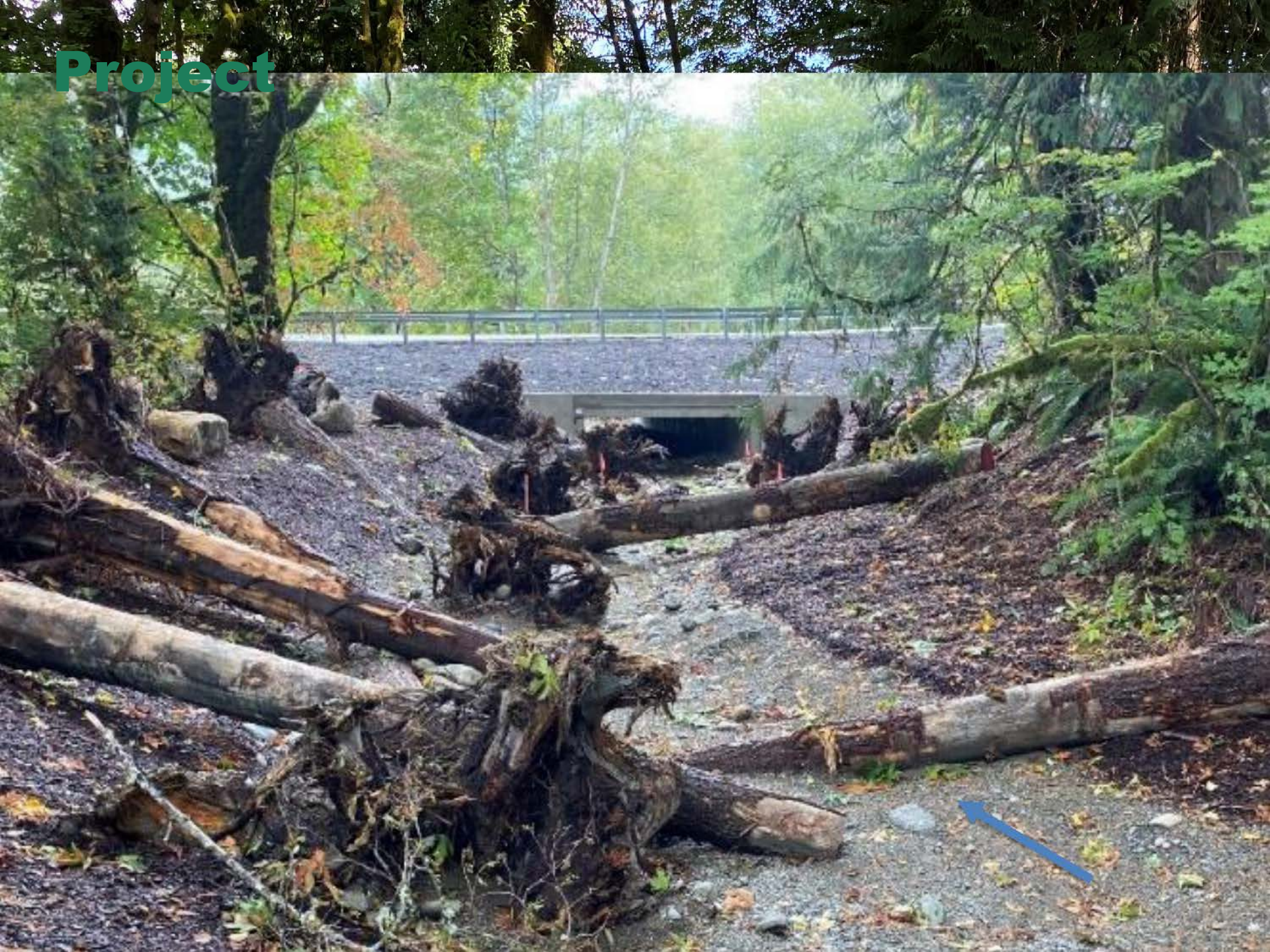
LWM Installation

- *Very large rootwads for channel.*

LWM Installation


Project

Project

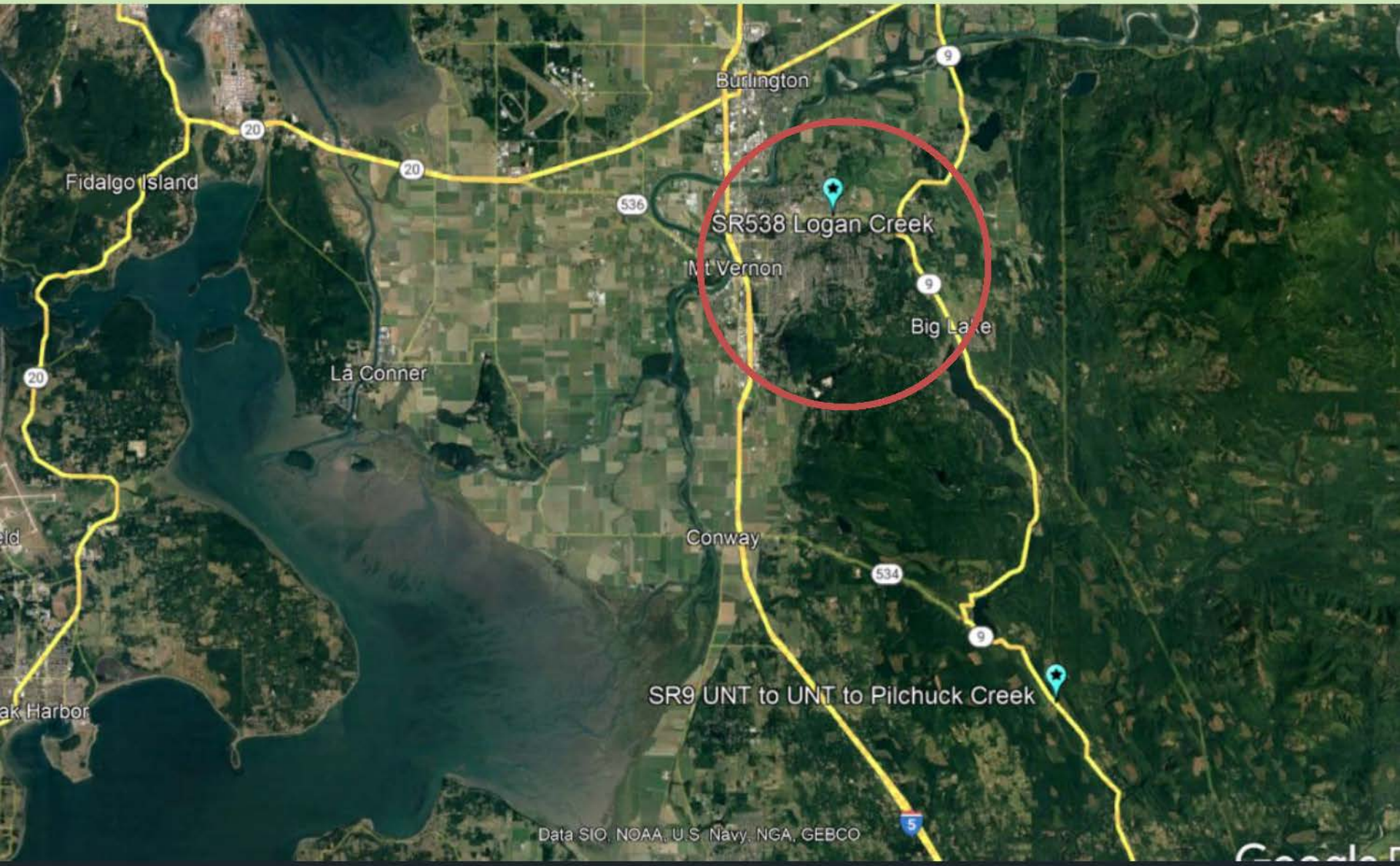


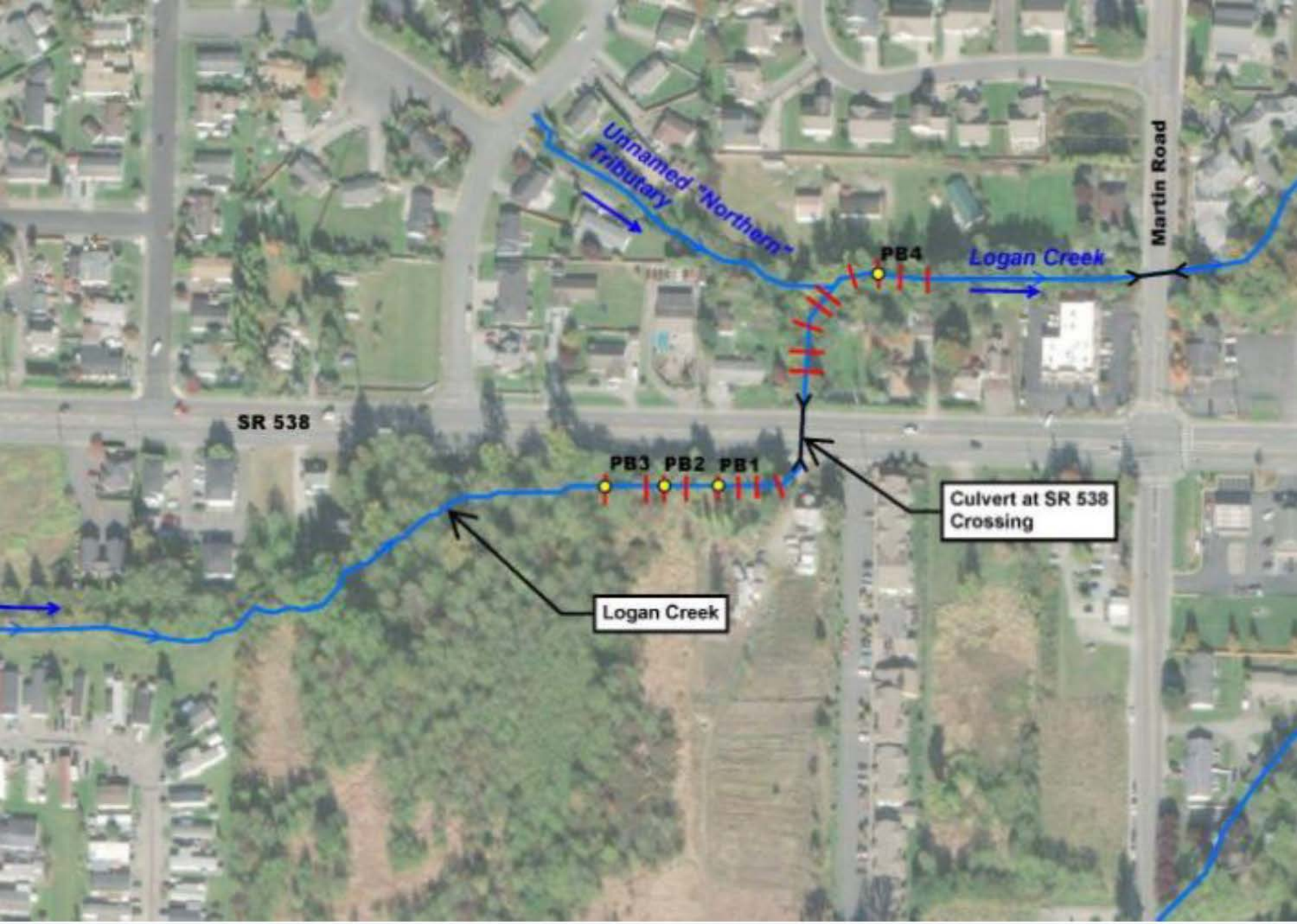

12/06/2021 11:45

Lessons Learned

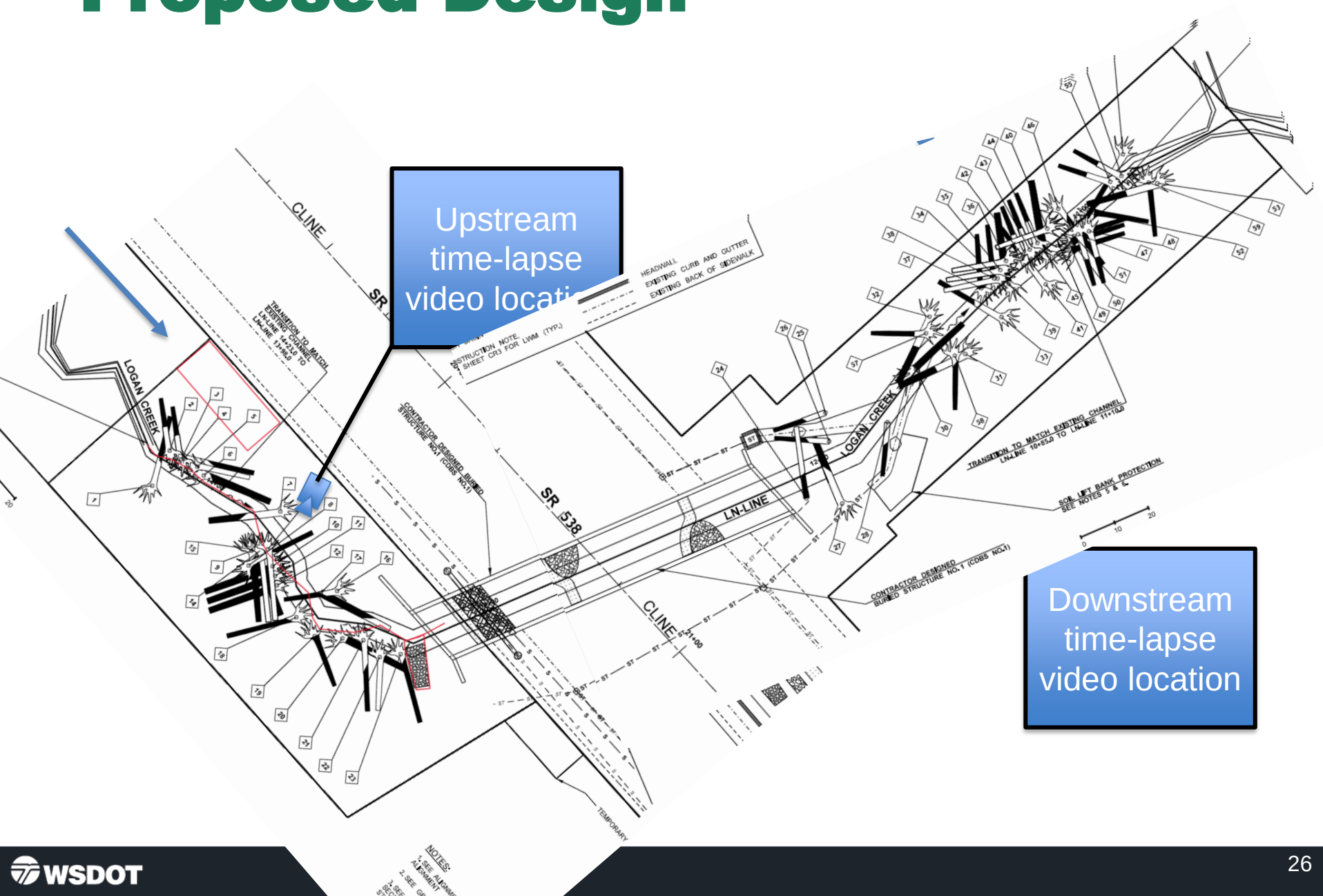
Challenges	Success	Opportunities
Downstream project tie-in	Contractor – wanted to be successful	Show LWM to scale
Limited water resources for watering in	Early start in fish window	Additional Freeboard clearance
Consider proposed condition with clearing/grubbing areas	Layering & Watering in Blended materials	Shorter crossing structure
High flows before bank stabilization	Good LWM design & details	Extension of Meander Bars
	Added Meander Bar in the field	Coarser Meander Bars
		Better coordination with downstream project

SR 538 MP 2.18
Logan Creek #NC129




Unnamed "Northern" Tributary
PB4
Logan Creek
Martin Road
SR 538
PB3
PB2
PB1
Culvert at SR 538 Crossing
Logan Creek

Proposed Design



Proposed Design

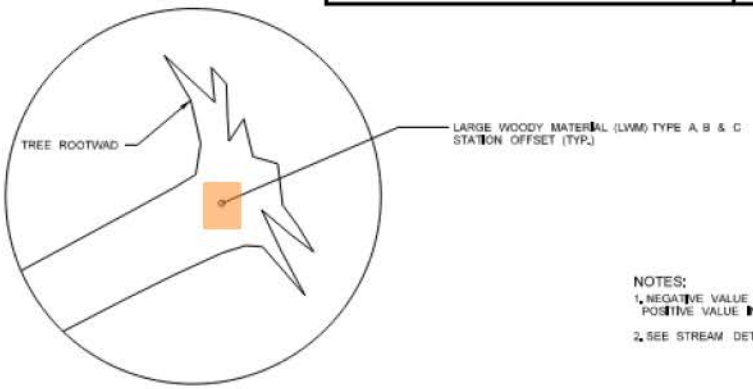
LARGE WOODY MATERIAL (LWM) LOCATION TABLE

SHEET NO.	LWM NO.	TYPE	MIN. LENGTH (FT)	DIAM. (INCHES)	ROOTWAD (Y/N)	STATION/OFFSET	ANGLE A (DEG.)	ANGLE B (DEG.)	DISTANCE C (FT) (SEE NOTE 1)	DISTANCE D (FT)	LOGS LOCATED ABOVE
CR1	1	B	20	18-24	Y	LN 14+15 (8'RT)	120	115	4.4	6.5	2, 3
CR1	2	C	15	18-24	Y	LN 14+18 (3'RT)	-45	105	-1.0	13.5	
CR1	3	C	15	18-24	Y	LN 14+12 (3'RT)	-45	105	-1.0	13.5	
CR1	4	B	20	18-24	Y	LN 14+11 (3'LT)	-160	110	-5.0	6.5	5
CR1	5	C	15	18-24	Y	LN 14+07 (3'RT)	-160	99	1.0	7.5	
CR1	6	A	20	24-30	Y	LN 14+04 (2'RT)	-179	110	-7.4	0.5	5
CR1	7	A	20	24-30	Y	LN 13+82 (6'RT)	-135	120	-5.7	6.5	
CR1	8	B	20	18-24	Y	LN 13+16 (10'LT)	80	125	-5.2	6.5	13
CR1	9	A	20	24-30	Y	LN 13+79 (7'LT)					
CR1	10	A	20	24-30	Y	LN 13+72 (5'LT)					
CR1	11	A	20	24-30	Y	LN 13+66 (5'LT)					
CR1	12	A	20	24-30	Y	LN 13+63 (5'LT)					
CR1	13	B	20	18-24	Y	LN 13+76 (3'LT)					
CR1	14	C	15	18-24	Y	LN 13+77 (5'LT)					
CR1	15	A	20	24-30	Y	LN 13+79 (7'LT)					
CR1	16	C	15	18-24	Y	LN 13+47 (8'RT)					
CR1	17	A	20	24-30	N	LN 13+57 (5'RT)					
CR1	18	B	20	18-24	Y	LN 13+55 (5'LT)					
CR1	19	C	15	18-24	Y	LN 13+52 (5'LT)					
CR1	20	A	20	24-30	Y	LN 13+44 (5'LT)					
CR1	21	B	20	18-24	Y	LN 13+38 (4'LT)					
CR1	22	C	15	18-24	Y	LN 13+31 (7'LT)					
CR1	23	B	20	18-24	Y	LN 13+25 (4'LT)					

LARGE WOODY MATERIAL (LWM) LOCATION TABLE

SHEET NO.	LWM NO.	TYPE	MIN. LENGTH	DIAM.	ROOTWAD (Y/N)	STATION/ OFFSET	ANGLE A (DEG.)	ANGLE B (DEG.)	DISTANCE C (FT) (SEE NOTE 1)	DISTANCE D (FT)	LOGS LOCATED ABOVE
CR2	24	B	20	18-24	N	LN 12+07 (6'LT)	-120	108	-3.4	9.0	
CR2	25	C	15	18-24	N	LN 11+86 (13'RT)	165	115	-3.9	0.0	
CR2	26	C	15	18-24	N	LN 11+95 (6'RT)	-165	115	-3.9	0.0	
CR2	27	A	20	24-30	Y	LN 11+99 (12'LT)	90	115	-3.8	6.5	
CR2	28	C	15	18-24	N	LN 11+80 (6'LT)	-165	115	-3.9	0.0	
CR2	30	A	20	24-30	Y	LN 11+62 (1'RT)	-180	110	-7.4	0.5	
CR2	31	A	20	24-30	Y	LN 11+50 (5'LT)	160	115	-5.8	0.0	30, 56
CR2	32	A	20	24-30	Y	LN 11+49 (8'RT)	-160	115	-5.8	0.0	30, 57
						+36 (6'LT)	110	115	-4.4	6.5	34, 35, 36
						+29 (2'RT)	-45	100	1.5	12.5	
						+27 (3'RT)	-45	100	1.5	12.5	
						+24 (4'RT)	-45	100	1.5	12.5	
						+34 (3'RT)	-130	100	-2.5	14.5	34, 35, 36
						+30 (3'RT)	-130	100	-2.5	14.5	34, 35, 36
						+28 (1'LT)	-130	100	-2.5	19.5	34, 35, 39, 40
						+10 (4'RT)	-25	95	2.5	9.5	
						+20 (8'LT)	90	115	-5.4	9.5	36, 40
						+20 92'RT)	-110	100	0.5	18.5	40
						+17 (3'RT)	-110	100	0.5	18.5	40
						+15 (3'RT)	-110	100	0.5	18.5	40
						+15 (1'LT)	-130	100	-2.5	19.5	40
						+04 (6'RT)	-90	115	-5.4	9.5	47, 48, 49, 50, 51
						+05 (3'LT)	65	105	-0.4	15.0	
						+02 (4'LT)	65	105	-0.4	15.0	
						+09 (5'LT)	160	110	-3.4	7.5	47, 48
						+07 (3'LT)	160	110	-3.4	7.5	47, 48, 52
						+06 (2'LT)	160	110	-3.4	7.5	47, 48, 52
						+98 (1'LT)	135	105	-1.4	14.5	
						+78 (6'LT)	160	115	-5.8	0.0	
						+81 (6'RT)	-155	110	-4.4	0.5	55, 56
CR2	55	C	15	18-24	Y	LN 10+89 (2'RT)	-65	105	-0.4	15.0	
CR2	56	C	15	18-24	Y	LN 10+85 (2'RT)	-65	105	-0.4	15.0	
CR2	57	C	15	18-24	Y	LN 11+53 (5'RT)	-45	115	-2.4	13.5	
CR2	58	C	15	18-24	Y	LN 11+52 (5'LT)	45	115	-2.4	13.5	
CR2	59	C	15	18-24	Y	LN 10+80 (5'LT)	45	115	-2.4	13.5	

LARGE WOODY DEBRIS (LWD) TOTALS	
TYPE A	16
TYPE B	12
TYPE C	31
3-MAN BOULDER	2



TREE LOCATION DETAIL

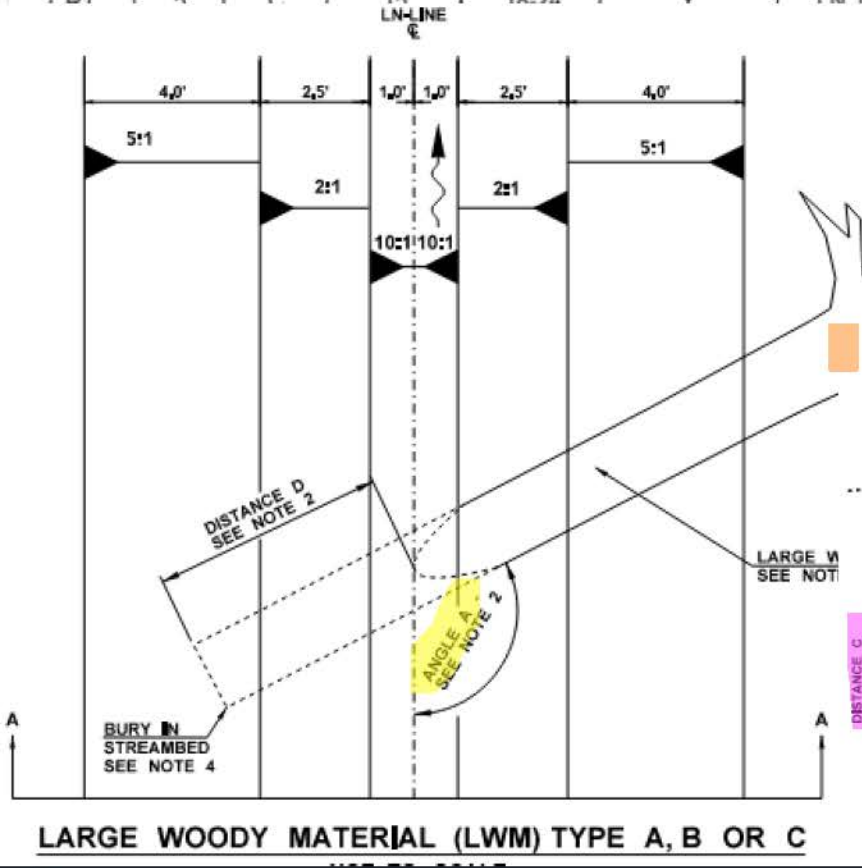
NOTES:
1. NEGATIVE VALUE INDICATES DEPTH BENEATH THALWEG
   POSITIVE VALUE INDICATES DEPTH ABOVE THALWEG
2. SEE STREAM DETAILS SHEETS FOR LWM DETAILS

LARGE WOODY DEBRIS (LWD) TOTALS	
TYPE A	16
TYPE B	12
TYPE C	31
3-MAN BOULDER	2

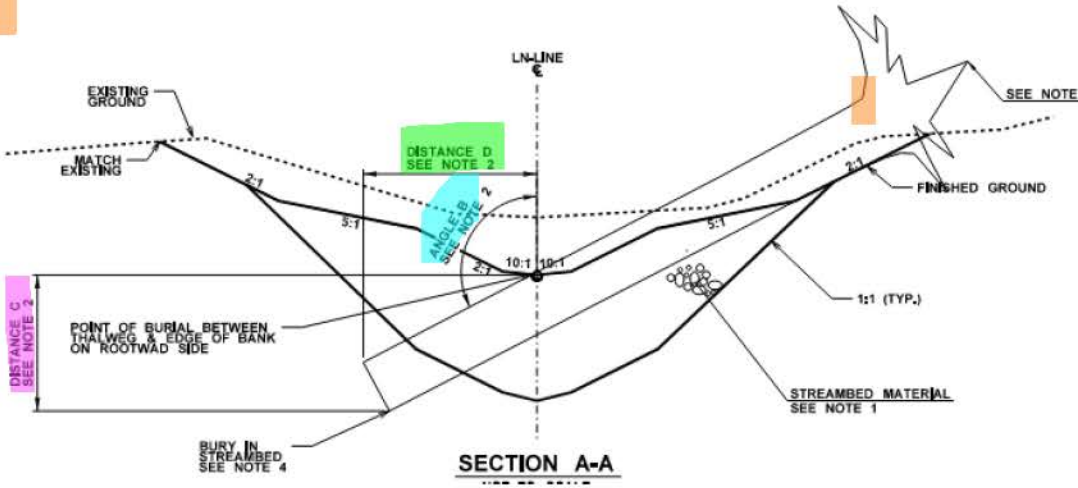
Proposed Design

LARGE WOODY MATERIAL (LWM) LOCATION TABLE

SHEET NO.	LWM NO.	TYPE	MIN. LENGTH (Ft)	DIAM. (INCHES)	ROOTWAD (Y/N)	STATION/OFFSET	ANGLE A (DEG.)	ANGLE B (DEG.)	DISTANCE C (FT) (SEE NOTE 1)	DISTANCE D (FT)	LOGS LOCATED ABOVE
CR1	1	B	20	18-24	Y	LN 14+15 (8'RT)	120	115	-4.4	6.5	2, 3
CR1	2	C	15	18-24	Y	LN 14+18 (3'RT)	-45	105	-1.0	13.5	
CR1	3	C	15	18-24	Y	LN 14+12 (3'RT)	-45	105	-1.0	13.5	
CR1	4	B	20	18-24	Y	LN 14+11 (3'LT)	-160	110	-5.0	8.5	5
CR1	5	C	15	18-24	Y	LN 14+07 (3'RT)	-160	99	2.0	7.5	



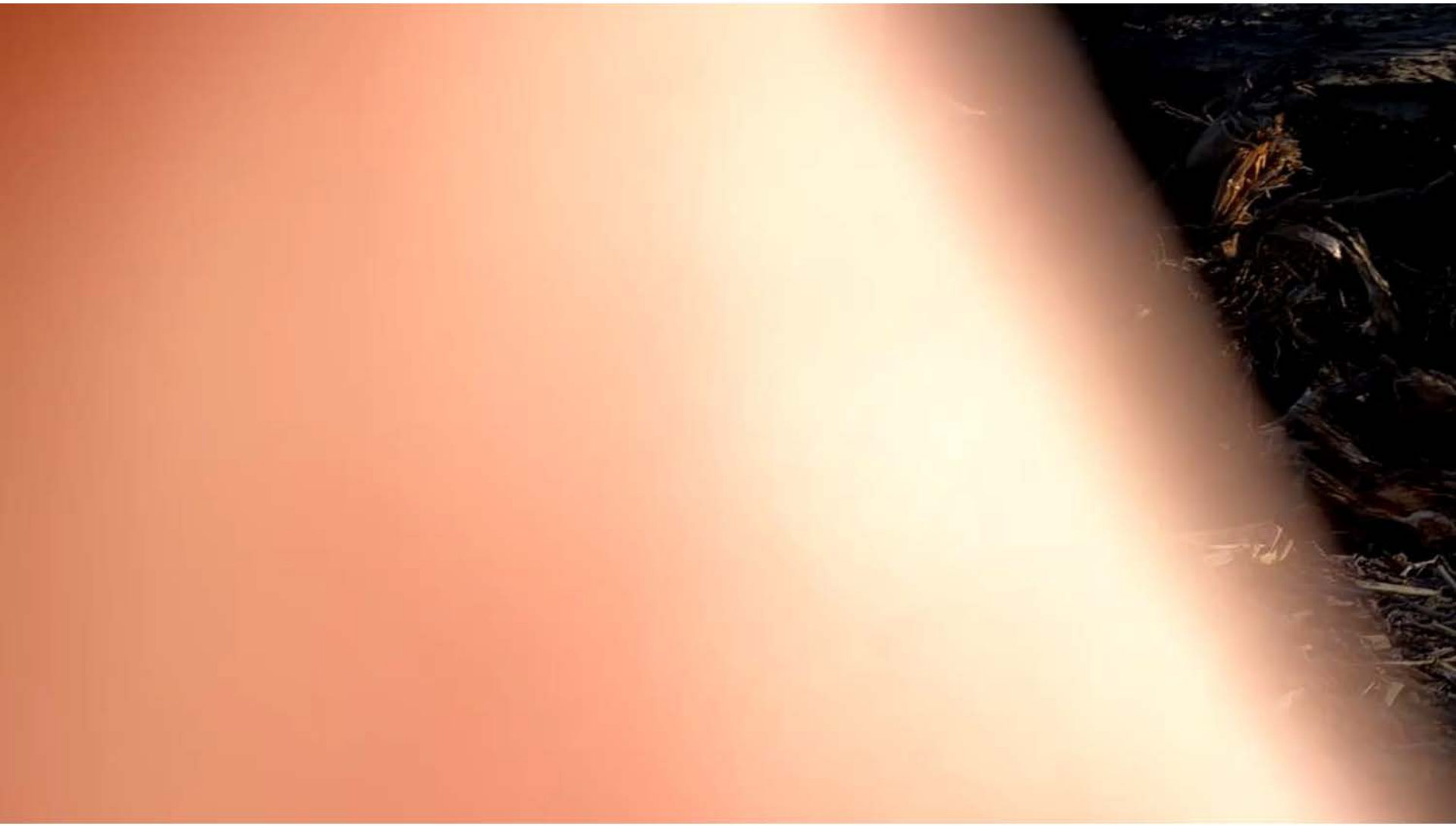
LARGE WOODY MATERIAL (LWM) TYPE A, B OR C



SECTION A-A

LWM Installation

LWM Installation



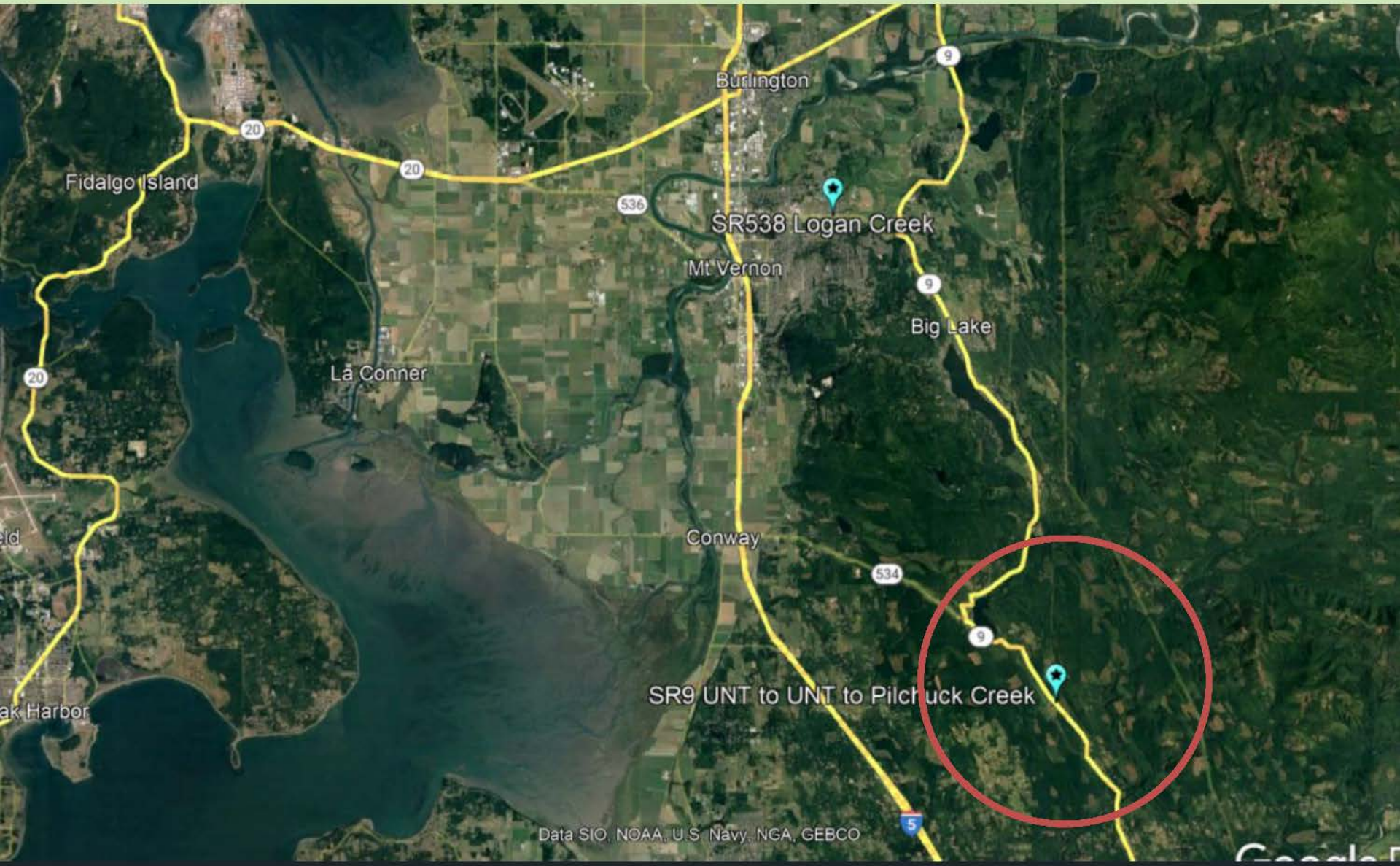
LWM Installation

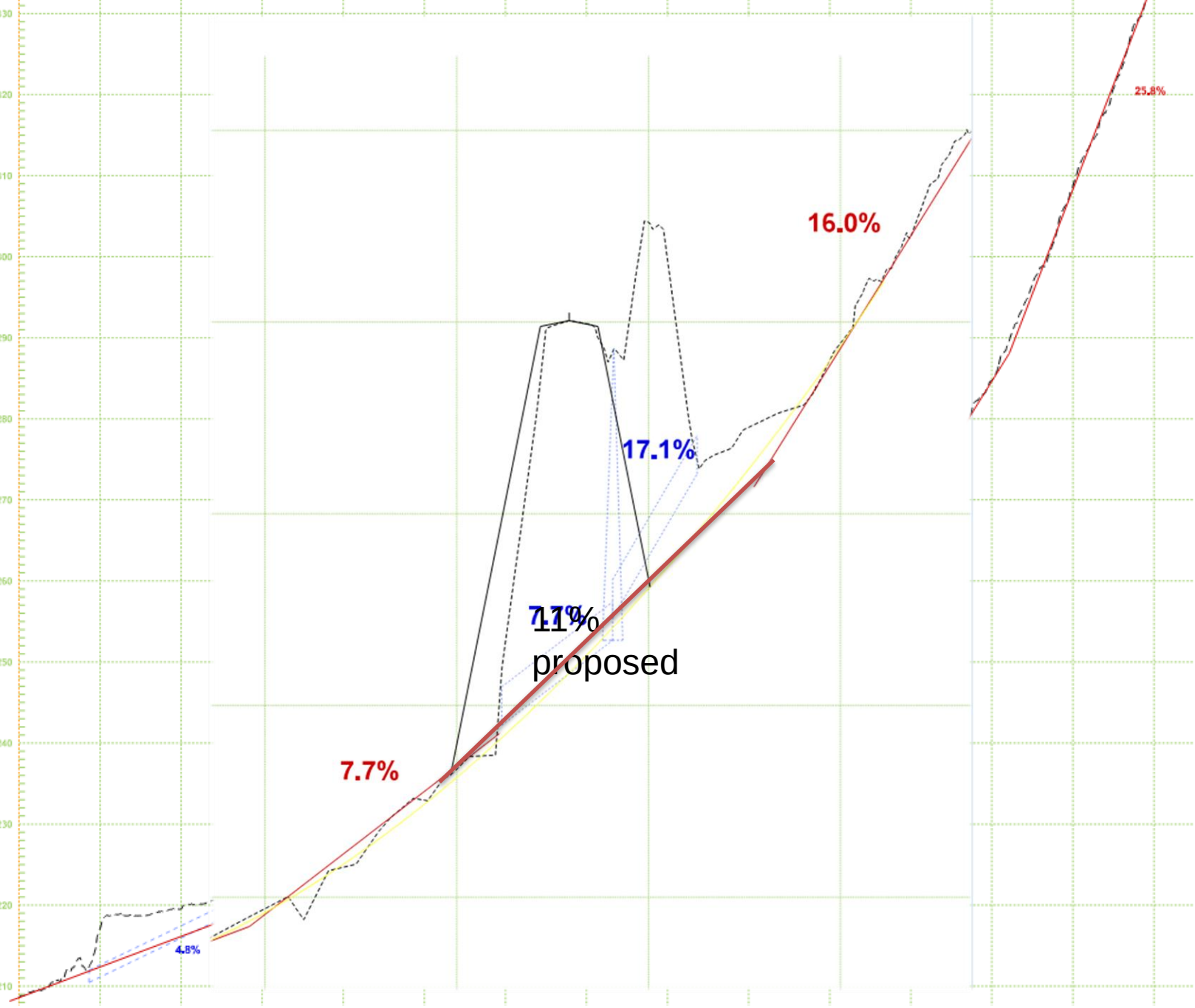
Blended Streambed Material

Streambed Material shall be a mix of the following aggregates with th
as called out in the plans:

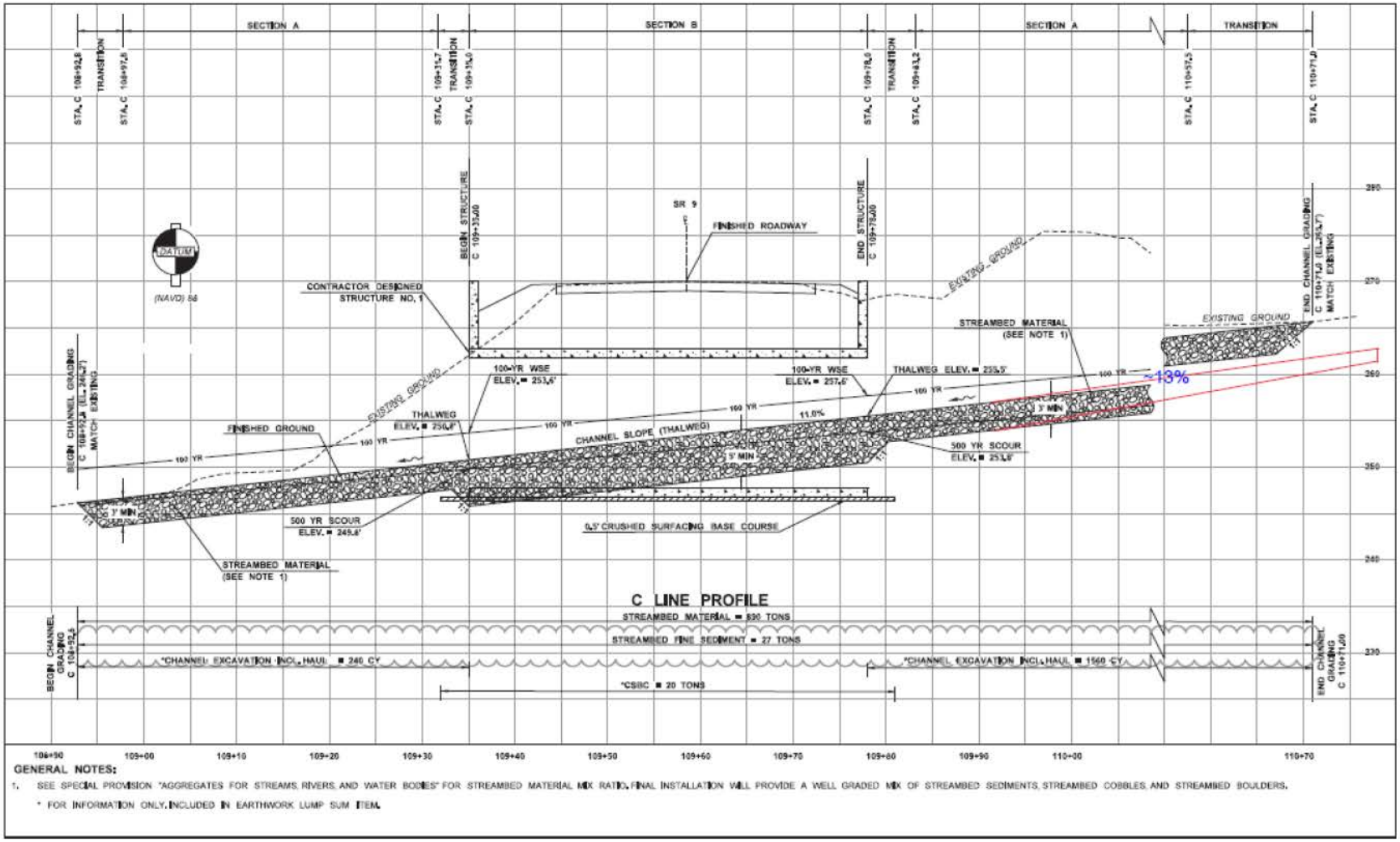
Streambed Material	
Streambed Sediment:	60%, by volume
Streambed Cobbles 4 In.:	40%, by volume

SR 9 MP 37.3
UNT to Pilchuck Creek (WDFW #LP19)




330
320
310
300
290
280
270
260
250
240
230
220
210
25.8%
16.0%
17.1%
11%
proposed
7.7%
4.8%

Proposed Design

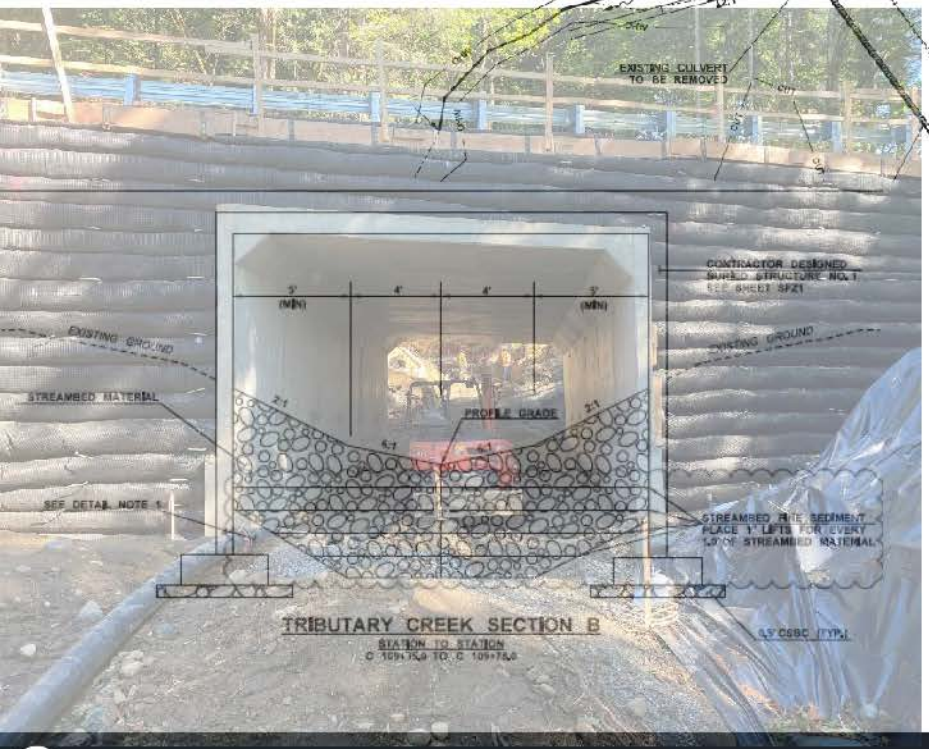


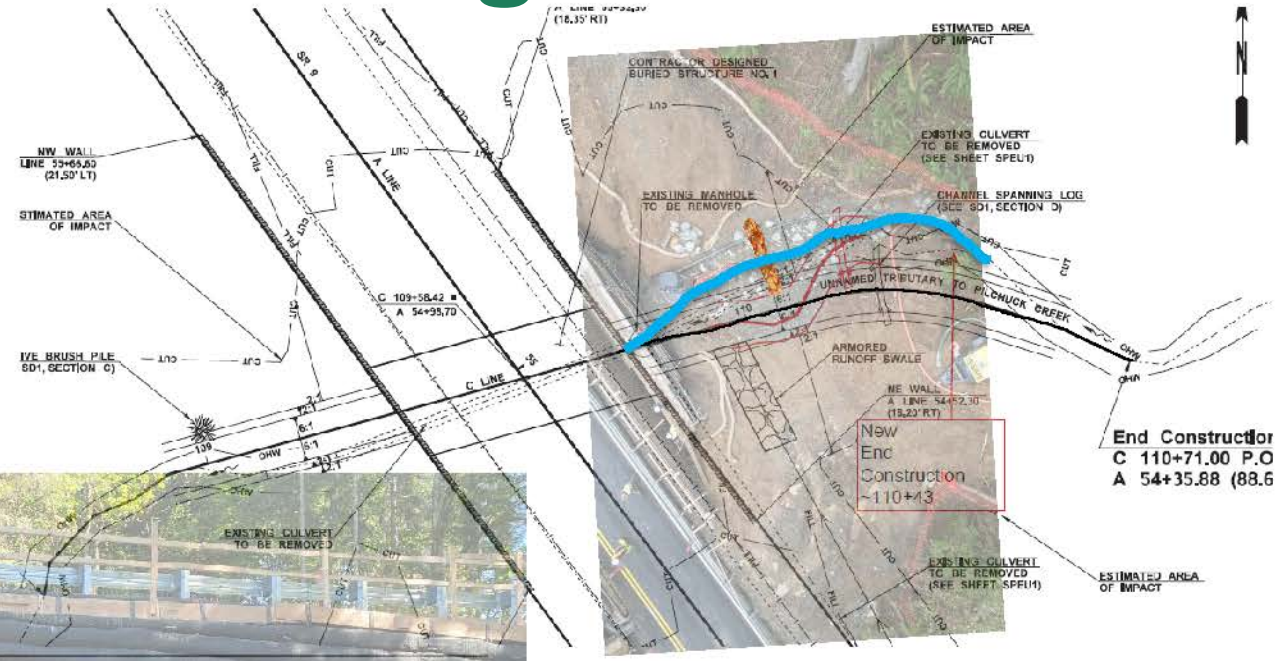
GENERAL NOTES:

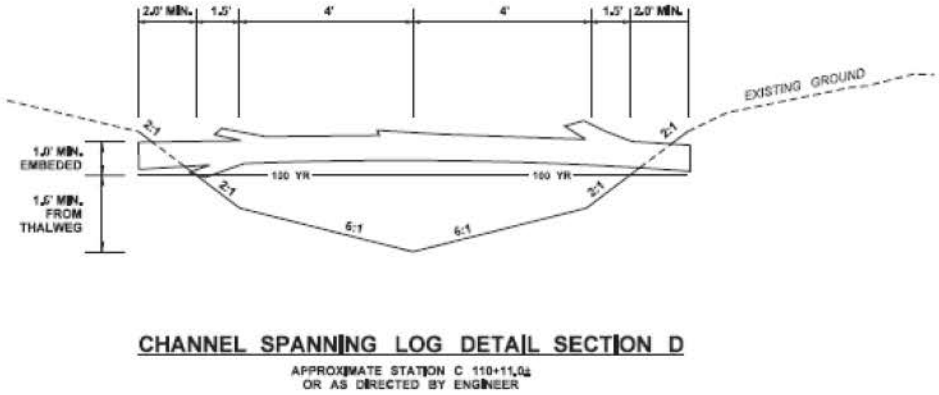
1. SEE SPECIAL PROVISION "AGGREGATES FOR STREAMS, RIVERS, AND WATER BODIES" FOR STREAMBED MATERIAL MIX RATIO. FINAL INSTALLATION WILL PROVIDE A WELL GRADED MIX OF STREAMBED SEDIMENTS, STREAMBED COBBLES, AND STREAMBED BOULDERS.

* FOR INFORMATION ONLY. INCLUDED IN EARTHWORK LUMP SUM ITEM.

Proposed Design





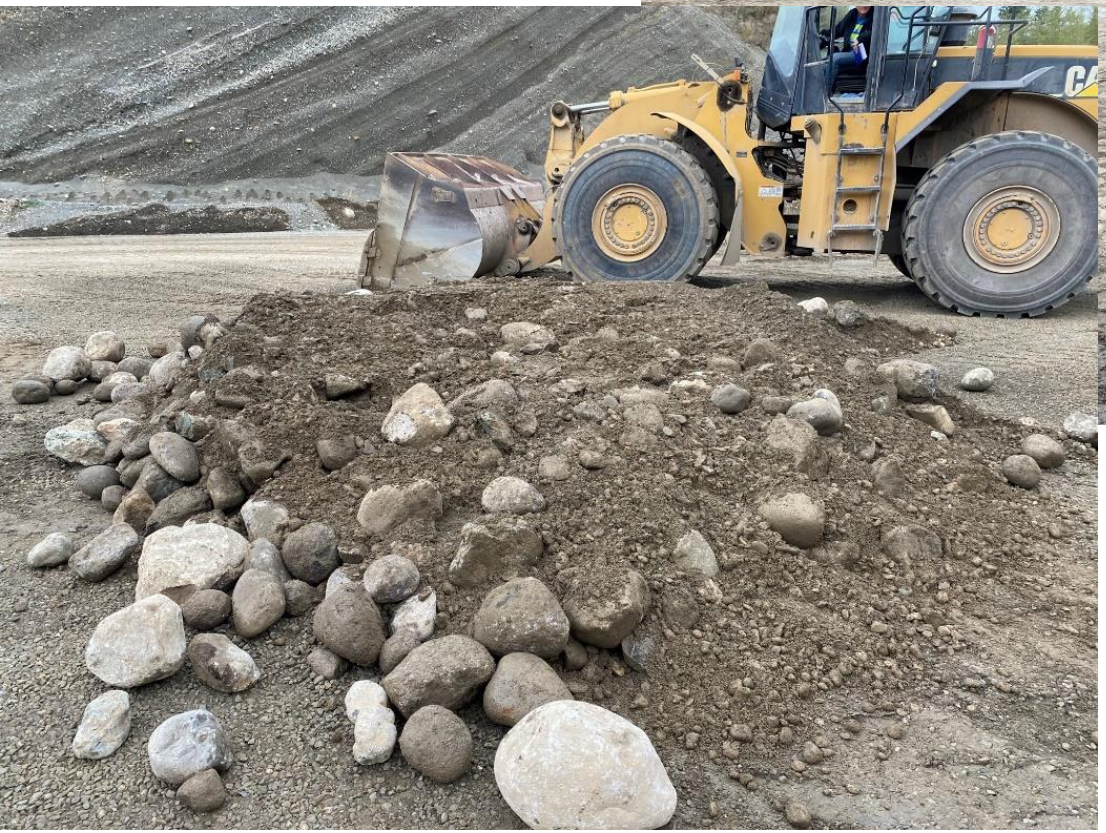


CHANNEL SPANNING LOG DETAIL SECTION D

APPROXIMATE STATION C 110+11.0±
OR AS DIRECTED BY ENGINEER

Construction

Blended Streambed Material



Streambed Material

Streambed Sediment:	30%, by volume
Streambed Cobbles 12 IN.:	24%, by volume
Streambed Boulders One Man:	23%, by volume
Streambed Boulders Two Man:	23%, by volume

Streambed Materials

9-03.11(1) Streambed Sediment

Streambed sediment shall meet the following requirements for grading when placed in hauling vehicles for delivery to the project or during manufacture and placement into temporary stockpile. Alternate gradations may be used if proposed by the Contractor and accepted by the Engineer. The Contractor shall submit a Type 2 Working Drawing

9-03.11(2) Streambed Cobbles

The grading of the cobbles shall be determined by the Engineer by visual inspection of the load before it is dumped into place, or, if so ordered by the Engineer, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load.

Native Alluvium

Imported Sediment

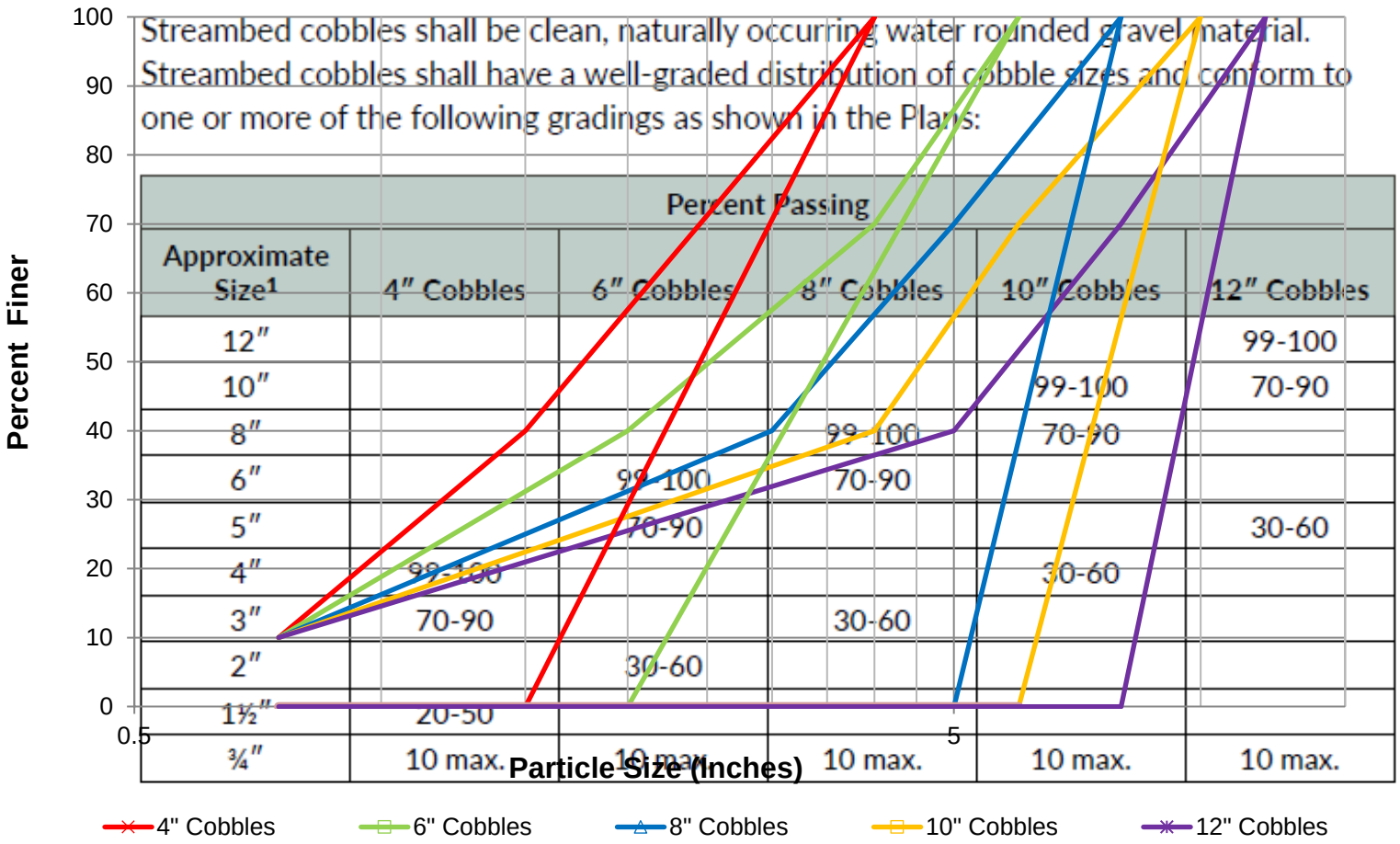
Streambed Mixes

Standard Specification 9-03.11(2)

9-03.11(2) Streambed Cobbles

Streambed cobbles shall be clean, naturally occurring water rounded gravel material. Streambed cobbles shall have a well-graded distribution of cobble sizes and conform to one or more of the following gradings as shown in the Plans:

Approximate Size[1]	Percent Passing				
	4″ Cobbles	6″ Cobbles	8″ Cobbles	10″ Cobbles	12″ Cobbles
12″					99-100
10″				99-100	70-90
8″			99-100	70-90	
6″		99-100	70-90		
5″		70-90			30-60
4″	99-100			30-60	
3″	70-90		30-60		
2″		30-60			
1½″	20-50				
¾″	10 max.	10 max.	10 max.	10 max.	10 max.



Streambed Material

Streambed Material shall be a mix of the following aggregates with the associated ratios, as called out in the plans:

Streambed Material	
Streambed Sediment:	50%, by volume
Streambed Cobbles 6 In.:	50%, by volume

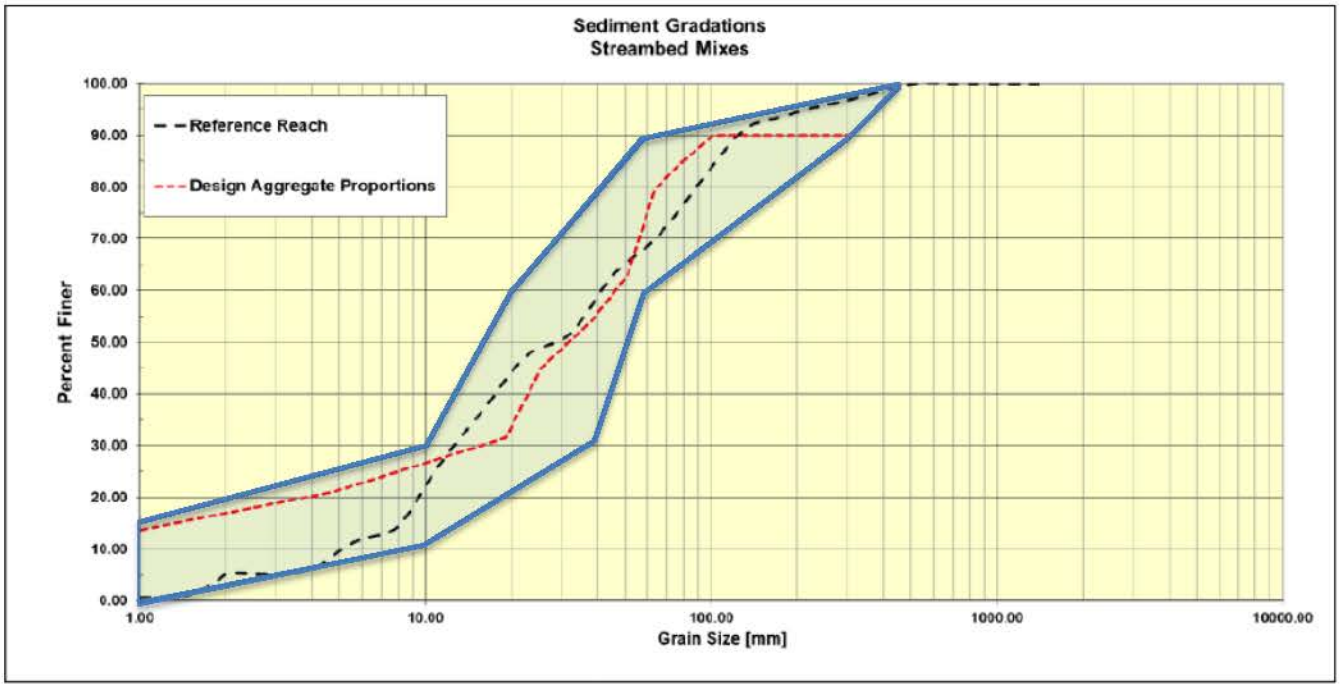
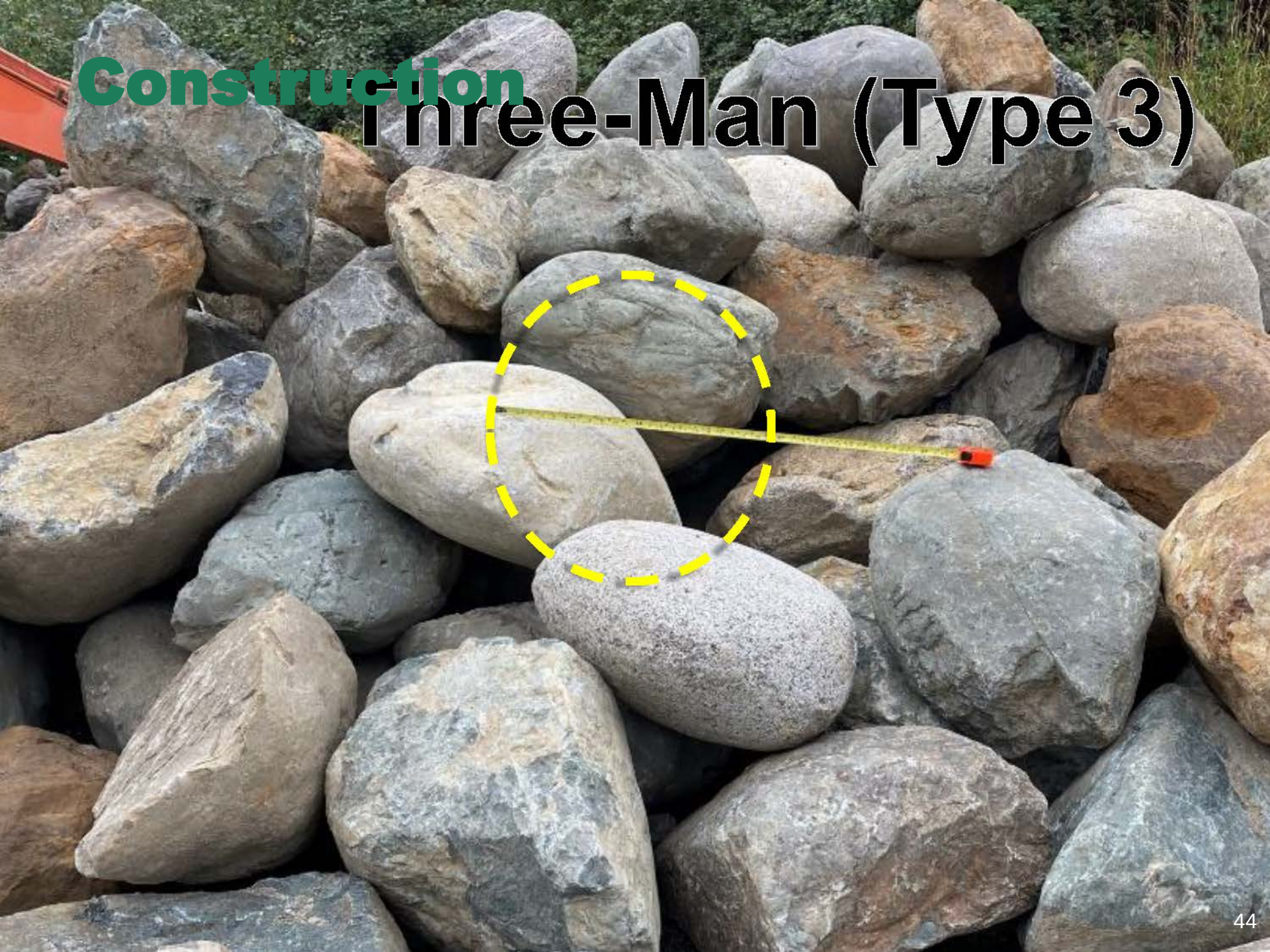


Figure 42 Proposed Sediment Gradation


Streambed
Sediment


Construction
Three-Man (Type 3)

Construction

Construction

Lessons Learned

Challenges	Success	Opportunities
Contractor – Not in it to win it	Steep Step-Pool Bed Design	More LWM and MWM
Communication – PEO to Contractor to HQ	Good team work once initiated	Increase structure height
Contractor - Unsure how to execute, lack urgency	Mixing and placement of material	Minimized impact – US grading and slope grading
Schedule uncertainty – extension of fish window	Layering & Watering in Blended materials & Boulders	
Survey - bust		
TSD Plan		

Placing Streambed Material

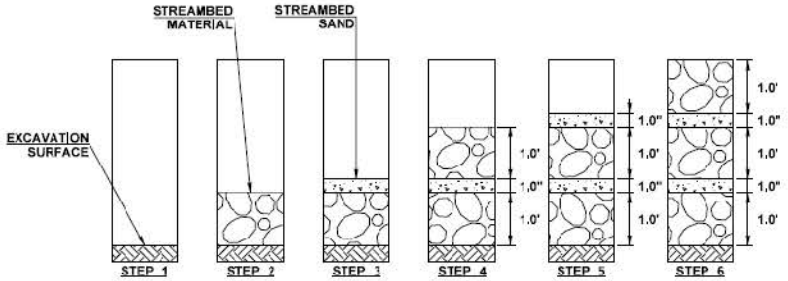
Placement of Aggregates for Streams, Rivers, and Waterbodies

Stockpiling Aggregate
Streambed Sediment and Streambed Cobbles as described above, shall be blended into single well graded stockpiles separate from other aggregates.

Placing Aggregate in Streambed
Streambed Material shall be placed in the prepared channel excavation to the lines and grades shown on the Plans and in such a way as to prevent material segregation. Streambed Material shall be placed in lifts no thicker than 12 inches. Streambed Material in its final location shall be a well graded mix.

Placement of Streambed Material shall be constructed to ensure that stream low flow rate of 30 gallons per minute, or as determined by the Engineer, is conveyed above each lift. The Contractor shall apply water and 1-inch depth of Streambed Sand to each lift to facilitate filling the interstitial voids of the Streambed Materials. The voids are satisfactorily filled when water equivalent to the low flow rate of the stream does not go subsurface and there is no perceivable difference in the low flow rate from upstream of the project limits to the downstream of project limits. The Contractor shall apply water at the low flow rate to the stream channel for visual acceptance by the Engineer. Water shall be free from contaminates, chlorination and any additive that has a risk on fish and other ecological life.

Placing Streambed Material



STREAMBED MATERIAL PLACEMENT
SEQUENCE OF WORK
NOT TO SCALE

STREAMBED CHANNEL PREPARATION

STEP 1
EXCAVATE CHANNEL TO ACCOMODATE STREAMBED MATERIAL.

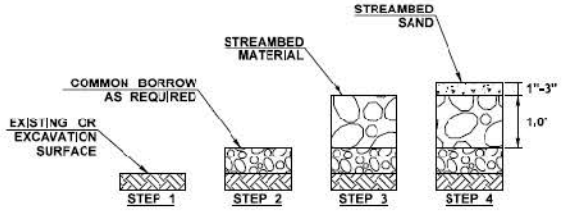
STEP 2
PLACE 1.0' LIFT OF STREAMBED MATERIAL.

STEP 3
PLACE A LAYER OF STREAMBED SAND UNIFORMLY OVER STREAMBED MATERIAL. APPLY WATER TO STREAMBED SAND. SEE DETAIL NOTE 2.

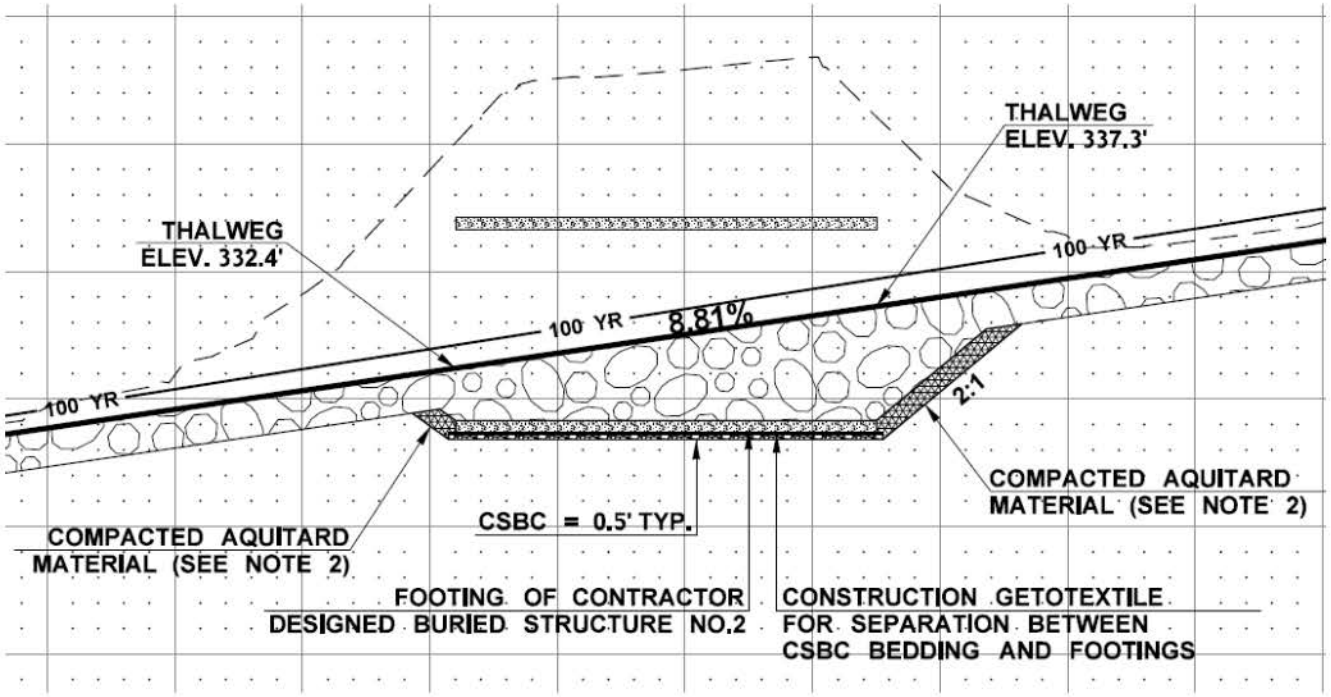
STEP 4
(REPEAT STEP 2)

STEP 5
(REPEAT STEP 3)

STEP 6
PLACE REMAINING ~1.0' LIFT OF STREAMBED MATERIAL, GRADE AS SHOWN IN STREAMBED SECTION DETAILS. SEE DETAIL NOTE 3.



STREAMBED MATERIAL PLACEMENT
ALTERNATIVE - FLOOD PLAIN EXTENSION
NOT TO SCALE



Streambed Sand

Sealing the Bed

Sealing the Bed

Sealing the Bed

Sealing the Bed

Sealing the Bed

Entrainment

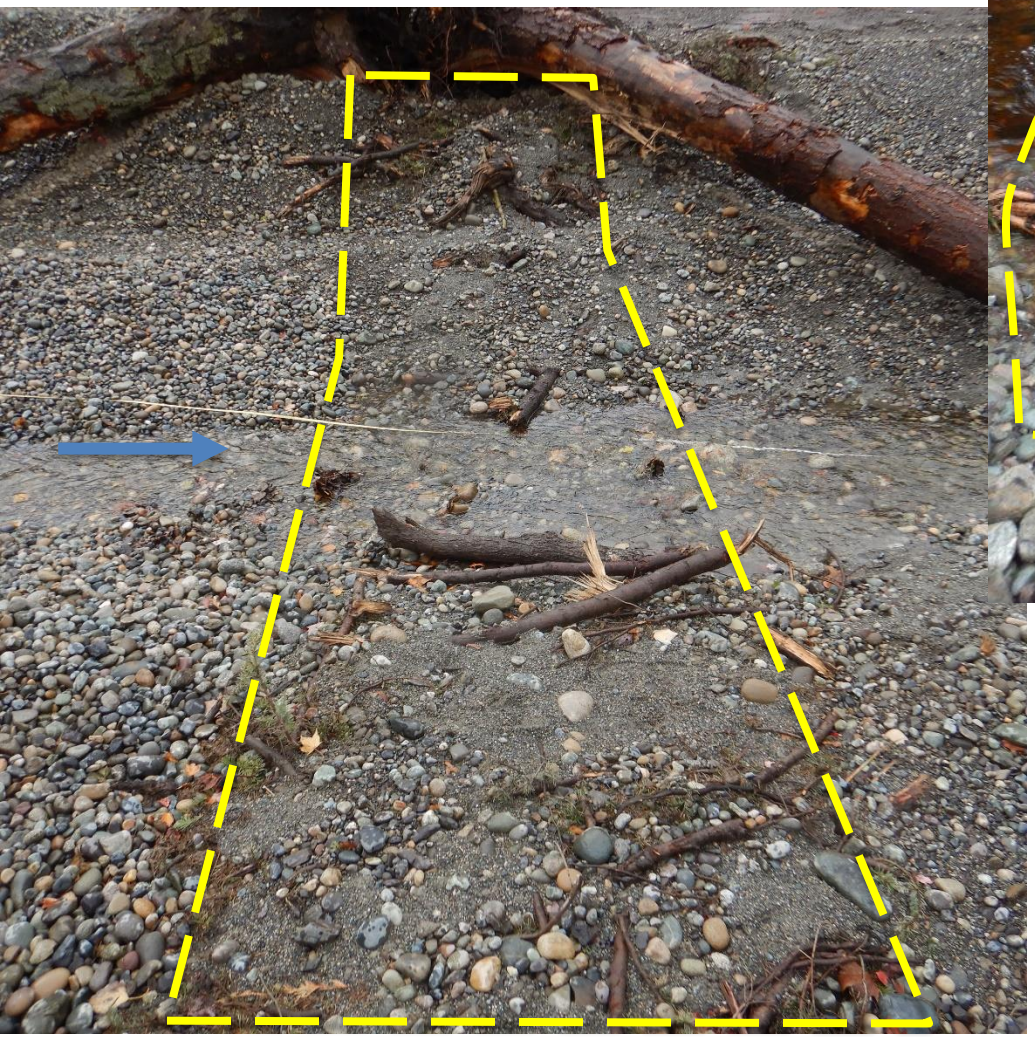
Plane bed

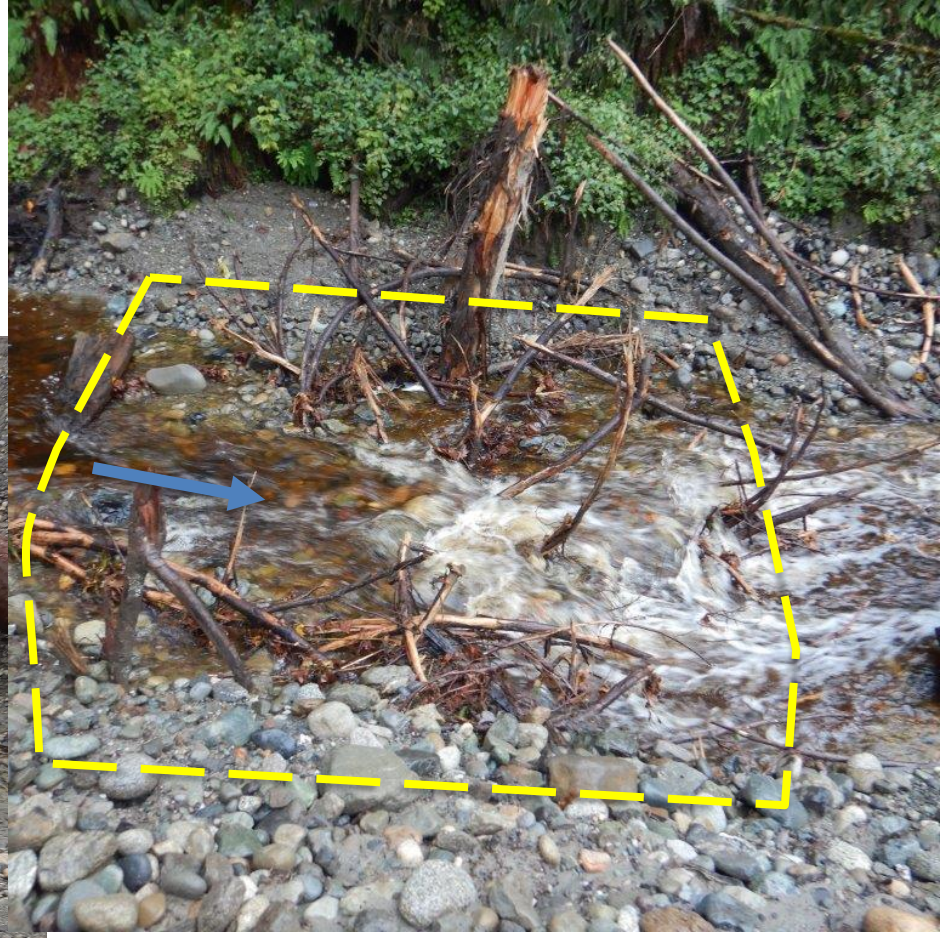
Channel Complexities

- Coarse bands
- Meander bars
- Boulder clusters
- Large Woody Material
- Deformable Grade Control

Meander Bars & Boulder Clusters

Deformable Grade Controls





Structure Scour

Local Scour

- Boulders
- Large Woody Material
- Deflection

Bank Stabilization

- Transition
  - Margins
  - Plant establishment
    - Coir mats/wraps
    - Willow plantings
    - Staking

Large Woody Material

Onsite Evaluation Meeting

An onsite evaluation meeting shall be held at least held at least 3 working days prior to the reintroduction of flows into the new channel or removal of the temporary stream diversion, whichever occurs first.

Those attending shall include:

1. Contractor: The superintendent, on site supervisor, foreman, the Environmental Compliance Lead and any other personnel that will have on-site responsibility for in-channel streambed Work.

1. WSDOT: The WSDOT Engineer, key inspection personnel, Region Environmental, Headquarters Hydraulics and Headquarters Environmental Service Office (Fish Passage Biologist & Monitoring Program Lead).

1. Representatives from interested permitting agencies (WDFW) and affected Tribes shall be invited by WSDOT.

The Contractor shall provide notice to the Engineer 14 calendar days prior to this meeting taking place.

The meeting will evaluate and discuss the streambed installation and large woody material placement to ensure the streambed will performing as intended. As a result of the onsite evaluation meeting, modifications to the streambed materials, features or large woody materials may be made by the Engineer.

SR 20 MP 88.82
Lorenzan Creek (WDFW GR23)

SR 20 MP 87.82
Fish Creek (WDFW ID #GR9)

Additional Information

- Final Hydraulic Design Report (link in Special Provisions)
- HQ site inspection
- Just-In-Time (JIT) Training – hosted annually
- WSDOT Fish Passage Training Certification
  - Hydraulics & hydrology training | WSDOT (wa.gov)
- WSDOT Certified Inspector Training – March 2022
- Me **nggabe@wsdot.wa.gov** **or** **gabe.ng@jacobs.com**

Questions & Feedback?

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Fish Passage Design Manager
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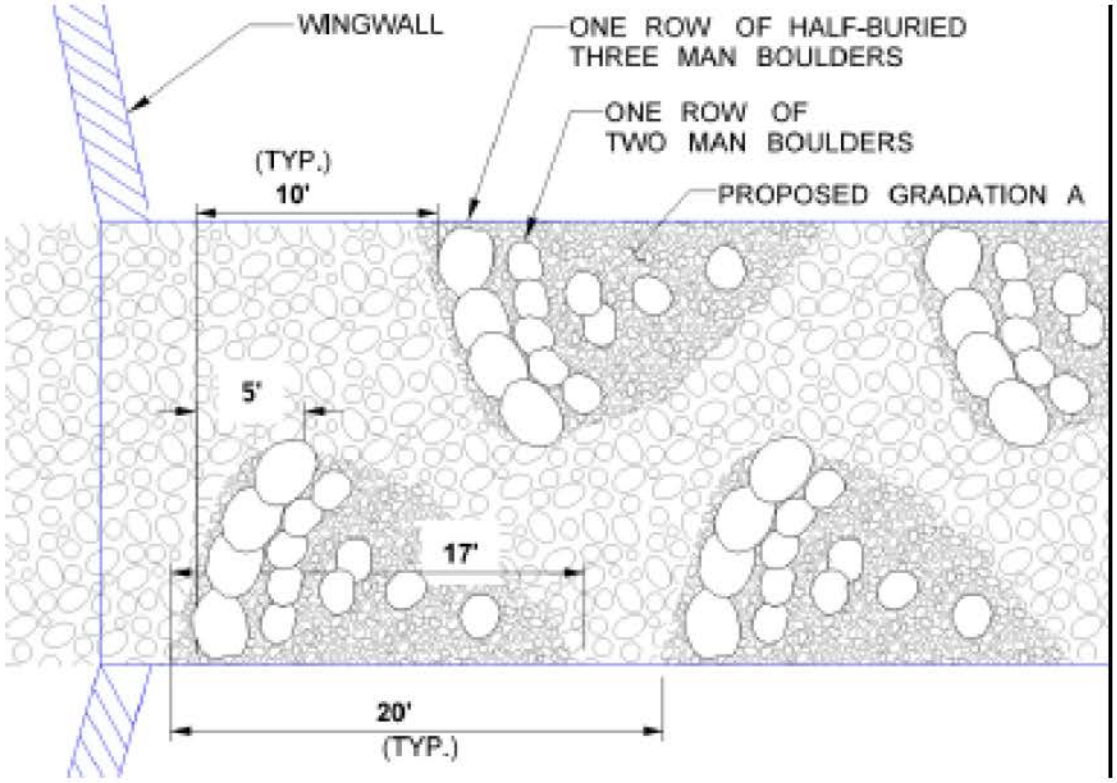
Gabe.ng@jacobs.com
206-718-5252

Meander Bar


WINGWALL
ONE ROW OF HALF-BURIED
THREE MAN BOULDERS
ONE ROW OF
TWO MAN BOULDERS
PROPOSED GRADATION A
(TYP.)
10'
5'
17'
20'
(TYP.)