



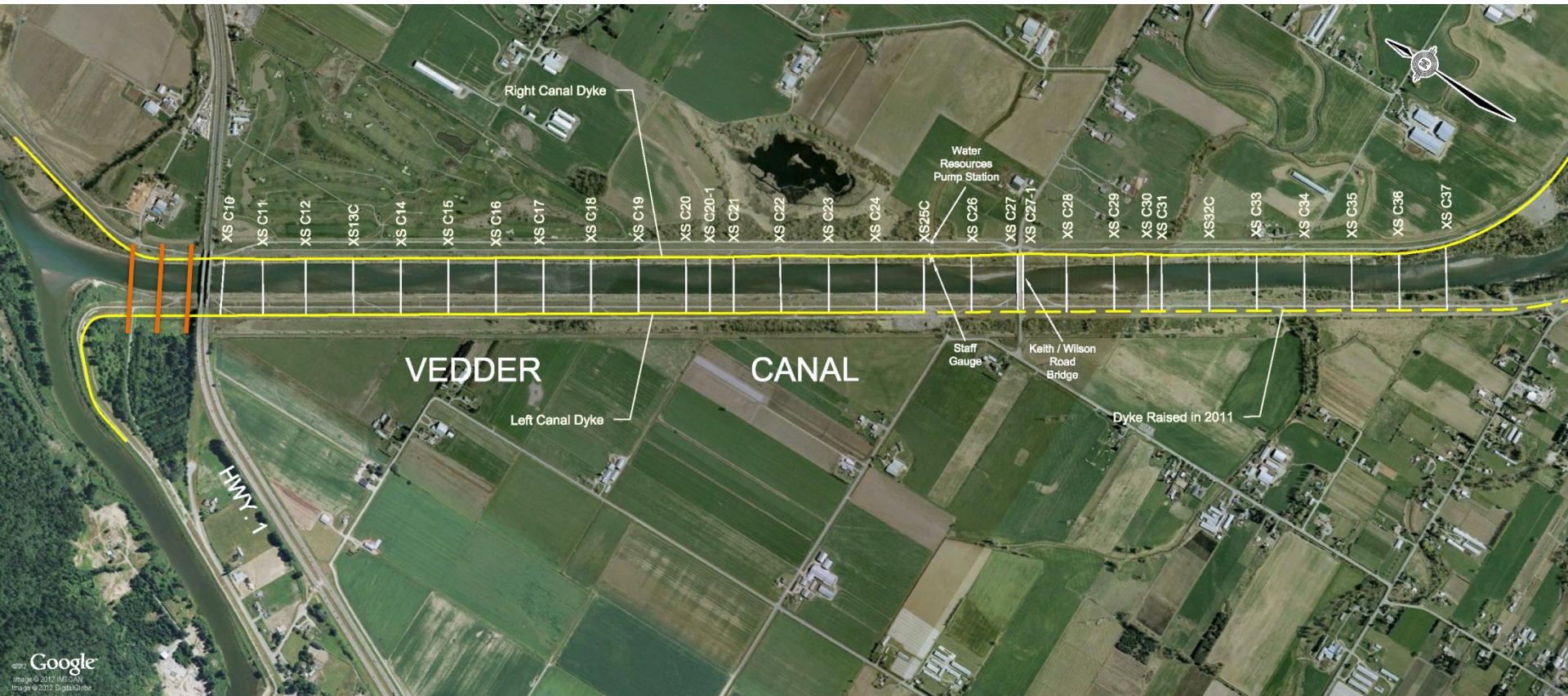
KERR WOOD LEIDAL
consulting engineers



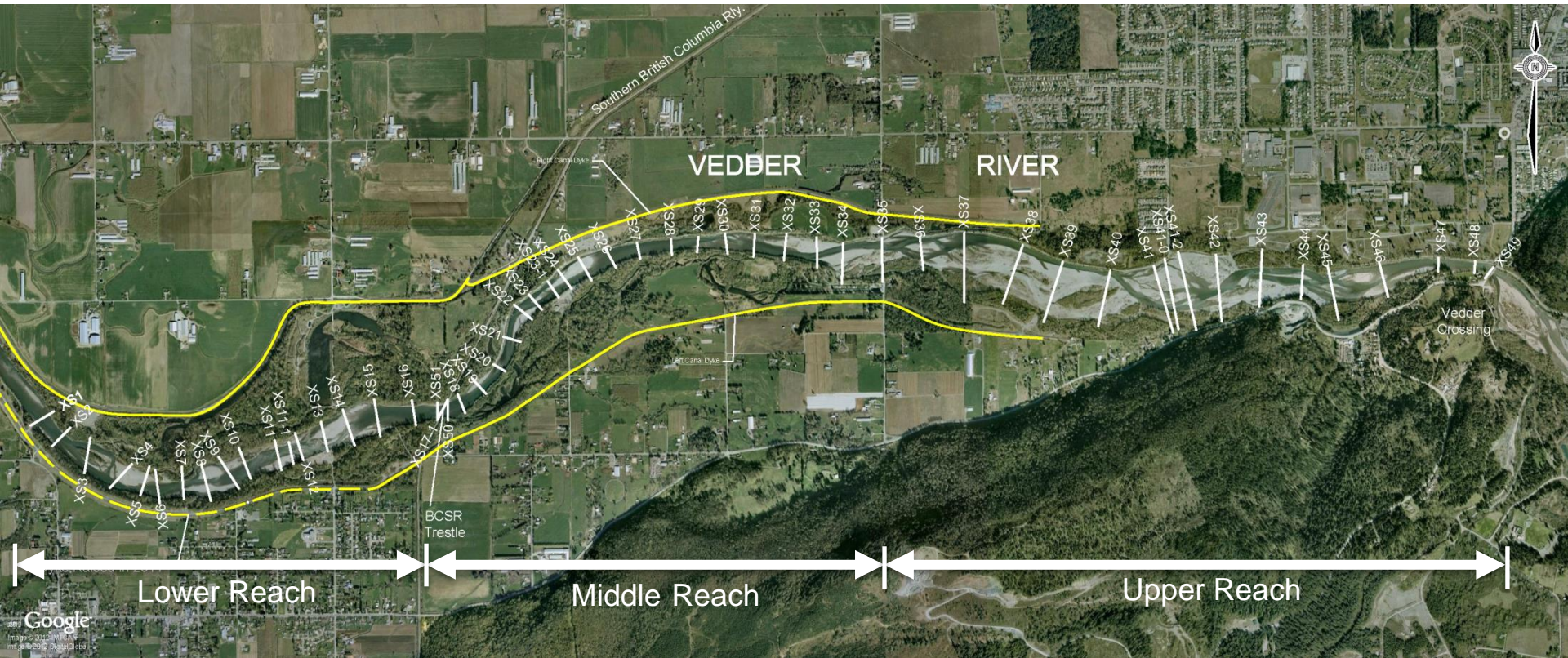
2020 Vedder River and Canal Hydraulic Profile Update

May 7, 2020

Study Area – Vedder Canal



Study Area – Vedder River



- Update the HEC-RAS hydraulic model using the 2020 channel survey with a design flow of 1470 m³/s and starting water level of 7.4 m at the HWY 1 Bridge
- Compare the 2020, 2018, and 2016 thalweg profiles
- Estimate the volume of gravel accumulation or loss using the 2020, 2018, 2016, 1996/1991 surveys
- Identify areas where the desired set back dike freeboard of 0.75 m is not met
- Evaluate the hydraulic effect on the 2020 candidate gravel removal sites

Review of Flood Record

Year	Top Five Flood (m ³ /s)	Date
2003	1140	October 20
2006	1040	November 6
1980	856	December 26
1975	787	December 3
1979	781	December 17

Year	Recent Peak Flow (m ³ /s)	Return Period
2013	367	1:2 y
2014	392	1:2 y
2015	600	1:5 y
2016	340	1:2 y
2017	442	1:2 y
2020	307	1:2 y

Sediment Quantities - Summary

Location	2016-2018 Natural Deposition m ³ /yr	2018-2020 Natural Deposition m ³ /yr	2016-2020 Natural Deposition m ³ /yr
Vedder Canal	-27,200	16,600	-5,400
Vedder River	25,800	-24,700	600
Total	-1,400	-8,100	-4,800



Sediment Quantities - Cumulative

Location	2018-2020 Bed Change m ³	2018 Excavation m ³	2018-2020 Natural Deposition m ³ /yr
XSC10 to XS1 (Canal)	33,155	0	16,600
XS1 to SRBC (Lower)	-20,816	0	-10,400
SRBC to XS35 (Middle)	-11,478	0	-5,700
XS35 to XS45 (Upper)	-17,135	0	-8,600
Total	-16,275	0	-8,100

Location	2016-2020 Bed Change m ³	2016 Excavation m ³	2016-2020 Natural Deposition m ³ /yr
XSC10 to XS1 (Canal)	-38,419	-16,944	-5,400
XS1 to SRBC (Lower)	9,408	-16,566	6,500
SRBC to XS35 (Middle)	-21,387	-18,593	-700
XS35 to XS45 (Upper)	-61,310	-40,382	-5,200
Total	-111,708	-92,485	-4,800

Long Term Sediment Quantities - Cumulative

Location	1991/6-2016 Bed Change m ³	1991/6-2016 Excavation m ³	Annual Deposition m ³ /yr
XSC10 to XS1 (Canal)	-114,300	-99,900	-600
XS1 to SRBC (Lower)	-148,500	-411,200	13,200
SRBC to XS35 (Middle)	-105,600	-237,800	6,700
XS35 to XS45 (Upper)	104,400	-415,900	26,100
Total	-264,000	-1,164,800	45,400

Location	1991/6-2018 Bed Change m ³	1991/6-2018 Excavation m ³	Annual Deposition m ³ /yr
XSC10 to XS1 (Canal)	-186,000	-117,800	-2,500
XS1 to SRBC (Lower)	-118,000	-428,000	14,100
SRBC to XS35 (Middle)	-116,000	-256,000	6,400
XS35 to XS45 (Upper)	60,000	-456,000	23,500
Total	-359,000	-1,257,000	41,500

Location	1991/6-2020 Bed Change m ³	1991/6-2020 Excavation m ³	Annual Deposition m ³ /yr
XSC10 to XS1 (Canal)	-152,500	-117,800	-1,200
XS1 to SRBC (Lower)	-139,100	-428,000	12,000
SRBC to XS35 (Middle)	-127,100	-256,000	5,400
XS35 to XS45 (Upper)	43,100	-456,000	20,800
Total	-375,700	-1,257,000	37,000

Cross Section Gravel Quantities – Vedder River

CROSS SECTION	DISTANCE TO D/S (m)	BED CHANGE VOLUME 2016-2020 (m ³)	BED CHANGE VOLUME 2018-2020 (m ³)	BED CHANGE VOLUME 1996-2020 (m ³)
XS45	169.62	350	-748	-26,489
XS44	212.92	-504	2,889	-33,386
XS43	221.05	-9,573	-1,192	-1,101
XS42	289.75	-20,262	-9,375	68,937
XS41	303.19	-12,629	-7,078	50,740
XS40	264.43	-9,248	-6,471	18,335
XS39	225.47	-6,128	-2,334	16,271
XS38	251.80	-611	4,390	221
XS37	230.76	-672	1,200	-22,872
XS36	204.57	-2,034	1,584	-27,588

Cross Section Gravel Quantities – Vedder River

CROSS SECTION	DISTANCE TO D/S (m)	BED CHANGE VOLUME 2016-2020 (m ³)	BED CHANGE VOLUME 2018-2020 (m ³)	BED CHANGE VOLUME 1996-2020 (m ³)
XS35	204.85	-10,263	954	-21,962
XS34	142.69	-6,904	-34	-9,919
XS33	165.19	-2,333	-960	-13,256
XS32	159.56	-4,575	-4,890	-12,804
XS31	143.30	-1,592	-1,700	-7,759
XS30	146.78	1,180	1,005	-6,699
XS29	135.43	387	82	-4,579
XS28	169.52	2,302	827	-3,942
XS27	147.59	2,182	44	-4,045
XS26	143.62	-211	-1,429	-4,766
XS25	116.34	-1,782	-458	-4,642
XS24	78.46	-1,466	1,336	-3,934
XS23	80.84	1,229	1,459	502
XS22	150.55	1,988	1,739	-2,660
XS21	160.14	880	678	-5,578
XS20	140.85	583	219	-5,357
XS19	126.63	380	-4,051	-6,469
XS18	78.16	-2,292	-4,853	-6,729
XS50	27.32	-1,080	-1,448	-2,490

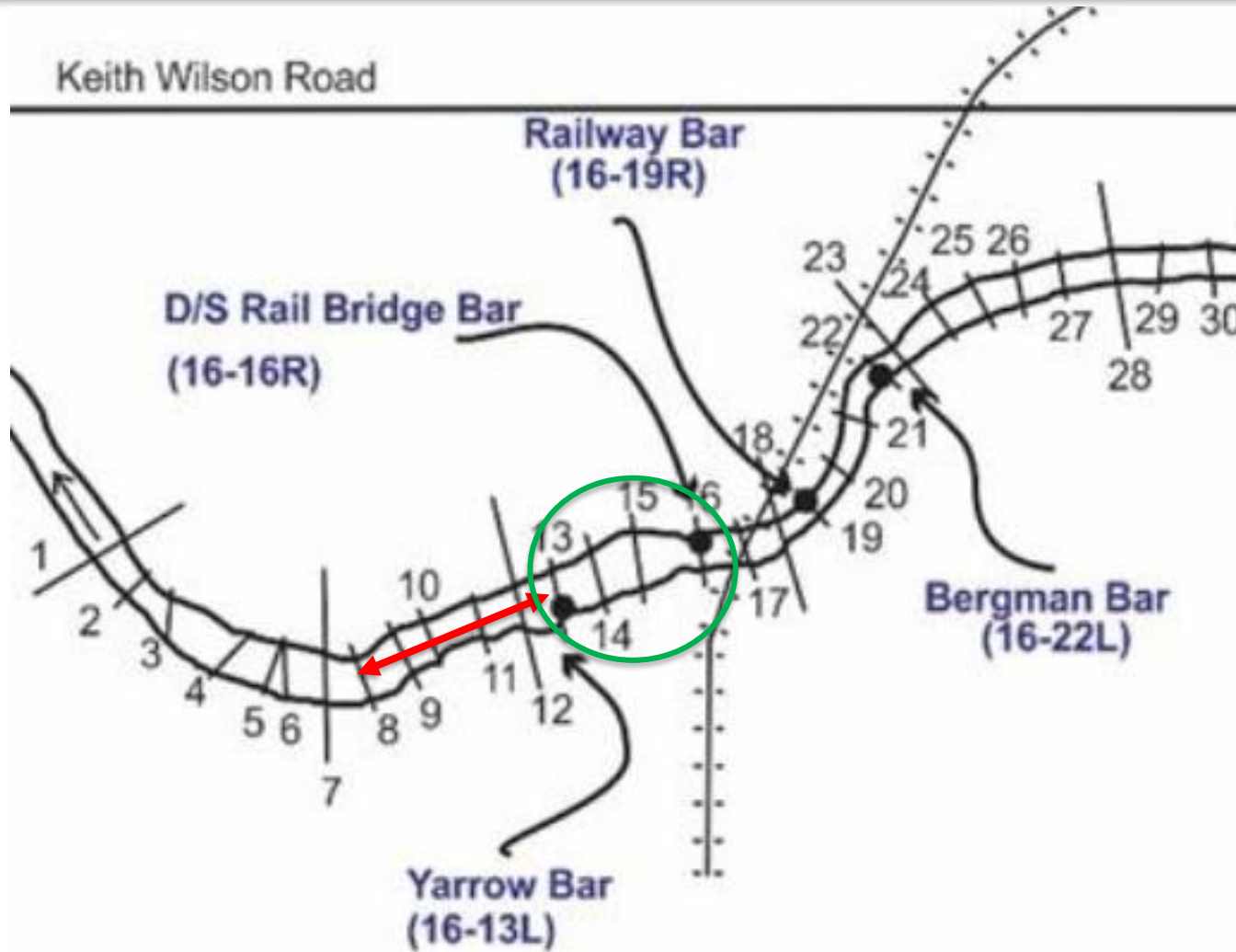
Cross Section Gravel Quantities – Vedder River

CROSS SECTION	DISTANCE TO D/S (m)	BED CHANGE VOLUME 2016-2020 (m ³)	BED CHANGE VOLUME 2018-2020 (m ³)	BED CHANGE VOLUME 1996-2020 (m ³)
XS51 (SRBC)	120.45	667	-2,581	-10,101
XS16	190.13	6,530	-806	-16,047
XS15	154.57	5,627	-13	-4,763
XS14	132.73	4,244	-945	1,592
XS13	139.15	4,458	-997	-3,449
XS12	116.94	2,060	852	-7,058
XS11	175.51	-3,346	-1,541	-17,062
XS10	94.66	-4,045	-3,746	-9,313
XS9	126.44	-3,684	-3,995	-12,970
XS8	118.42	-1,469	-860	-12,906
XS7	131.03	257	-156	-5,069
XS6	71.08	524	-397	-128
XS5	125.46	160	-627	-4,796
XS4	201.70	-672	-935	-20,492
XS3	163.68	-540	-2,252	-11,689
XS2	136.11	-283	-369	-2,375

Cross Section Gravel Quantities – Vedder Canal 12

CROSS SECTION	DISTANCE TO D/S (m)	BED CHANGE VOLUME 2016-2020 (m ³)	BED CHANGE VOLUME 2018-2020 (m ³)	BED CHANGE VOLUME 1991-2020 (m ³)
XS1	185.93	-2,443	1,452	-4,855
C37	151.48	-3,581	1,204	-6,471
C36	152.07	-2,748	1,794	-6,818
C35	152.34	-1,958	1,614	-6,021
C34	152.36	-1,993	1,472	-4,582
C33	152.34	-2,351	1,373	-3,466
C32	152.30	-2,660	1,190	-3,125
C31	152.39	-2,565	767	-3,525
C29	292.16	-5,303	-1,482	-19,454
C27	148.98	-2,511	-1,023	-10,066
C26	152.36	-2,960	4,056	-5,530
C25	152.36	-1,275	4,613	-5,861
C24	152.38	-443	1,064	-5,781
C23	154.14	-1,837	652	-5,086
C22	150.56	-2,369	837	-5,491
C21	152.35	-2,163	741	-6,480
C20	304.71	-172	1,781	-12,080
C18	609.41	1,910	6,921	-20,261
C14	572.00	-688	4,318	-17,291

Vedder River Sedimentation Zones

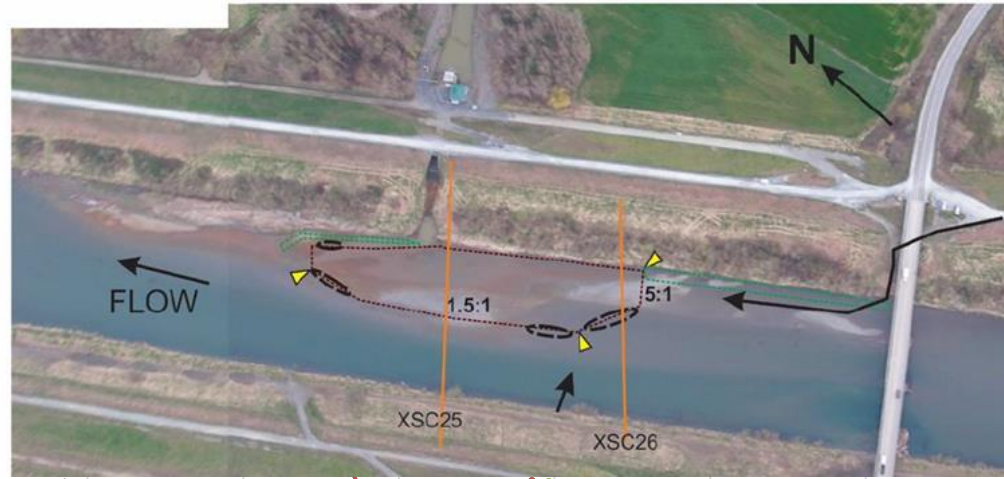


Vedder Canal XS C25 Keith Wilson Bar

2016 Construction Drawing: Keith Wilson Bar (16-C26R)



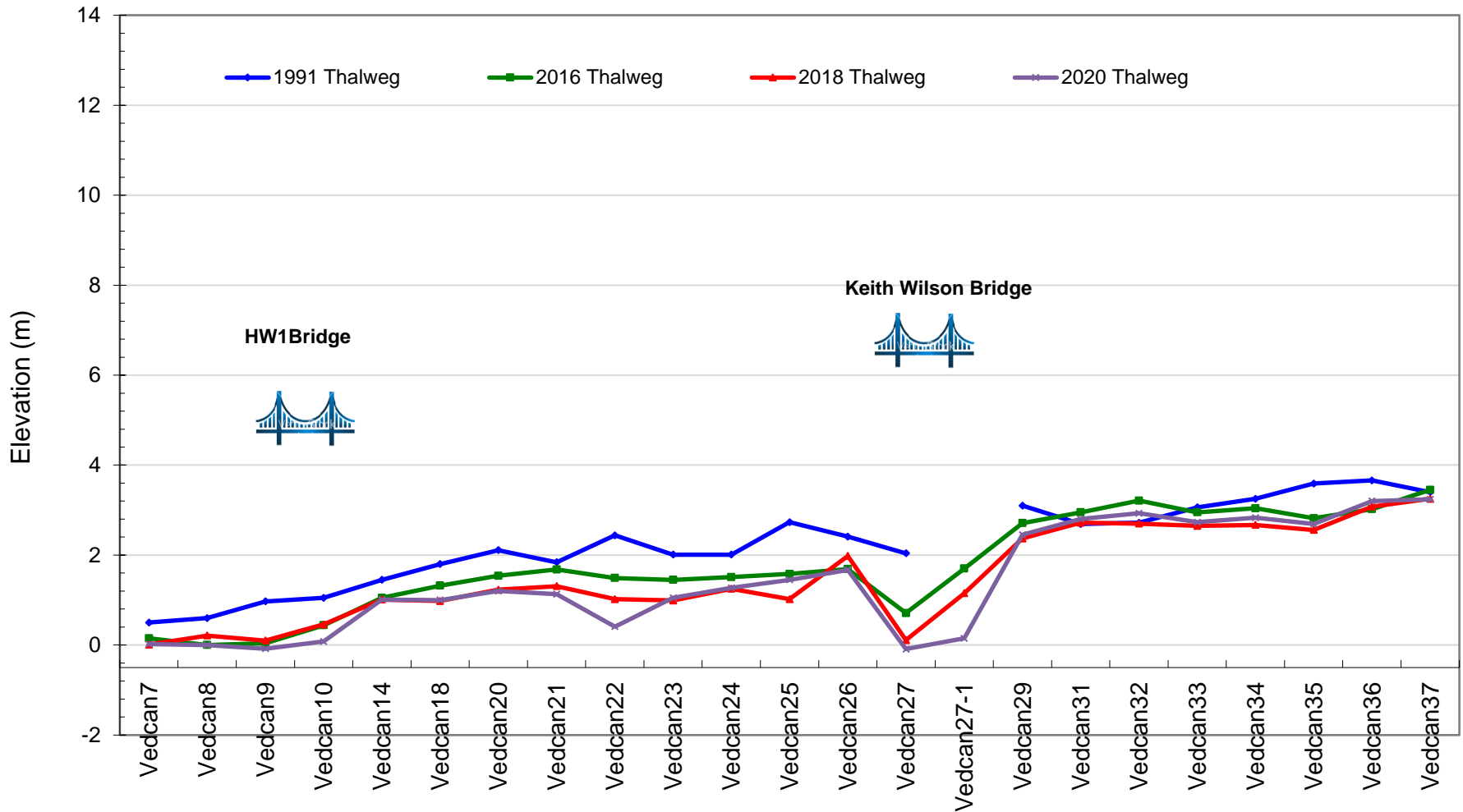
Plan Date: September 07, 2016 Photo: March 19, 2016



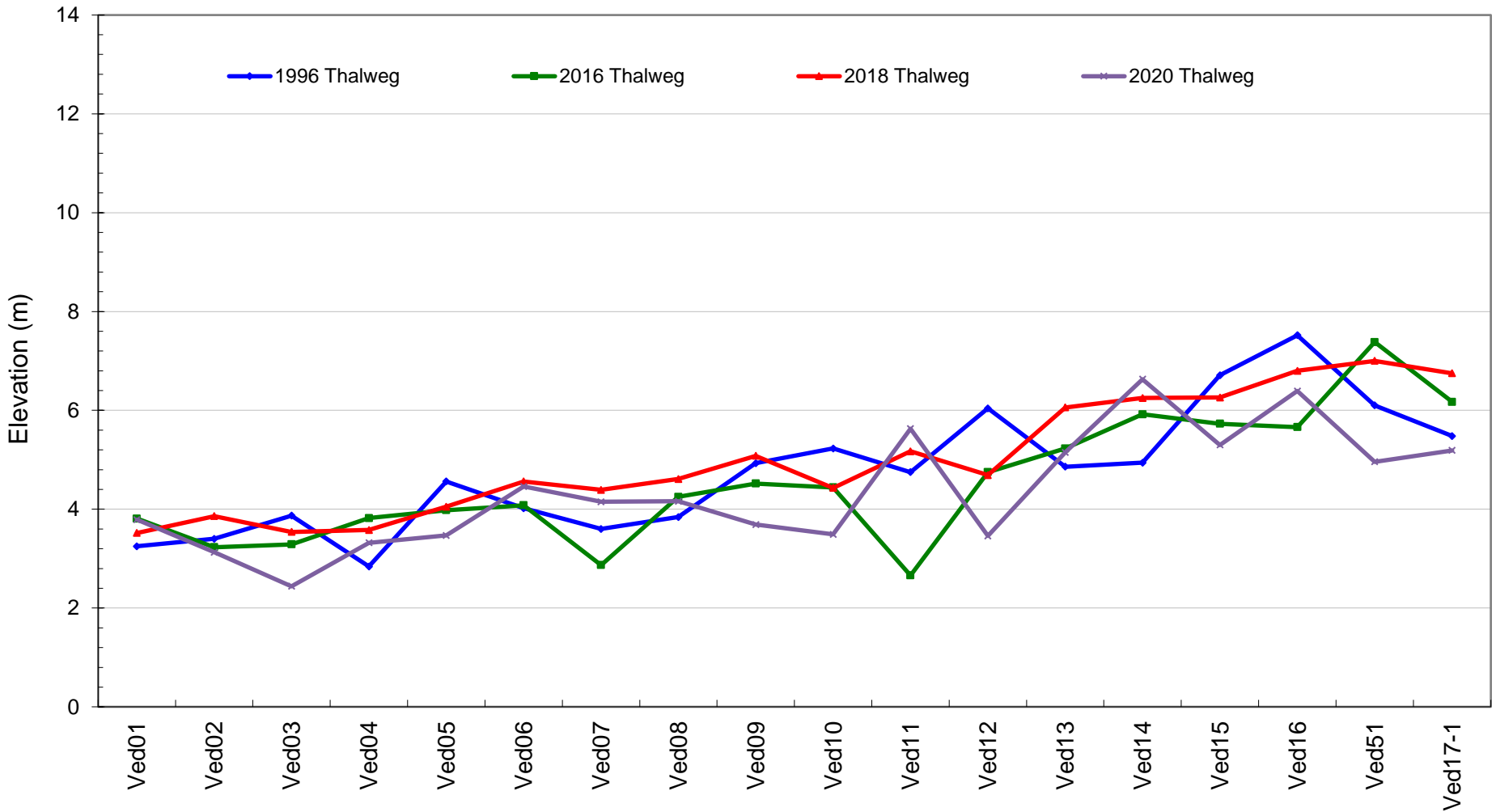
Vedder River Lower Reach - XS 13



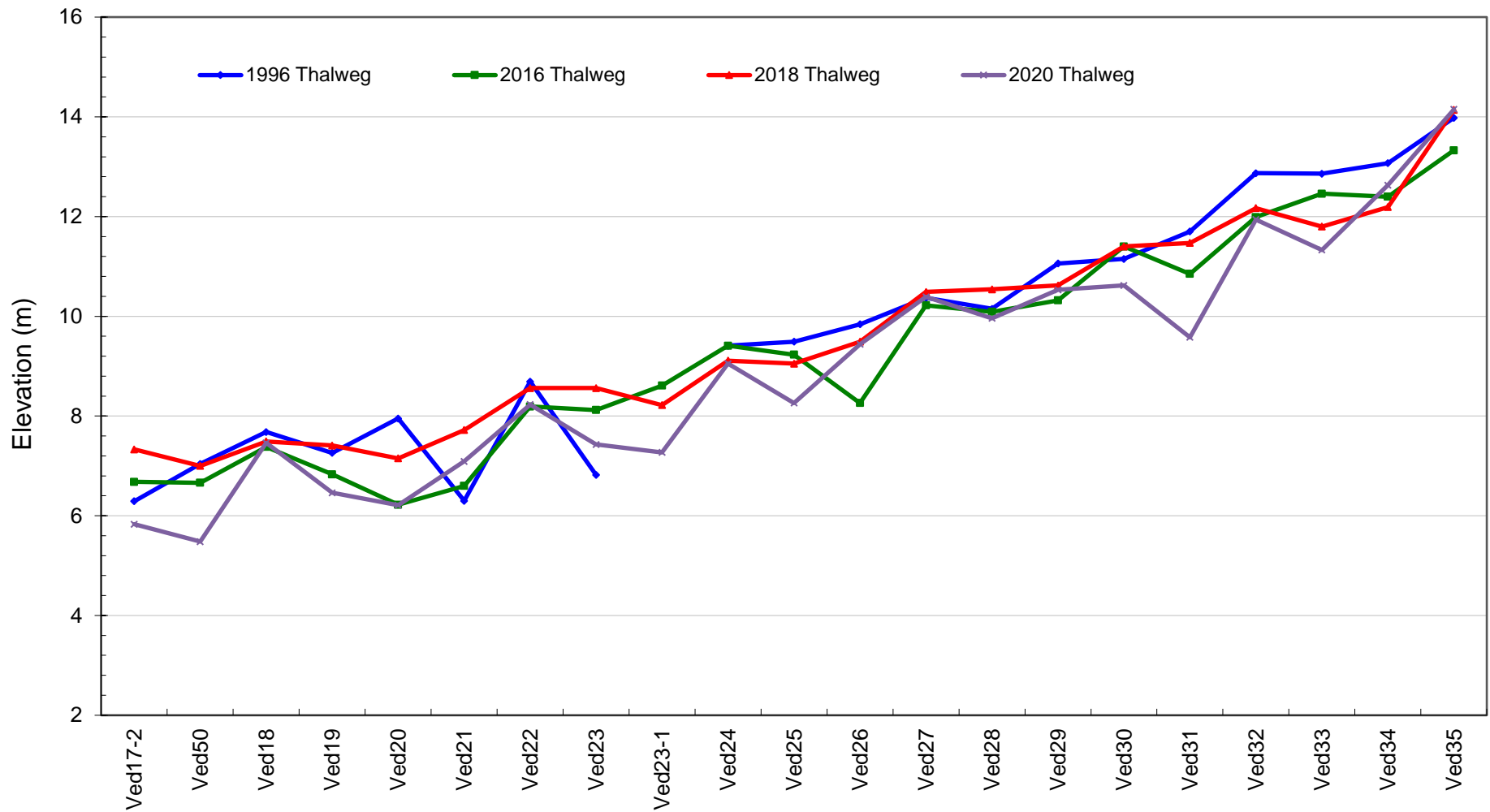
Thalweg Profile – Vedder Canal



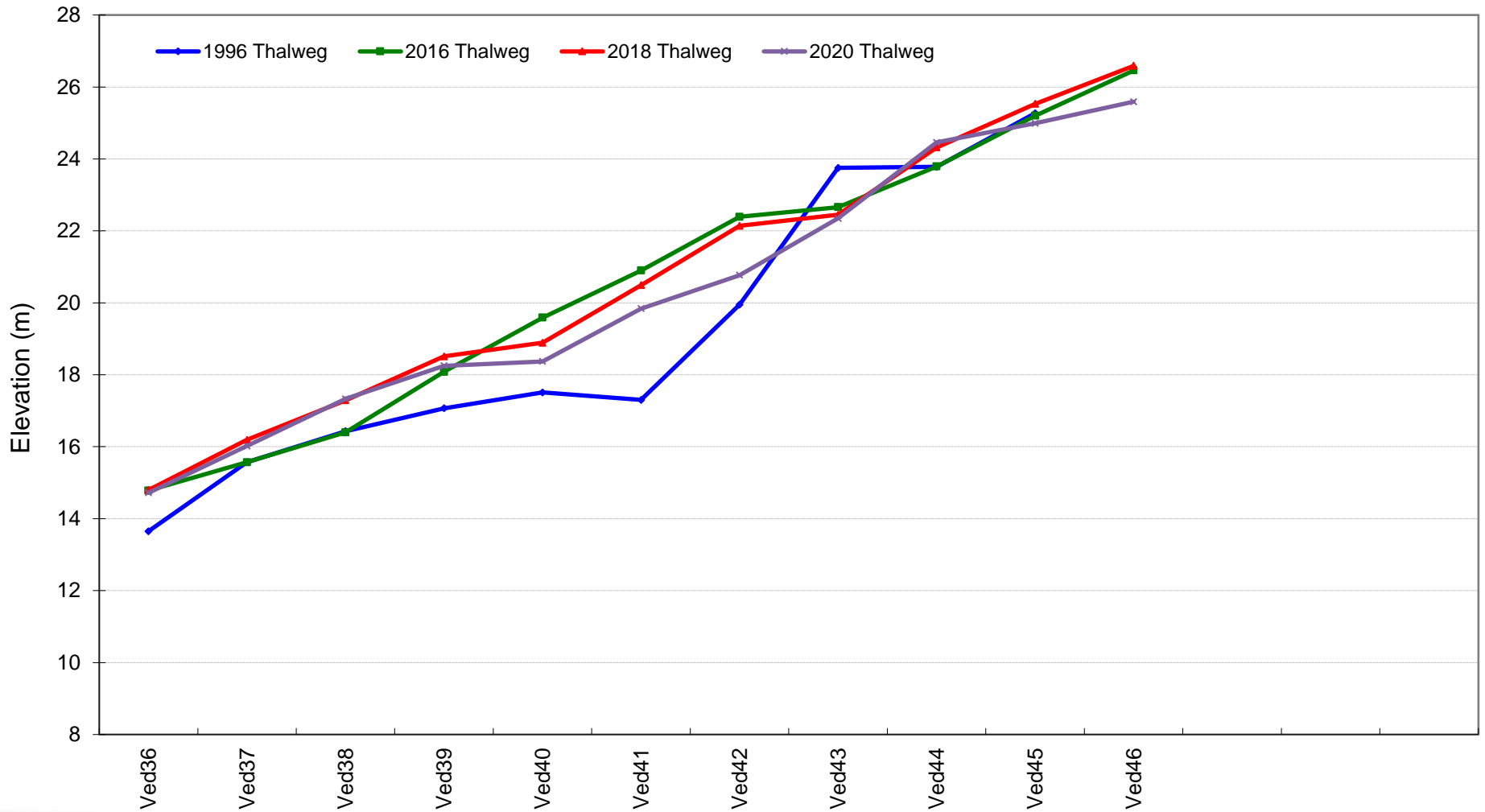
Thalweg Profile – Vedder River Lower Reach ¹⁷



Thalweg Profile – Vedder River Middle Reach¹⁸

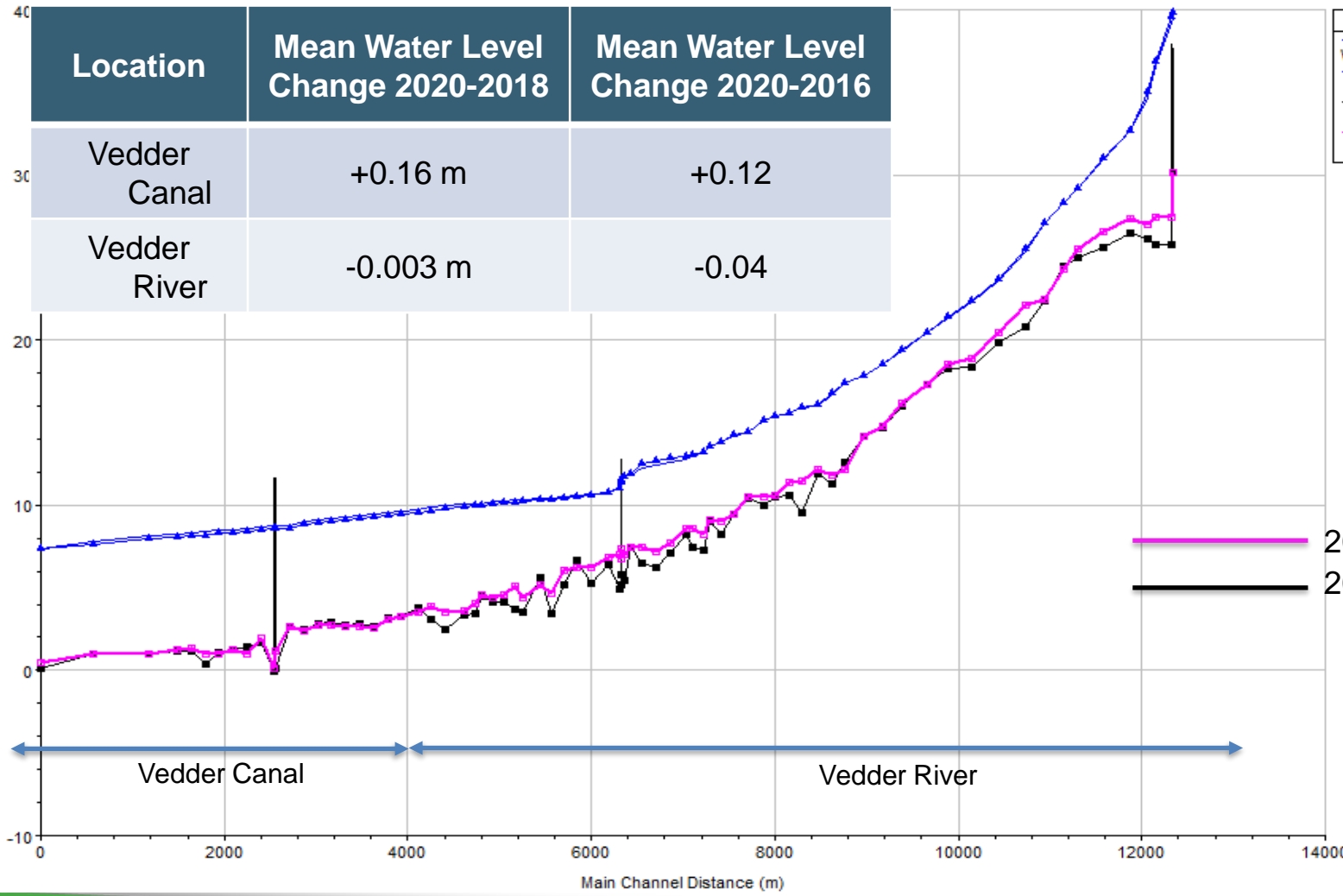


Thalweg Profile – Vedder River Upper Reach ¹⁹



Flood Profile 2018 vs. 2020

vedder2020 Plan: 1) Vedder2020_noC6 2020-03-25 2) 2018 2018-04-12

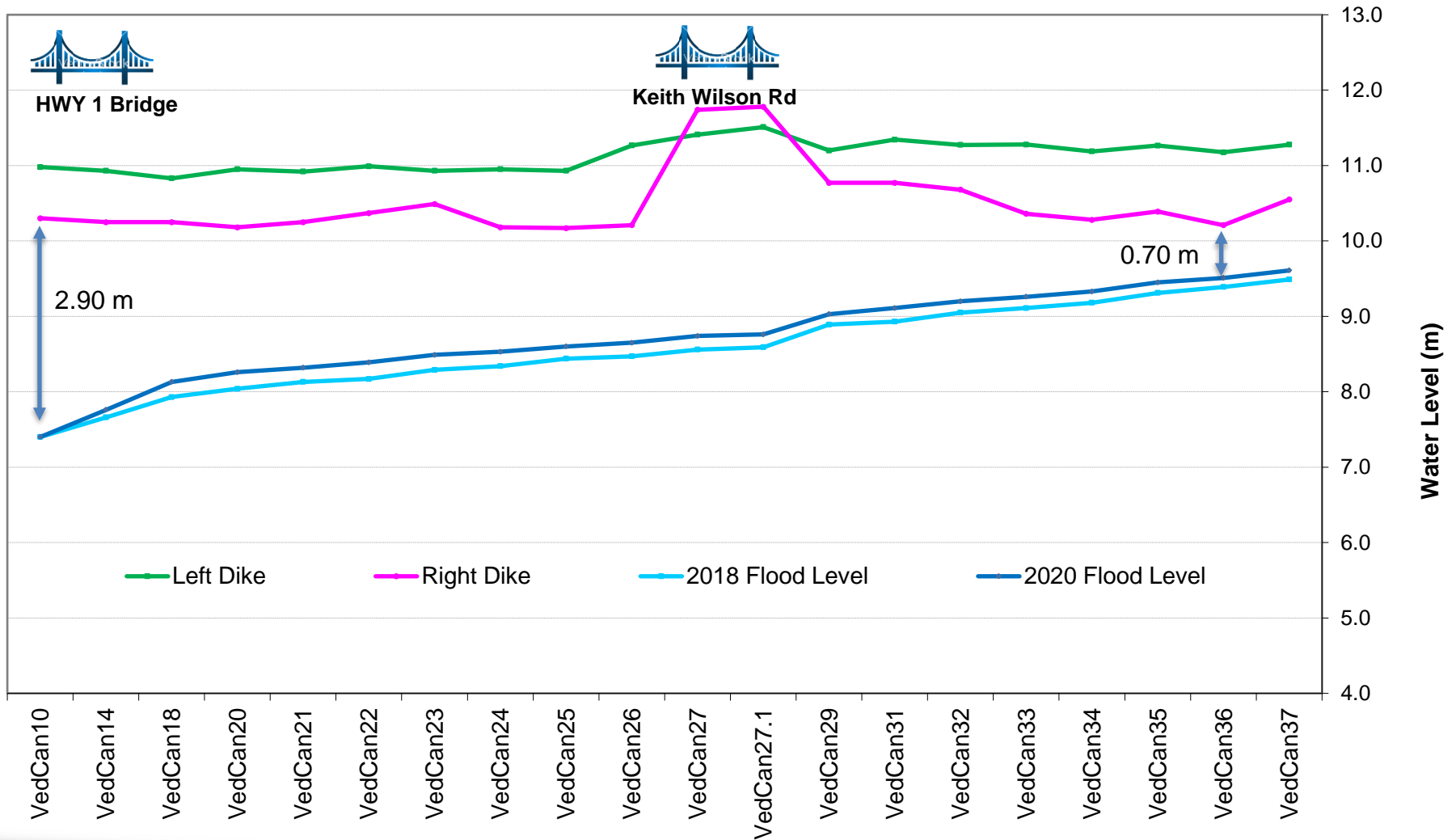


Legend	
WS PF 1 - Vedder2020_noC6	(Blue line with triangles)
WS PF 1 - 2018	(Black line with squares)
Ground	(Magenta line with squares)
Ground	(Black line with squares)

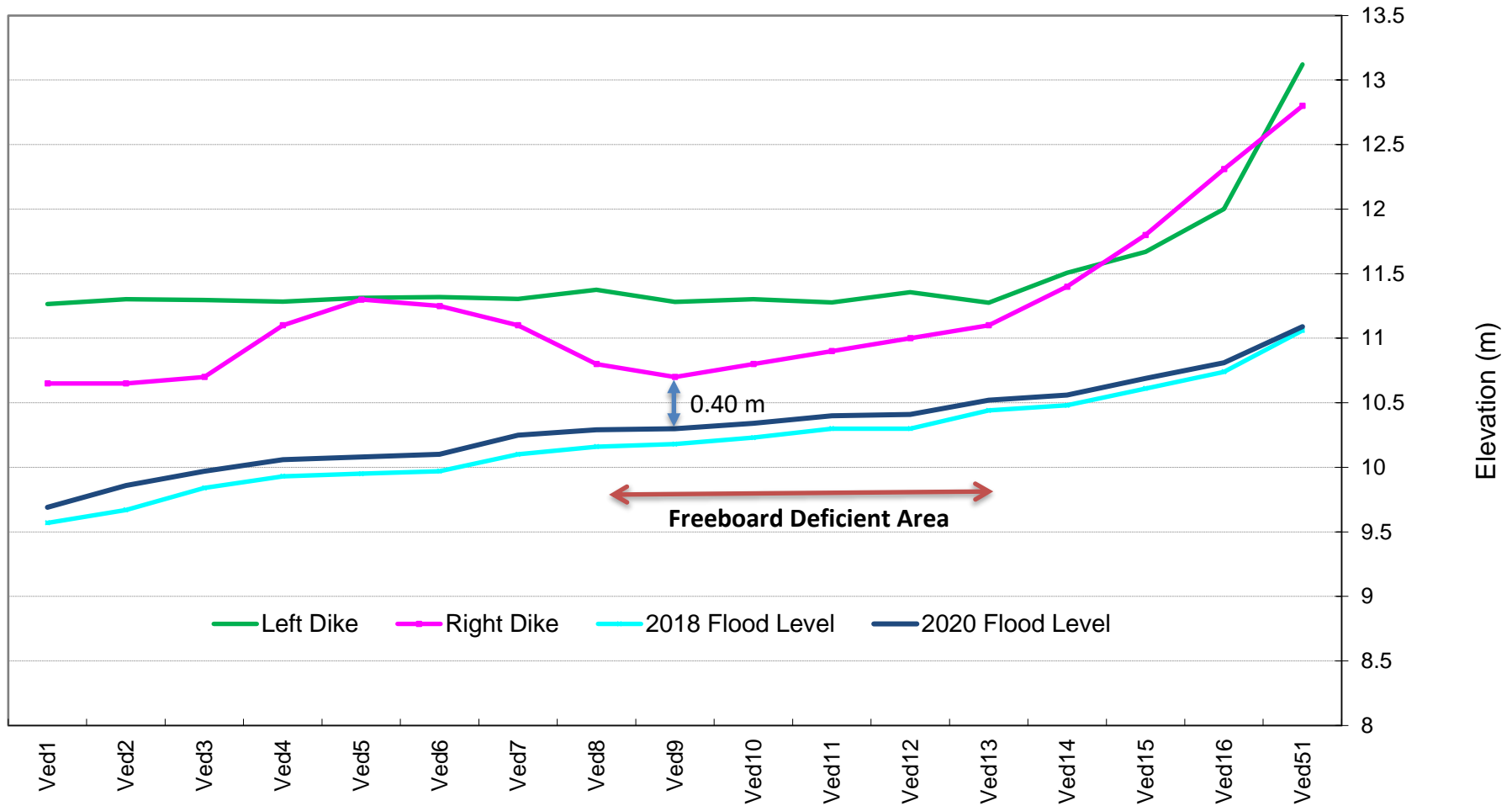
Location	Mean Water Level Change 2020-2018	Mean Water Level Change 2020-2016
Vedder Canal	+0.16 m	+0.12
Vedder River	-0.003 m	-0.04

2018 Ground
2020 Ground

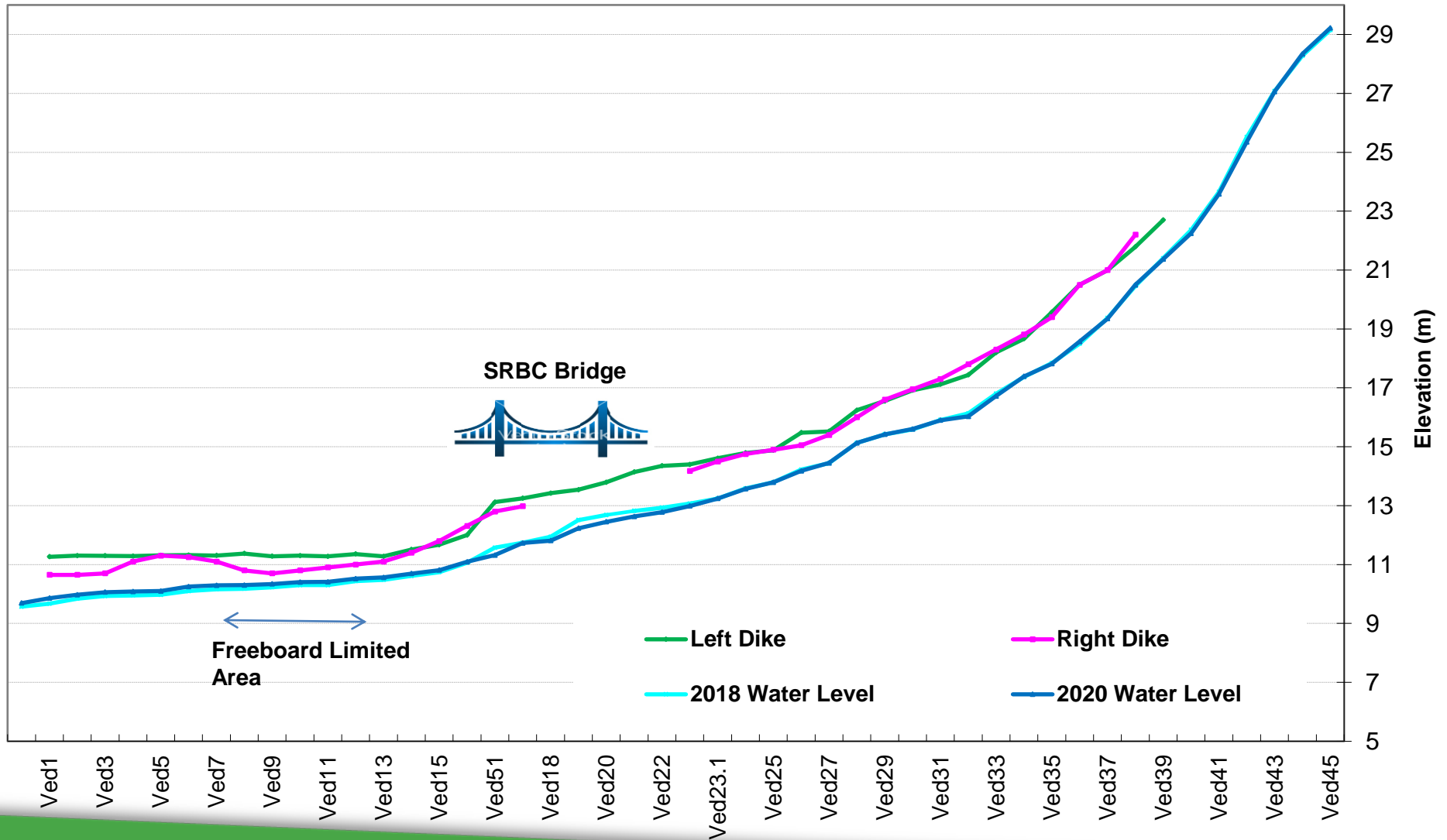
Vedder Canal Dike Freeboard Assessment



Vedder River Dike Freeboard



Vedder River Dike Freeboard



Vedder River Dike Freeboard

Cross Section	L. Dike Elev.(m)	R. Dike Elev.(m)	2018 W.L.	2020 W.L.	2018		2020	
					L. Dike F.B. (m)	R Dike F.B. (m)	L Dike F.B. (m)	R Dike F.B. (m)
39	22.70	--	21.40	21.37	1.30	--	1.33	--
38	21.79	22.20	20.46	20.50	1.33	1.74	1.29	1.70
37	21.00	21.00	19.37	19.35	1.63	1.63	1.65	1.65
36	20.50	20.50	18.50	18.57	2.00	2.00	1.93	1.93
35	19.57	19.40	17.84	17.82	1.73	1.56	1.75	1.58
34	18.67	18.81	17.37	17.39	1.30	1.44	1.28	1.42
33	18.20	18.30	16.80	16.72	1.40	1.50	1.48	1.58
32	17.44	17.80	16.13	16.03	1.31	1.67	1.41	1.77
31	17.12	17.30	15.91	15.9	1.21	1.39	1.22	1.40
30	16.92	16.95	15.59	15.6	1.33	1.36	1.32	1.35
29	16.55	16.60	15.42	15.42	1.13	1.18	1.13	1.18
28	16.24	16.00	15.13	15.13	1.11	0.87	1.11	0.87
27	15.52	15.40	14.44	14.45	1.08	0.96	1.07	0.95
26	15.48	15.05	14.22	14.18	1.26	0.83	1.30	0.87
25	14.88	14.90	13.79	13.79	1.09	1.11	1.09	1.11
24	14.79	14.75	13.58	13.57	1.21	1.17	1.22	1.18
23	14.40	14.18	13.07	12.99	1.33	1.11	1.41	1.19
22	14.35	--	12.93	12.78	1.42	--	1.57	--
21	14.14	--	12.82	12.63	1.32	--	1.51	--
20	13.79	--	12.68	12.45	1.11	--	1.34	--
19	13.54	--	12.51	12.23	1.03	--	1.31	--
18	13.42	--	11.94	11.81	1.48	--	1.61	--
50	13.25	12.98	11.74	11.73	1.51	1.24	1.52	1.25

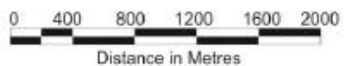
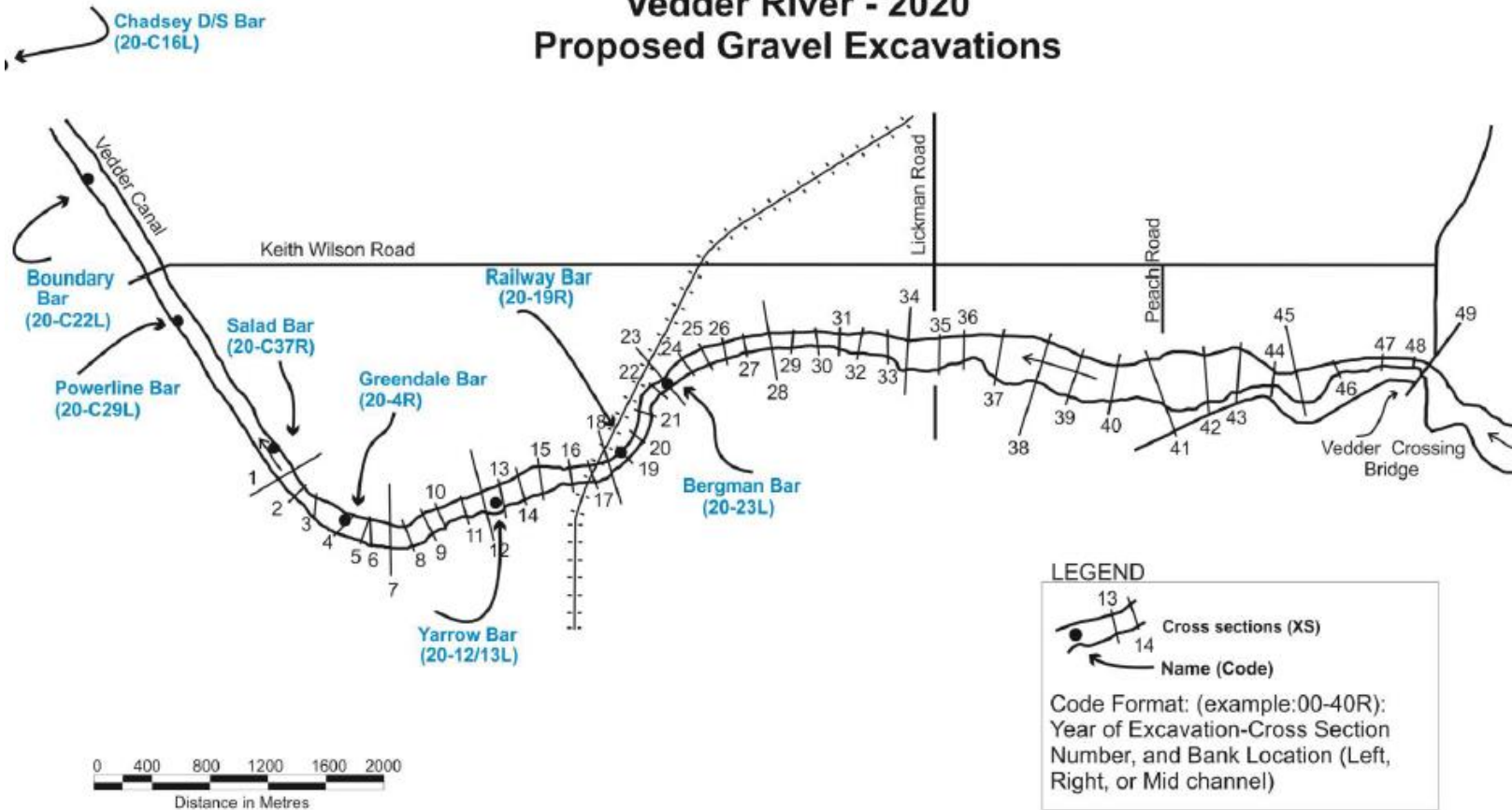
Vedder River Dike Freeboard

Cross Section	L. Dike Elev.(m)	R. Dike Elev.(m)	2018 W.L.	2020 W.L.	2018		2020	
					L. Dike F.B. (m)	R Dike F.B. (m)	L Dike F.B. (m)	R Dike F.B. (m)
51	13.12	12.80	11.06	11.09	2.06	1.74	2.03	1.71
16	12.00	12.31	10.74	10.81	1.26	1.57	1.19	1.50
15	11.67	11.80	10.61	10.69	1.06	1.19	0.98	1.11
14	11.51	11.40	10.48	10.56	1.03	0.92	0.95	0.84
13	11.28	11.10	10.44	10.52	0.84	0.66	0.76	0.58
12	11.36	11.00	10.30	10.41	1.06	0.70	0.95	0.59
11	11.28	10.90	10.30	10.4	0.98	0.60	0.88	0.50
10	11.30	10.80	10.23	10.34	1.07	0.57	0.96	0.46
9	11.28	10.70	10.18	10.3	1.10	0.52	0.98	0.40
8	11.38	10.80	10.16	10.29	1.22	0.64	1.09	0.51
7	11.31	11.10	10.10	10.25	1.21	1.00	1.06	0.85
6	11.32	11.25	9.97	10.1	1.35	1.28	1.22	1.15
5	11.31	11.30	9.95	10.08	1.36	1.35	1.23	1.22
4	11.28	11.10	9.93	10.06	1.35	1.17	1.22	1.04
3	11.30	10.70	9.84	9.97	1.46	0.86	1.33	0.73
2	11.30	10.65	9.67	9.86	1.63	0.98	1.44	0.79
1	11.27	10.65	9.57	9.69	1.70	1.08	1.58	0.96

Vedder Canal Dike Freeboard

Cross Section	L. Dike Elev.(m)	R. Dike Elev.(m)	2018 W.L.	2020 W.L.	2018		2020	
					L. Dike F.B. (m)	R Dike F.B. (m)	L Dike F.B. (m)	R Dike F.B. (m)
C37	11.28	10.55	9.49	9.61	1.79	1.06	1.67	0.94
C36	11.18	10.21	9.39	9.51	1.79	0.82	1.67	0.70
C35	11.26	10.39	9.31	9.45	1.95	1.08	1.81	0.94
C34	11.19	10.28	9.18	9.33	2.01	1.10	1.86	0.95
C33	11.28	10.36	9.11	9.26	2.17	1.25	2.02	1.10
C32	11.27	10.68	9.05	9.20	2.22	1.63	2.07	1.48
C31	11.34	10.77	8.93	9.11	2.41	1.84	2.23	1.66
C29	11.20	10.77	8.89	9.03	2.31	1.88	2.17	1.74
C27.1	11.51	11.78	8.59	8.76	2.92	3.19	2.75	3.02
C27	11.41	11.74	8.56	8.74	2.85	3.18	2.67	3.00
C26	11.27	10.21	8.47	8.65	2.80	1.74	2.62	1.56
C25	10.93	10.17	8.44	8.60	2.49	1.73	2.33	1.57
C24	10.95	10.18	8.34	8.53	2.61	1.84	2.42	1.65
C23	10.93	10.49	8.29	8.49	2.64	2.20	2.44	2.00
C22	10.99	10.37	8.17	8.39	2.82	2.20	2.60	1.98
C21	10.92	10.25	8.13	8.32	2.79	2.12	2.60	1.93
C20	10.95	10.18	8.04	8.26	2.91	2.14	2.69	1.92
C18	10.83	10.25	7.93	8.13	2.90	2.32	2.70	2.12
C14	10.93	10.25	7.66	7.76	3.27	2.59	3.17	2.49
C10	10.98	10.30	7.4	7.40	3.58	2.90	3.58	2.90

Vedder River - 2020 Proposed Gravel Excavations



Summary of Proposed Excavation Volumes ²⁸

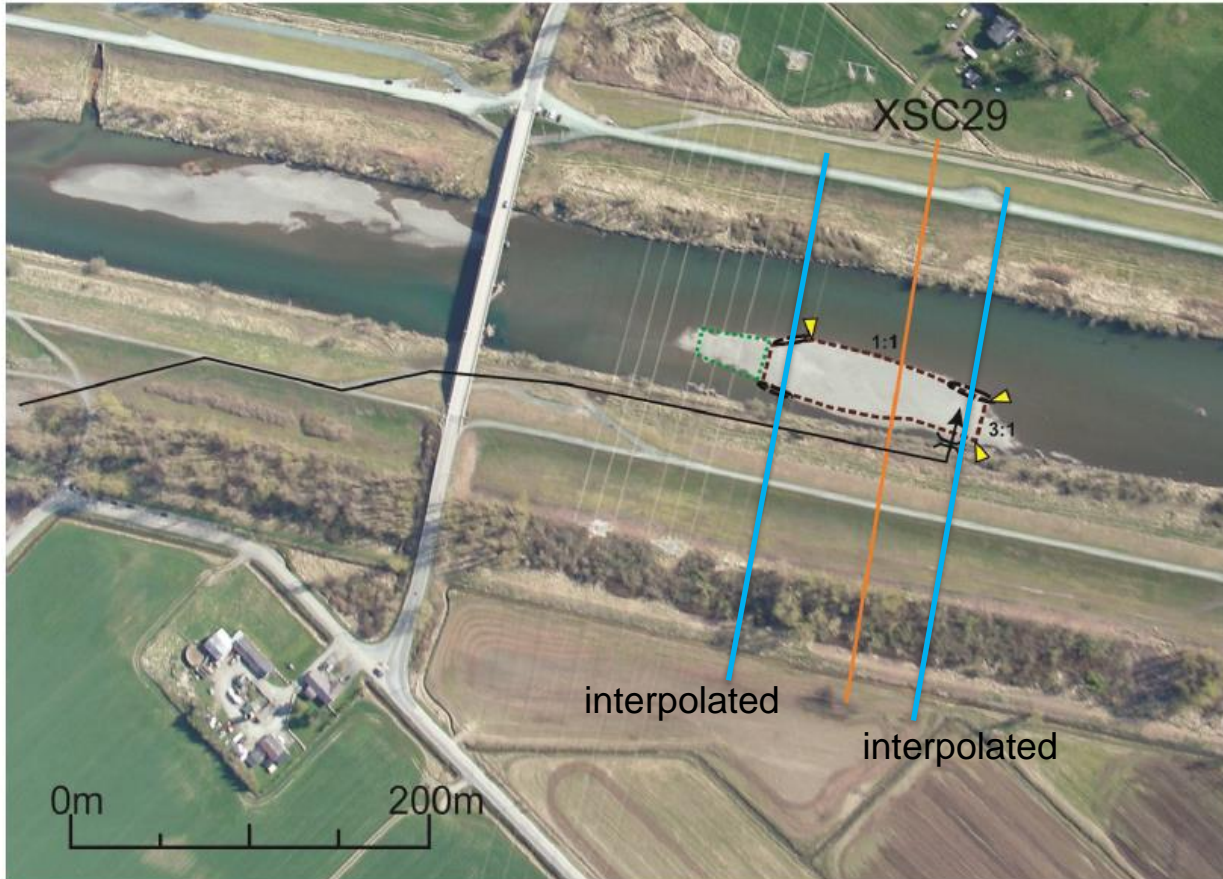
Site #	Bar Name	Volume (m ³)	Subtotal (m ³)
1	Bergman	20,000	Middle Reach - 24,000
2	Railway	4,000	
3	Yarrow	7,000	Lower Reach - 19,000
4	Greendale	6,000	
5	Salad (A)	6,000	
6	Powerline	8,000	Canal - 52,000
7	Boundary	19,000	
8	Chadsey	25,000	
Total		95,000	



Proposed Excavation – Powerline Bar

2020 Proposed Excavations: Powerline Bar (20-C 29L)

Plan Date: April 24, 2020 Photo: April 9, 2020

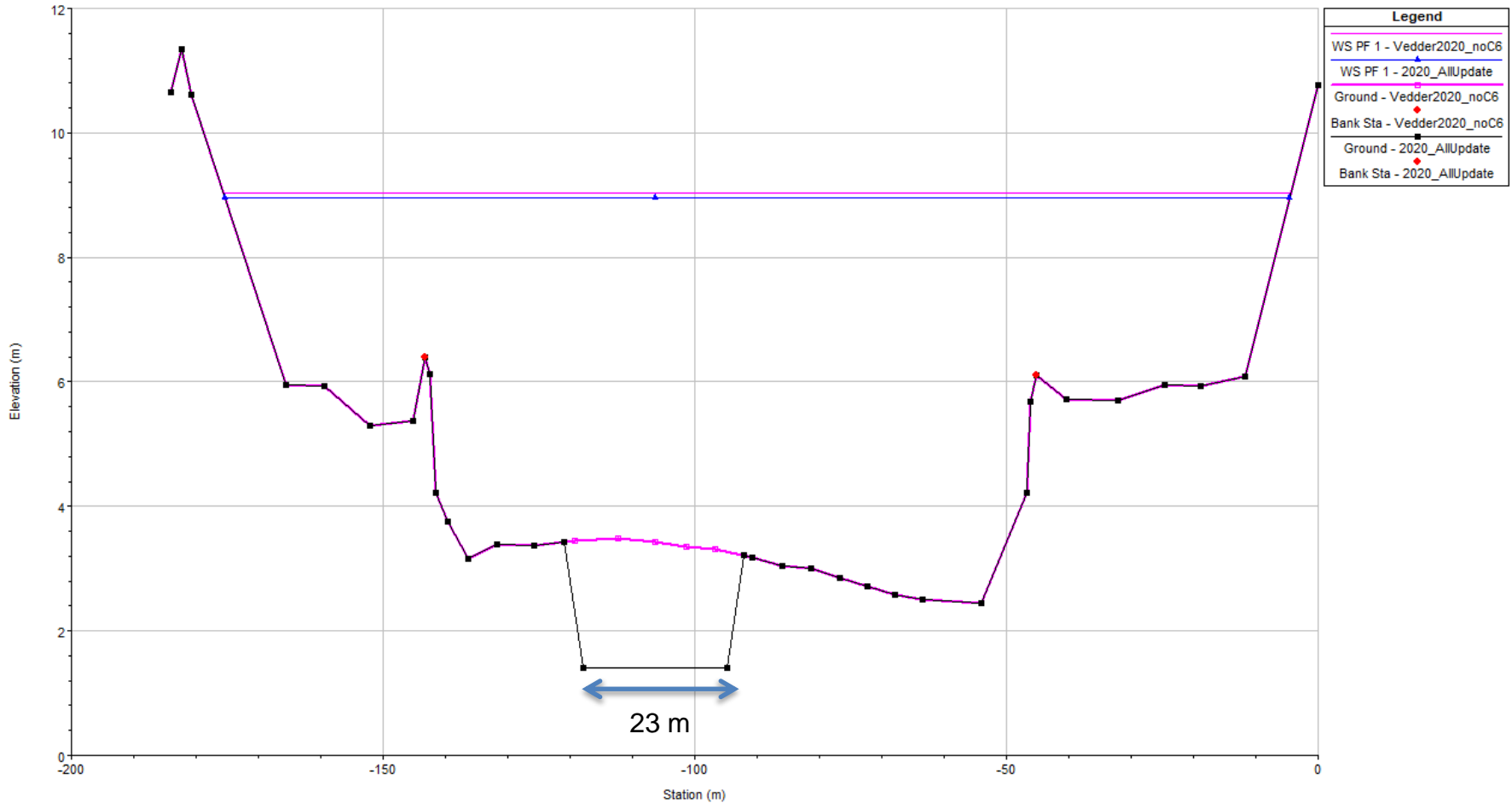


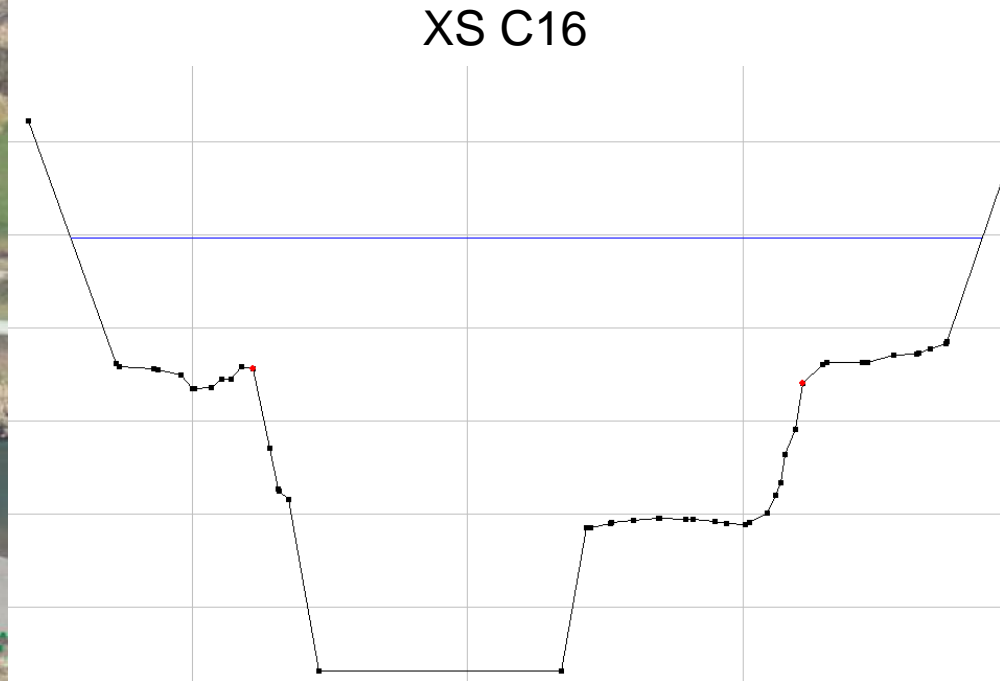
- X Culvert Crossing
- - - Perimeter of proposed excavation
- - - Habitat excavation
- ▲ Slope change point
- ⬇ Pit openings
- ➔ Access Route
- Pit Slopes are 1.5:1 unless otherwise shown

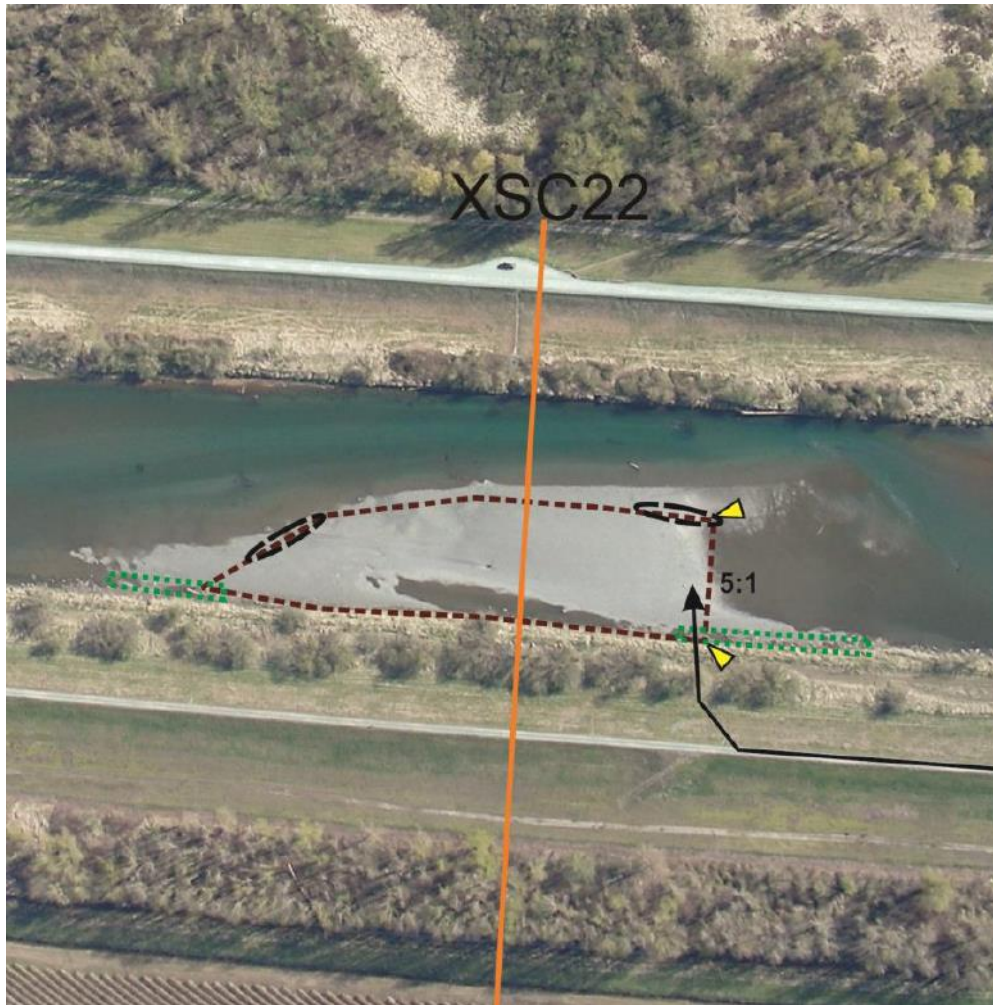
Volume = 8,000m³
Avg. Length = 121m
Width = 23m
Depth = 3m

Channel Modification – Powerline Bar

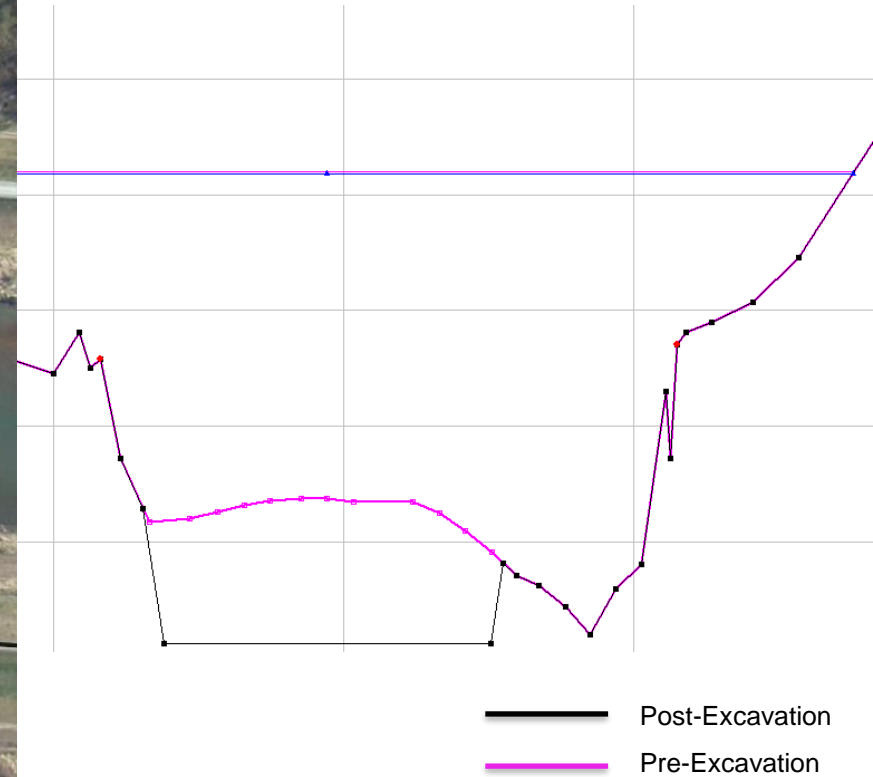
vedder2020 Plan: 1) 2020_AllUpdate 2) Vedder2020_noC6
XS C29 - updated channel with 2020 survey

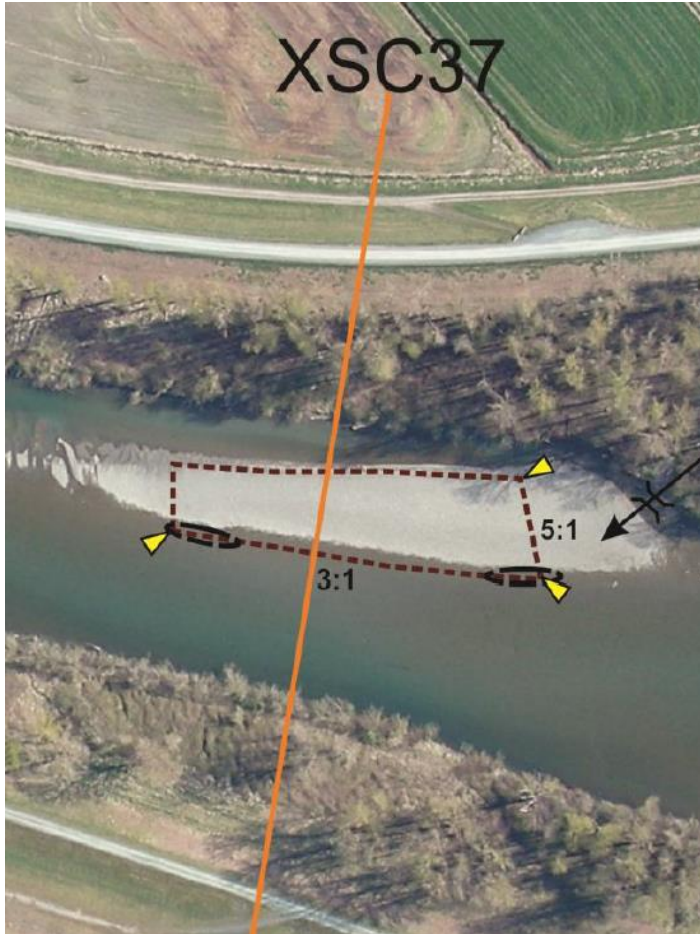


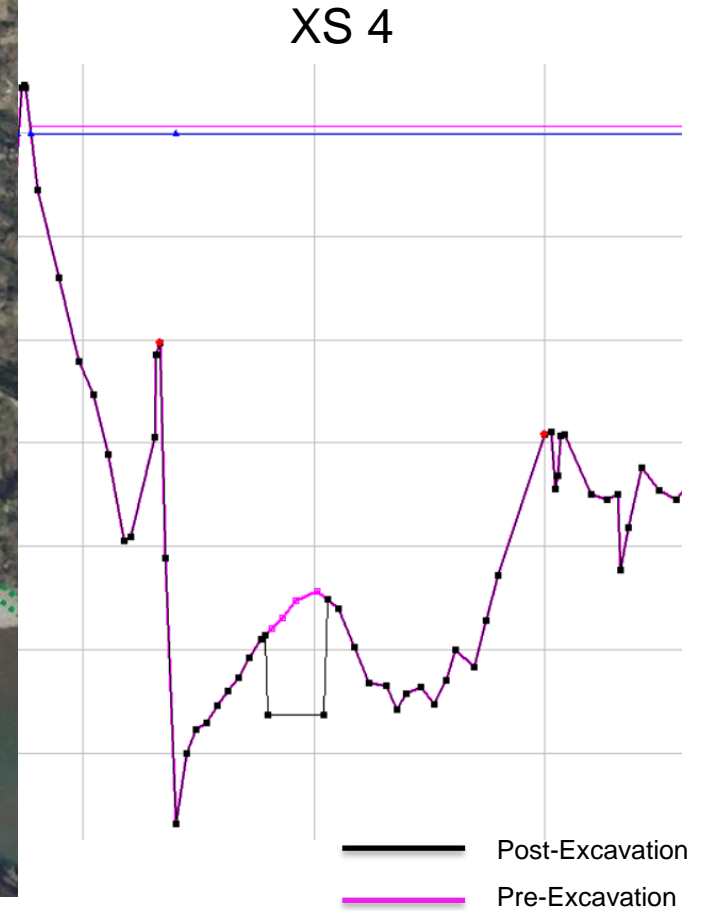
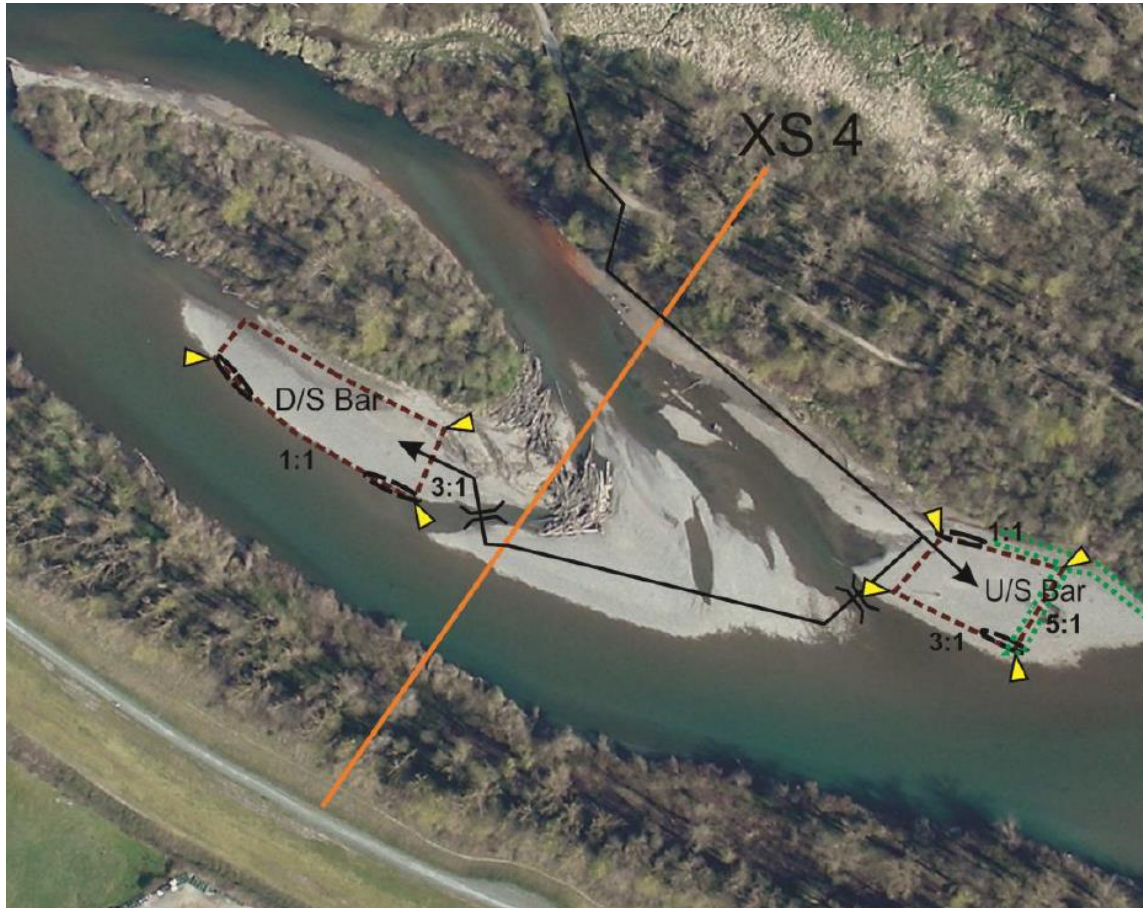


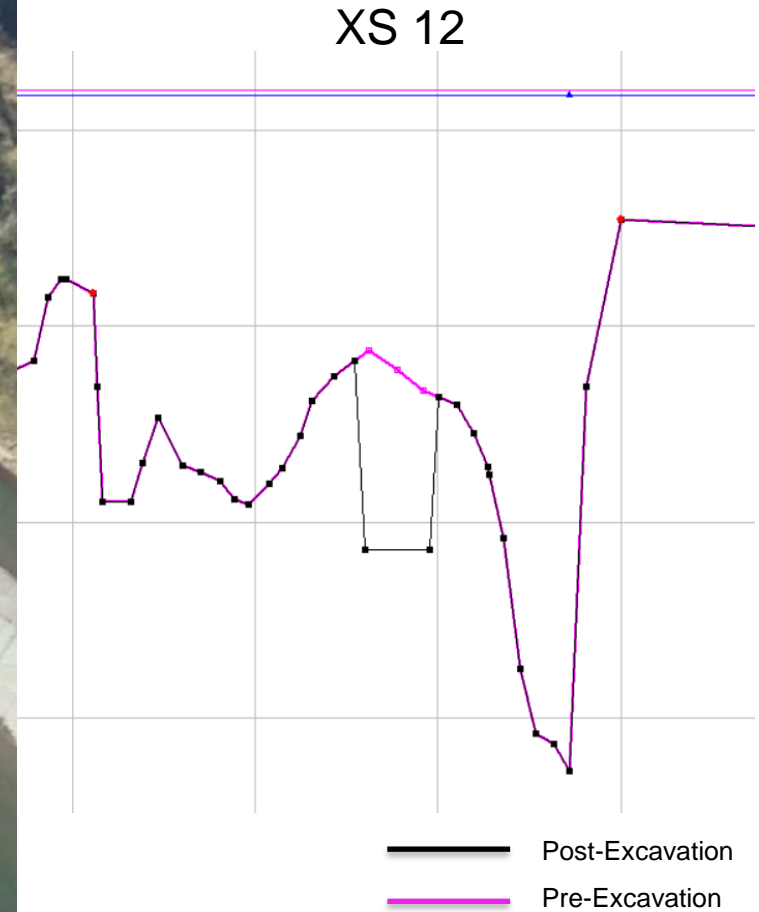
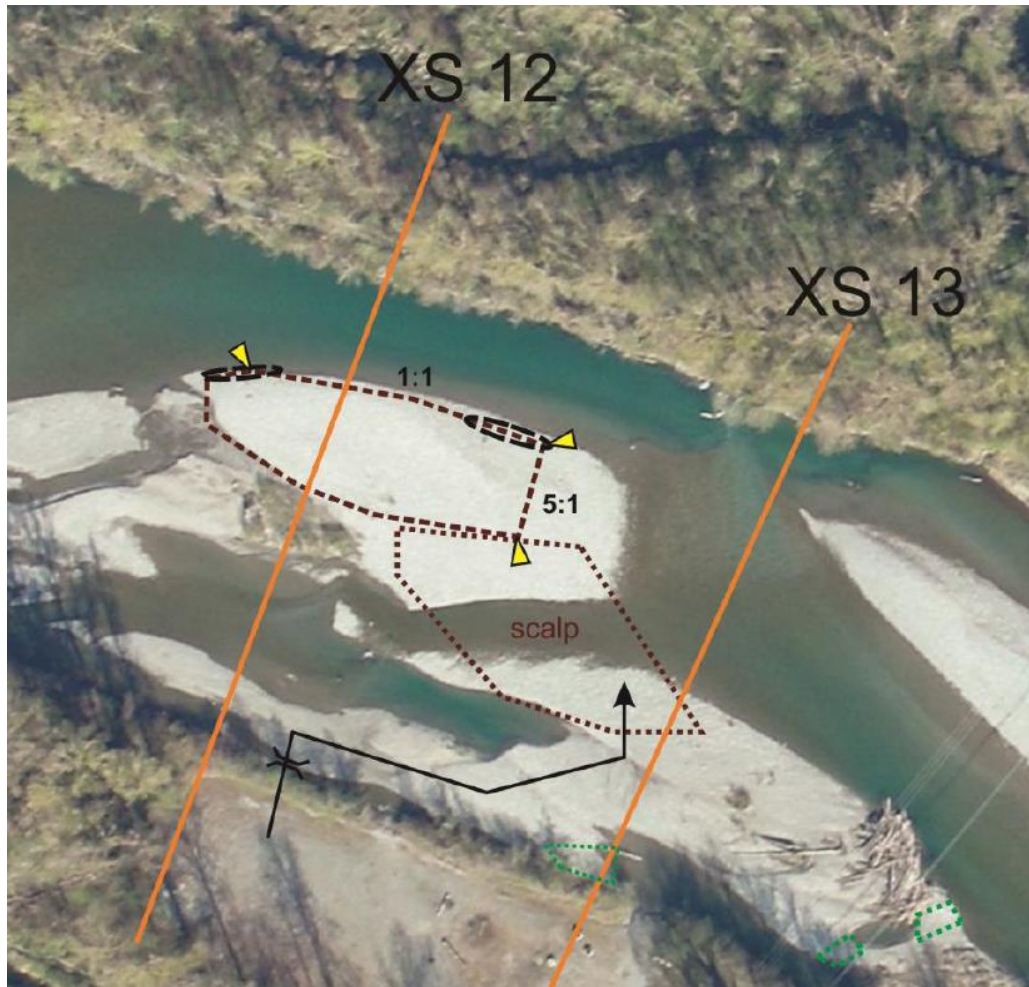


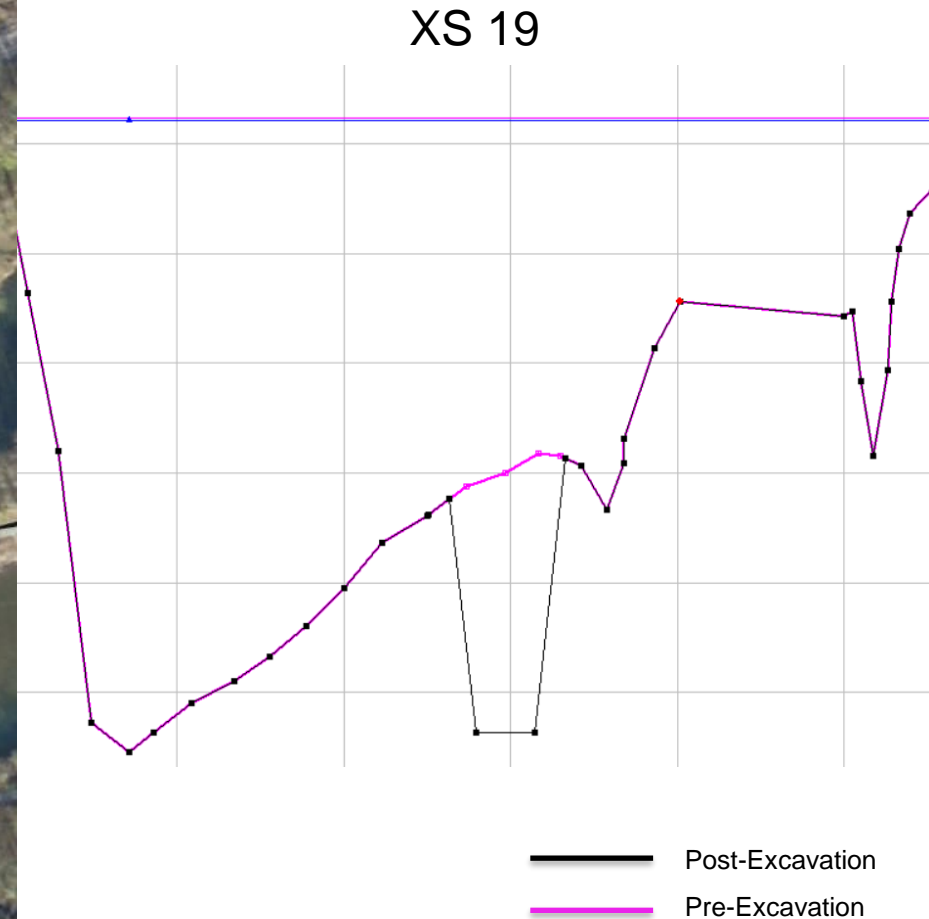
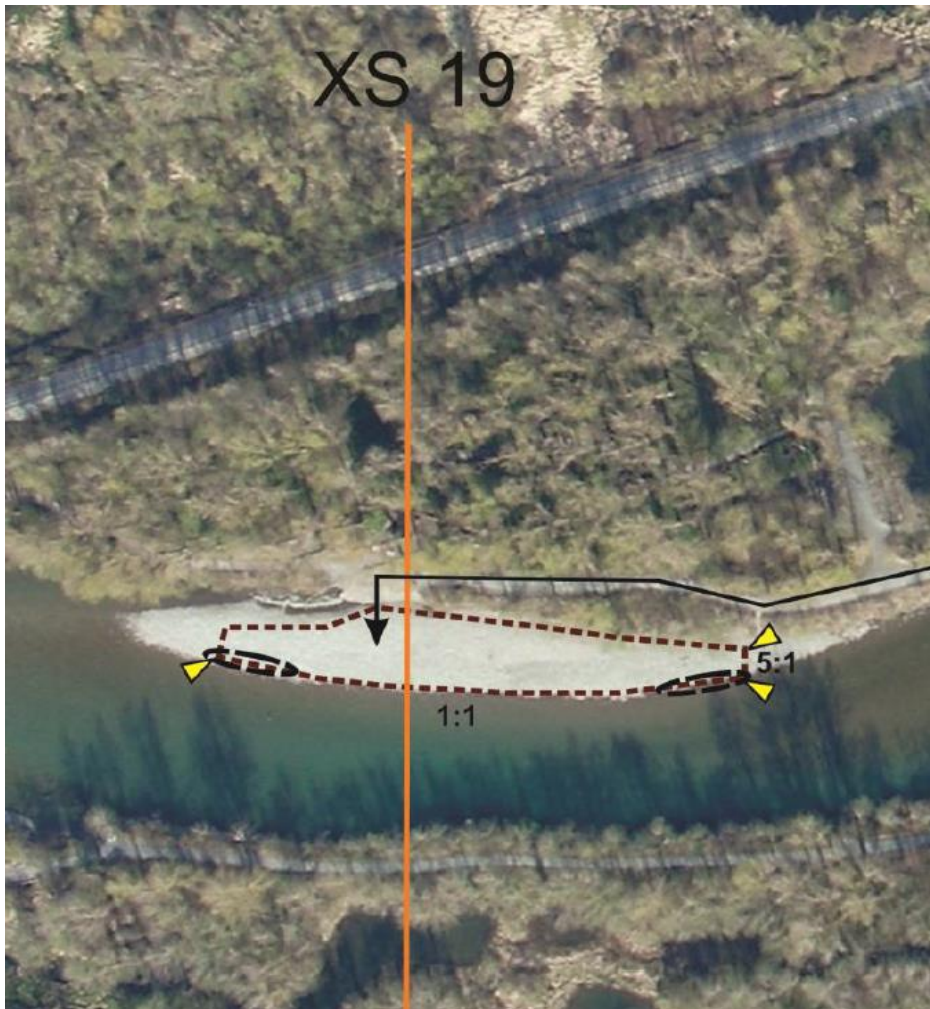
XS C22

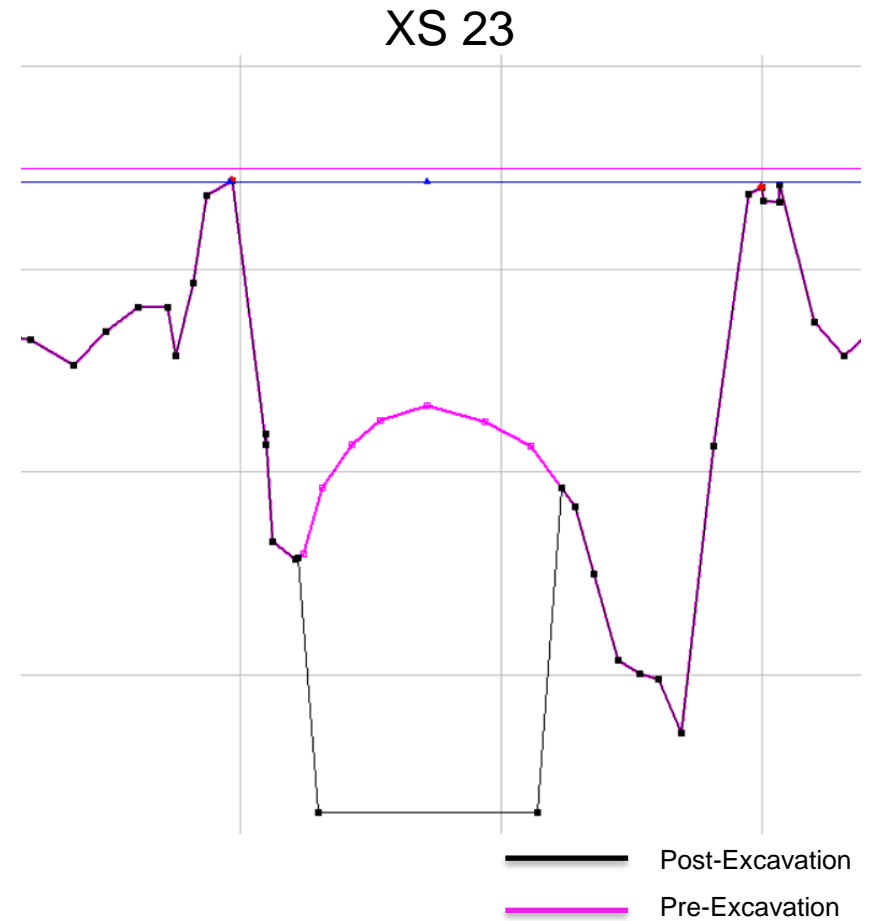




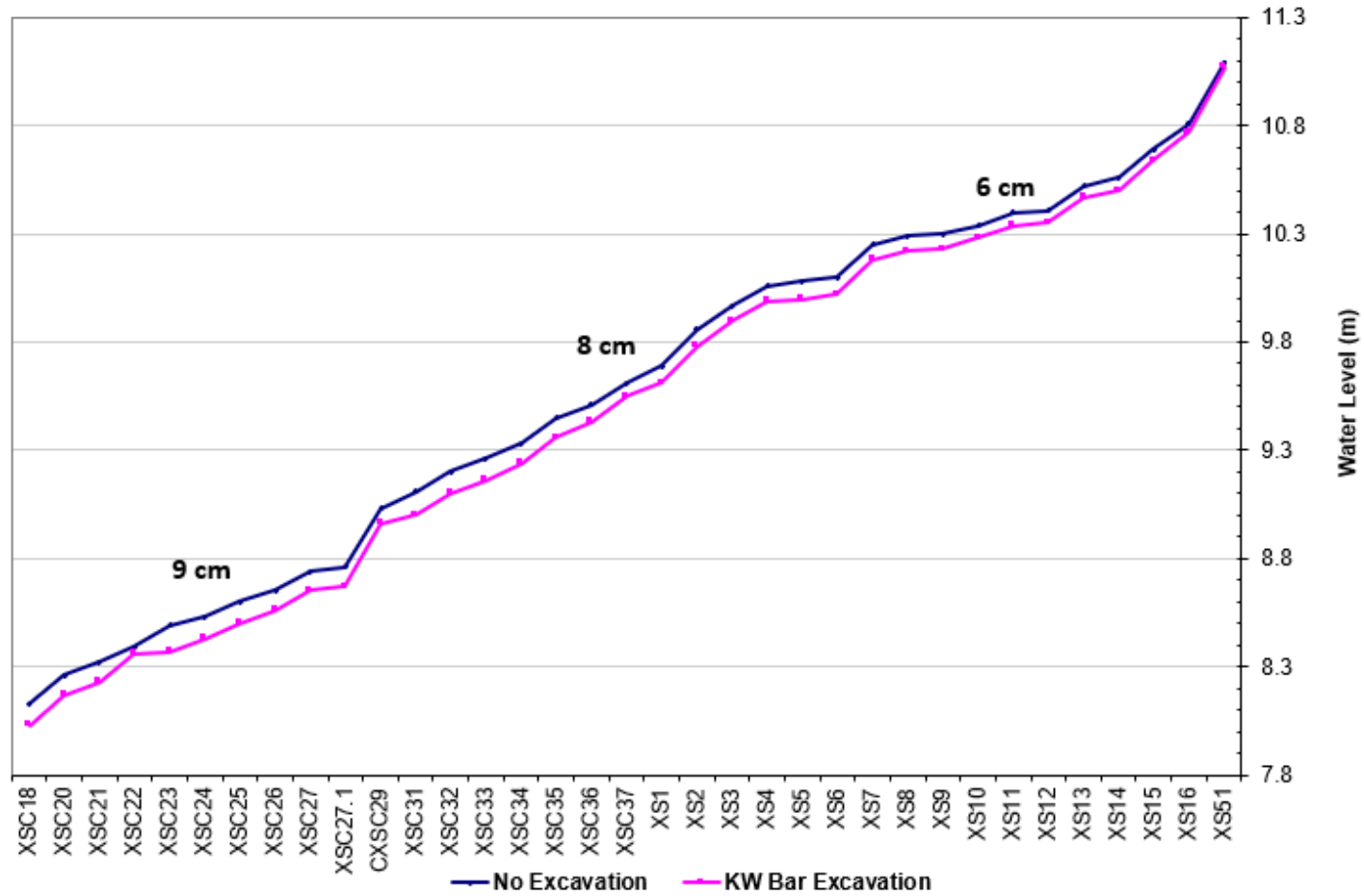








All Bars Removed



Effectiveness of Gravel Removal

Site	Excavation Volume (m ³)	Mean W.L. Reduction (cm)	Influence Reach	Reach Length (km)	Effectiveness (cm*km/10 ⁴ m ³)
Chadsey	25,000	4.4	XSC18-XS16	5.6	9.9
Boundary	19,000	1.4	XSC23-XS16	4.4	3.2
Powerline	8,000	1.8	XSC31-XS16	3.3	7.4
Salad A	6,000	0.9	XS1-XS16	2.3	3.5
Greendale	6,000	1.0	XS4-XS16	1.8	3.0
Yarrow	7,000	1.0	XS14-XS16	0.5	0.7
Railway	4,000	1.6	XS19-XS25	1.0	3.9
Bergman	20,000	9.6	XS22-XS28	1.0	4.8
Total (All bars)	95,000				

Vedder Canal Dike Freeboard Assessment

Cross Section	2020 Water Level Change with Gravel Removal (m)	Baseline		Post-Gravel Removal	
		L Dike F.B. (m)	R Dike F.B. (m)	L Dike F.B. (m)	R Dike F.B. (m)
C37	-0.06	1.67	0.94	1.73	1.00
C36	-0.08	1.67	0.70	1.75	0.78
C35	-0.09	1.81	0.94	1.90	1.03
C34	-0.09	1.86	0.95	1.95	1.04
C33	-0.10	2.02	1.10	2.12	1.20
C32	-0.10	2.07	1.48	2.17	1.58
C31	-0.11	2.23	1.66	2.34	1.77
C29	-0.07	2.17	1.74	2.24	1.81
C27.1	-0.09	2.75	3.02	2.84	3.11

Freeboard Requirement = 0.75 m

Vedder River Dike Freeboard

Cross Section	2020 Water Level Change with Gravel Removal (m)	L Dike F.B. (m)	R Dike F.B. (m)	L Dike F.B. Post Removal (m)	R Dike F.B. Post Removal (m)
16	-0.04	1.19	1.50	1.23	1.54
15	-0.05	0.98	1.11	1.03	1.16
14	-0.06	0.95	0.84	1.01	0.90
13	-0.05	0.76	0.58	0.81	0.63
12	-0.06	0.95	0.59	1.01	0.65
11	-0.06	0.88	0.50	0.94	0.56
10	-0.06	0.96	0.46	1.02	0.52
9	-0.07	0.98	0.40	1.05	0.47
8	-0.07	1.09	0.51	1.16	0.58
7	-0.07	1.06	0.85	1.13	0.92
6	-0.08	1.22	1.15	1.30	1.23
5	-0.08	1.23	1.22	1.31	1.30
4	-0.07	1.22	1.04	1.29	1.11
3	-0.07	1.33	0.73	1.40	0.80
2	-0.08	1.44	0.79	1.52	0.87
1	-0.08	1.58	0.96	1.66	1.04

Freeboard Requirement = 0.75 m

Thank you!

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Questions?



KERR WOOD LEIDAL
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May 7, 2020