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Rainwater Management Plan: Ella Stream, Nott Brook, Throup Stream, and Wright Road Creek Watersheds

Final Report - Appendices
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Appendix A

Hydrotechnical Inventory and Modelling Results

Table A-1: Hydraulic Structures Inventory

Watershed	Link Name[1]	Diameter/ Height (m)	Shape	Elevation (m)					Entrance Loss	Collector Road	Highway 14
				Upstream Invert	Downstream Invert	Upstream Crown	Downstream Crown	Ground (Spill Crest)			
Nott Brook	LNC01	0.9	Circular	11.5	11.3	12.4	12.2	14.1	0.90		Y
	LNC01	0.9	Circular	11.6	11.5	12.5	12.4	14.1	0.90		Y
	LNC02	0.8	Circular	27.1	26.3	27.9	27.1	29.4	0.50	Y	
	LNC02	1.55	Circular	26.4	25.6	28.0	27.2	29.4	0.50	Y	
	LNC03	1.2	Circular	32.1	31.9	33.3	33.1	34.3	0.90		
	LNC06	1.375	Circular	32.6	33.2	34.0	34.6	35.6	0.90		
	LNC08	0.6	Circular	36.3	36.3	36.9	36.9	37.9	0.90		
	LNC08	0.45	Circular	36.7	36.8	37.1	37.2	37.9	0.90		
	LNC08	0.6	Circular	36.1	36.1	36.7	36.7	37.9	0.90		
	LNC09A	0.6	Circular	36.8	36.6	37.4	37.2	38.0	0.90	Y	
	LNC09B	0.8	Circular	36.6	36.5	37.4	37.3	38.0	0.00		
	LNC09B2	0.6	Circular	36.6	36.5	37.2	37.1	38.0	0.90	Y	
	LNC09B2	0.6	Circular	36.7	36.5	37.3	37.1	38.0	0.90	Y	
	LNC10	1.05	Special	37.2	37.1	38.3	38.1	39.7	0.50		
	LNC11	0.9	Circular	40.3	40.3	41.2	41.2	42.8	0.90	Y	
	LNC12	0.525	Circular	40.5	40.5	41.0	41.0	41.1	0.90		
	LNC13	0.25	Circular	40.9	40.9	41.2	41.1	41.3	0.90		
	LNC14	0.45	Circular	41.6	41.8	42.1	42.2	43.2	0.50		
	LNCO4	0.9	Circular	32.9	32.5	33.8	33.4	34.4	0.90		
	LNCO4	1.05	Circular	32.7	32.5	33.8	33.5	34.4	0.90		
	LNT1C01	0.75	Circular	38.6	33.8	39.4	34.6	42.0	0.00		
	LNT1C02	0.8	Circular	39.5	39.3	40.3	40.1	40.9	0.50		
	LNT1C03	0.75	Circular	42.9	42.3	43.7	43.0	44.4	0.50	Y	
	LNT1C04	0.75	Circular	44.8	44.6	45.5	45.3	45.6	0.50		
	LNT1C05	0.75	Circular	45.3	45.2	46.1	46.0	46.3	0.50		
	LNT1C06	0.75	Circular	46.0	45.9	46.7	46.6	47.2	0.50		
	LNT1C07	0.75	Circular	46.1	46.1	46.9	46.9	47.5	0.50		
	LNT1C08	0.75	Circular	46.2	46.1	46.9	46.9	47.6	0.50		
	LNT1C09	0.91	Special	46.9	46.8	47.9	47.7	48.3	0.50		
	LNT2C01	0.75	Circular	41.6	33.1	42.3	33.9	44.0	0.00	Y	
	LNT2C02	0.6	Circular	43.2	42.9	43.8	43.5	44.0	0.90		
	LNT2C03	0.5	Circular	45.3	44.2	45.8	44.7	45.9	0.90		
	LNTW1C01	0.6	Circular	51.7	51.5	52.3	52.1	54.5	0.50		
	LNTW1C01	0.6	Circular	51.7	51.5	52.3	52.1	54.5	0.50	Y	
	LNTW1C02	0.45	Circular	56.0	55.7	56.5	56.2	58.4	0.50		
	LNTW2C01	0.3	Circular	48.2	47.5	48.5	47.8	49.6	0.50	Y	
	LNTWC01	0.9	Circular	15.8	13.9	16.7	14.8	18.5	0.50		Y
Throup Stream	LTC1	0.9	Circular	0.5	0.5	1.4	1.4	3.5	0.90		
	LTC2	0.75	Circular	0.2	0.2	0.9	0.9	3.5	0.90		
	LTC3	0.9	Circular	2.2	1.9	3.1	2.8	6.8	0.90		Y
	LTC3	0.6	Circular	0.2	0.1	0.8	0.7	6.8	0.90		Y
	LTC4	0.9	Circular	2.5	2.5	3.4	3.4	5.2	0.90		
	LTC5	0.6	Circular	22.4	21.7	23.0	22.3	27.7	0.90		
	LTC5	0.75	Circular	22.5	22.0	23.2	22.7	27.7	0.90	Y	
	LTC6	0.9	Circular	35.4	34.7	36.3	35.6	37.4	0.20		
	LTC7	0.9	Circular	40.7	37.0	41.6	37.9	42.0	0.00		
	LTC7A	0.9	Circular	42.2	40.7	43.1	41.6	44.0	0.50		
	LTC8	0.6	Circular	42.7	42.4	43.3	43.0	44.0	0.00	Y	
	LTT1C01	0.6	Circular	42.8	42.8	43.4	43.4	44.0	0.50		
Wright Road Creek	LWC01	0.9	Circular	8.6	8.3	9.5	9.2	12.0	0.90		
	LWC01	0.9	Circular	8.7	8.4	9.6	9.3	12.0	0.90		
	LWC02	0.6	Circular	10.4	9.7	11.0	10.3	13.5	0.90		
	LWC02	1.1	Special	10.0	9.3	11.1	10.4	13.5	0.90		
	LWC03	0.9	Circular	12.0	12.0	12.9	12.9	14.0	0.90		
	LWC03	0.9	Circular	11.9	11.9	12.8	12.8	14.0	0.90		
	LWC04	0.9	Circular	12.5	12.4	13.4	13.3	14.0	0.50	Y	
	LWC04	0.9	Circular	12.4	12.3	13.3	13.2	14.0	0.50	Y	
	LWC05	0.9	Circular	14.5	14.4	15.4	15.3	16.3	0.50		Y
	LWC05	0.6	Circular	14.6	14.6	15.2	15.2	16.3	0.50		Y
	LWC06	0.5	Circular	15.1	15.1	15.6	15.6	16.1	0.90		
	LWC06	0.5	Circular	15.1	15.0	15.6	15.5	16.1	0.90		
	LWC07	0.6	Circular	15.8	15.4	16.4	16.0	17.3	0.90		
	LWC07	0.6	Circular	15.9	15.4	16.5	16.0	17.3	0.90		

Note:
1 - See Figure 5-1 for culvert locations

Table A-2: Model Catchments

Watershed	Sub-watershed Name[1]	Model Node	Area (ha)	Existing Impervious (%)	Future Impervious (%)	Slope (m/m)	Width (m)	Infiltration Reference	Groundwater Reference
Nott Brook	Nott-1	NX12	35.3	27.3	40.1	0.07	11,761	Lawn	5-Loamy Sand
	Nott-2	NC11out	17.2	20.5	46.3	0.08	5,724	Lawn	3-Sandy Loam
	Nott-3-Trib2	NT2	22.5	28.4	40	0.09	7,489	Lawn	5-Loamy Sand
	Nott-3-Trib1	NT102	44.2	39.1	40	0.11	14,739	Lawn	5-Loamy Sand
	Nott-4	NC04out	30.5	24.9	54.6	0.03	10,177	Lawn	3-Sandy Loam
	Nott-5	NC02out	26.2	9.5	40	0.03	8,737	Lawn	3-Sandy Loam
	Nott-6	NC01out	26.0	12.8	40	0.05	5,194	first nation	2-Sandy Loam
	Nott-Tributary-1	NTW1C02in	19.3	18.7	40	0.13	6,426	Lawn	4-Loamy Sand
	Nott-Tributary-2	NTW1C01out	47.8	21.2	40	0.05	15,950	Lawn	3-Sandy Loam
	Nott-Tributary-3	NTWC01out	66.7	9.1	18.3	0.05	4,446	Agricultural	3-Sandy Loam
Throup Stream	Throup-1	TT1X01	31.7	30.5	44	0.04	10,575	Lawn	3-Sandy Loam
	Throup-2	TC6in	16.8	29.2	40.1	0.06	5,615	Lawn	3-Sandy Loam
	Throup-3	TC5out	27.0	13.7	40	0.11	9,013	Lawn	3-Sandy Loam
	Throup-4	TC4out	11.1	22.4	40	0.11	3,709	Lawn	6-Sand
	Throup-5	TC3out	2.1	22.4	40	0.10	686	Lawn	6-Sand
Wright Road Creek	Wright-1	WT01	9.6	23.5	40	0.01	3,200	Lawn	1-Loam
	Wright-2	WC07in	10.8	23.5	40	0.01	3,600	Lawn	1-Loam
	Wright-3	WConf	12.0	23.5	40	0.01	3,995	Lawn	1-Loam

Note:
1 - See Figure 4-3 for sub-watershed locations

XP-SWMM Model Details

Table A-3: Modelling Results: Existing Scenario

Watershed	Link Name[1]	Diameter/ Height (m)	Shape	Max Flow (m^3/s)			Maximum Water Elevation (US) m			Max Surcharge Depth (m)			Meet Criteria ?	Proposed Culvert
				Return Period			Return Period			Return Period				Recommended Upgraded Culvert Dia.
				10-Year	25-Year	100-Year	10-Year	25-Year	100-Year	10-Year	25-Year	100-Year		
Nott Brook	LNC01	0.9	Circular	1.9	2.1	2.3	13.9	14.2	14.5	1.46	1.75	2.08	N	1.4
	LNC01	0.9	Circular	1.6	1.7	1.9	13.9	14.2	14.5	1.41	1.70	2.03	N	1.2
	LNC02	0.8	Circular	0.3	0.4	0.4	27.6	27.6	27.7	-0.36	-0.30	-0.24	Y	0.6
	LNC02	0.8	Circular	2.6	2.8	3.0	27.6	27.6	27.7	-0.37	-0.31	-0.25	Y	1.4
	LNC03	1.2	Circular	2.9	3.2	3.4	34.0	34.2	34.5	0.75	0.97	1.20	N	1.6
	LNC06	1.375	Circular	1.2	1.4	1.7	34.5	34.7	35.0	0.52	0.73	1.03	N	1.2
	LNC08	0.6	Circular	0.5	0.5	0.6	37.2	37.4	37.5	0.31	0.44	0.61	N	0.7
	LNC08	0.6	Circular	0.1	0.2	0.2	37.2	37.4	37.5	0.10	0.23	0.40	N	0.5
	LNC08	0.6	Circular	0.6	0.6	0.7	37.2	37.4	37.5	0.52	0.65	0.82	N	0.8
	LNC09A	0.6	Circular	0.4	0.5	0.5	37.8	38.1	38.4	0.42	0.71	1.07	N	0.7
	LNC09B	0.8	Circular	0.8	0.9	1.0	37.5	37.7	38.0	0.18	0.39	0.66	N	0.9
	LNC09B2	0.6	Circular	0.4	0.4	0.5	37.8	38.1	38.4	0.62	0.91	1.27	N	0.7
	LNC09B2	0.6	Circular	0.4	0.4	0.5	37.8	38.1	38.4	0.49	0.78	1.14	N	0.7
	LNC10	1.05	Special	1.2	1.4	1.6	38.0	38.2	38.6	-0.29	-0.06	0.33	Y	1.2
	LNC11	0.9	Circular	0.8	0.9	1.0	41.1	41.2	41.4	-0.06	0.06	0.21	N	0.9
	LNC12	0.525	Circular	0.1	0.1	0.1	41.3	41.4	41.5	0.24	0.32	0.43	N	0.5
	LNC13	0.25	Circular	0.1	0.1	0.1	41.7	41.8	41.8	0.57	0.61	0.66	N	0.5
	LNC14	0.45	Circular	0.6	0.6	0.6	43.4	43.4	43.5	1.34	1.38	1.43	N	0.8
	LNCO4	0.9	Circular	0.8	0.8	0.9	34.4	34.6	34.9	0.59	0.82	1.12	N	0.9
	LNCO4	0.9	Circular	1.5	1.7	1.8	34.4	34.6	34.9	0.62	0.85	1.15	N	1.2
	LNT1C01	0.75	Circular	0.8	0.8	0.8	39.0	39.0	39.0	-0.37	-0.37	-0.37	Y	0.9
	LNT1C02	0.8	Circular	0.8	0.8	0.8	40.4	40.4	40.4	0.06	0.06	0.06	N	0.9
	LNT1C03	0.75	Circular	0.8	0.8	0.8	43.8	43.8	43.8	0.14	0.14	0.14	N	0.9
	LNT1C04	0.75	Circular	0.8	0.8	0.8	45.7	45.7	45.7	0.15	0.15	0.15	N	0.9
	LNT1C05	0.75	Circular	0.8	0.8	0.8	46.2	46.2	46.2	0.16	0.16	0.16	N	0.9
	LNT1C06	0.75	Circular	0.8	0.8	0.8	46.9	46.9	46.9	0.15	0.15	0.15	N	0.9
	LNT1C07	0.75	Circular	0.8	0.8	0.8	47.2	47.2	47.2	0.37	0.37	0.37	N	0.9
	LNT1C08	0.75	Circular	0.8	0.8	0.8	47.6	47.6	47.6	0.64	0.64	0.64	N	0.9
	LNT1C09	0.91	Special	1.0	1.0	1.0	48.3	48.3	48.3	0.48	0.48	0.48	N	1
	LNT2C01	0.75	Circular	0.8	0.9	1.1	42.0	42.0	42.1	-0.38	-0.34	-0.29	Y	0.9
	LNT2C02	0.6	Circular	0.8	0.9	1.1	44.9	45.4	46.0	1.17	1.59	2.25	N	0.9
	LNT2C03	0.5	Circular	0.8	0.9	1.1	48.7	50.1	52.2	2.90	4.26	6.36	N	0.9
	LNTW1C01	0.6	Circular	0.1	0.1	0.3	52.1	52.1	52.3	-0.25	-0.19	-0.01	Y	0.5
	LNTW1C02	0.45	Circular	0.2	0.2	0.3	56.5	56.7	56.7	0.10	0.21	0.29	N	0.5
	LNTW2C01	0.3	Circular	0.1	0.1	0.1	48.5	48.5	48.6	-0.01	0.03	0.09	N	0.5
	LNTWC01	0.9	Circular	1.9	2.3	2.6	17.5	17.9	18.5	0.84	1.27	1.84	N	1.4
Throup Stream	LTC1	0.9	Circular	1.3	1.4	1.5	2.2	2.4	2.5	0.86	0.98	1.14	N	1.2
	LTC2	0.75	Circular	1.3	1.4	1.5	3.3	3.6	4.0	2.41	2.71	3.12	N	1.2
	LTC3	0.9	Circular	1.1	1.1	1.2	3.8	4.2	4.7	0.72	1.10	1.62	N	1
	LTC3	0.9	Circular	0.4	0.4	0.4	3.8	4.2	4.7	3.05	3.43	3.95	N	0.7
	LTC4	0.9	Circular	1.9	2.1	2.3	4.8	5.3	6.0	1.38	1.90	2.64	N	1.4
	LTC5	0.6	Circular	0.7	0.8	0.9	23.2	23.4	23.8	0.12	0.39	0.79	N	0.8
	LTC5	0.6	Circular	0.7	0.9	1.0	23.2	23.4	23.8	-0.04	0.23	0.63	Y	0.8
	LTC6	0.9	Circular	1.4	1.6	1.9	36.7	37.0	37.5	0.39	0.66	1.18	N	1.2
	LTC7	0.9	Circular	0.8	0.9	1.1	41.2	41.2	41.3	-0.43	-0.39	-0.35	Y	0.9
	LTC7A	0.9	Circular	0.8	0.9	1.1	43.0	43.1	43.5	-0.08	0.00	0.37	Y	0.9
	LTC8	0.6	Circular	0.8	0.9	1.1	43.7	44.0	44.6	0.38	0.63	1.24	N	0.9
	LTT1C01	0.6	Circular	0.8	0.9	1.1	45.6	46.3	47.6	2.13	2.91	4.13	N	0.9
Wright Road Creek	LWC01	0.9	Circular	0.6	0.7	0.7	9.3	9.4	9.4	-0.19	-0.11	-0.11	Y	0.8
	LWC01	0.9	Circular	0.5	0.6	0.6	9.3	9.4	9.4	-0.25	-0.17	-0.17	Y	0.8
	LWC02	0.6	Circular	0.9	1.1	1.1	10.9	11.0	11.0	-0.11	-0.03	-0.03	Y	0.9
	LWC02	0.6	Circular	0.2	0.3	0.3	10.9	11.0	11.0	-0.22	-0.14	-0.14	Y	0.6
	LWC03	0.9	Circular	0.6	0.7	0.7	12.7	12.7	12.7	-0.22	-0.15	-0.15	Y	0.8
	LWC03	0.9	Circular	0.6	0.7	0.7	12.7	12.7	12.7	-0.17	-0.10	-0.10	Y	0.8
	LWC04	0.9	Circular	0.6	0.7	0.7	13.1	13.2	13.2	-0.27	-0.20	-0.20	Y	0.8
	LWC04	0.9	Circular	0.6	0.7	0.7	13.1	13.2	13.2	-0.25	-0.18	-0.18	Y	0.8
	LWC05	0.9	Circular	0.3	0.3	0.4	14.9	15.0	15.0	-0.51	-0.47	-0.42	Y	0.7
	LWC05	0.9	Circular	0.1	0.1	0.2	14.9	15.0	15.0	-0.32	-0.28	-0.22	Y	0.5
	LWC06	0.5	Circular	0.2	0.2	0.3	15.6	15.7	15.8	0.01	0.08	0.18	N	0.5
	LWC06	0.5	Circular	0.2	0.2	0.3	15.6	15.7	15.8	0.00	0.07	0.17	N	0.5
	LWC07	0.6	Circular	0.2	0.2	0.3	16.3	16.3	16.4	-0.17	-0.11	-0.03	Y	0.5
	LWC07	0.6	Circular	0.2	0.2	0.3	16.3	16.3	16.4	-0.18	-0.13	-0.04	Y	0.5

Table A-4: Modelling Results: Future Scenario

Watershed	Link Name[1]	Diameter/ Height (m)	Shape	Max Flow (m^3/s) Return Period			Maximum Water Elevation (US) m Return Period			Max Surcharge Depth (m) Return Period			Meet Criteria?	Proposed Culvert Recommended Upgraded Culvert Dia.
				10-Year	25-Year	100-Year	10-Year	25-Year	100-Year	10-Year	25-Year	100-Year		
Nott Brook	LNC01	0.9	Circular	2.0	2.1	2.3	14.0	14.2	14.5	1.54	1.81	2.14	N	1.4
	LNC01	0.9	Circular	1.6	1.8	1.9	14.0	14.2	14.5	1.49	1.76	2.09	N	1.2
	LNC02	0.8	Circular	0.3	0.4	0.5	27.6	27.7	27.7	-0.34	-0.29	-0.23	Y	
	LNC02	0.8	Circular	2.6	2.8	3.0	27.6	27.7	27.7	-0.35	-0.30	-0.24	Y	
	LNC03	1.2	Circular	3.0	3.2	3.4	34.0	34.3	34.5	0.80	1.00	1.23	N	1.6
	LNC06	1.375	Circular	1.3	1.5	1.7	34.6	34.8	35.1	0.57	0.77	1.07	N	1.2
	LNC08	0.6	Circular	0.5	0.6	0.6	37.3	37.4	37.6	0.34	0.47	0.64	N	0.7
	LNC08	0.6	Circular	0.1	0.2	0.2	37.3	37.4	37.6	0.13	0.26	0.43	N	0.5
	LNC08	0.6	Circular	0.6	0.7	0.7	37.3	37.4	37.6	0.55	0.68	0.85	N	0.8
	LNC09A	0.6	Circular	0.4	0.5	0.5	37.8	38.1	38.5	0.49	0.76	1.13	N	0.7
	LNC09B	0.8	Circular	0.8	0.9	1.0	37.6	37.8	38.1	0.22	0.43	0.70	N	0.9
	LNC09B2	0.6	Circular	0.4	0.5	0.5	37.8	38.1	38.5	0.69	0.96	1.33	N	0.7
	LNC09B2	0.6	Circular	0.4	0.5	0.5	37.8	38.1	38.5	0.56	0.83	1.20	N	0.7
	LNC10	1.05	Special	1.2	1.4	1.6	38.0	38.2	38.6	-0.24	-0.01	0.38	Y	
	LNC11	0.9	Circular	0.8	0.9	1.0	41.1	41.3	41.4	-0.04	0.08	0.23	N	0.9
	LNC12	0.525	Circular	0.1	0.1	0.1	41.3	41.4	41.5	0.25	0.33	0.44	N	0.5
	LNC13	0.25	Circular	0.1	0.1	0.1	41.7	41.8	41.8	0.58	0.61	0.67	N	0.5
	LNC14	0.45	Circular	0.6	0.6	0.6	43.4	43.4	43.5	1.35	1.38	1.44	N	0.8
	LNCO4	0.9	Circular	0.8	0.8	0.9	34.5	34.7	35.0	0.65	0.87	1.16	N	0.9
	LNCO4	0.9	Circular	1.6	1.7	1.8	34.5	34.7	35.0	0.68	0.90	1.19	N	1.2
	LNT1C01	0.75	Circular	0.8	0.8	0.8	39.0	39.0	39.0	-0.37	-0.37	-0.37	Y	
	LNT1C02	0.8	Circular	0.8	0.8	0.8	40.4	40.4	40.4	0.06	0.06	0.06	N	0.9
	LNT1C03	0.75	Circular	0.8	0.8	0.8	43.8	43.8	43.8	0.14	0.14	0.14	N	0.9
	LNT1C04	0.75	Circular	0.8	0.8	0.8	45.7	45.7	45.7	0.15	0.15	0.15	N	0.9
	LNT1C05	0.75	Circular	0.8	0.8	0.8	46.2	46.2	46.2	0.16	0.16	0.16	N	0.9
	LNT1C06	0.75	Circular	0.8	0.8	0.8	46.9	46.9	46.9	0.15	0.15	0.15	N	0.9
	LNT1C07	0.75	Circular	0.8	0.8	0.8	47.2	47.2	47.2	0.37	0.37	0.37	N	0.9
	LNT1C08	0.75	Circular	0.8	0.8	0.8	47.6	47.6	47.6	0.64	0.64	0.64	N	0.9
	LNT1C09	0.91	Special	1.0	1.0	1.0	48.3	48.3	48.3	0.48	0.48	0.48	N	1
	LNT2C01	0.75	Circular	0.8	0.9	1.1	42.0	42.0	42.1	-0.38	-0.34	-0.28	Y	
	LNT2C02	0.6	Circular	0.8	0.9	1.1	45.0	45.4	46.1	1.20	1.61	2.27	N	0.9
	LNT2C03	0.5	Circular	0.8	0.9	1.1	48.8	50.2	52.2	2.99	4.34	6.42	N	0.9
	LNTW1C01	0.6	Circular	0.1	0.2	0.3	52.1	52.1	52.4	-0.23	-0.18	0.06	Y	
	LNTW1C01	0.6	Circular	0.1	0.2	0.3	52.1	52.1	52.4	-0.24	-0.19	0.05	Y	
	LNTW1C02	0.45	Circular	0.2	0.3	0.3	56.6	56.7	56.8	0.14	0.24	0.31	N	0.6
	LNTW2C01	0.3	Circular	0.1	0.1	0.1	48.5	48.5	48.6	-0.01	0.03	0.09	N	0.5
	LNTWC01	0.9	Circular	2.0	2.3	2.6	17.6	18.0	18.5	0.90	1.32	1.84	N	1.4
Throup Stream	LTC1	0.9	Circular	1.3	1.4	1.6	2.3	2.4	2.6	0.89	1.01	1.17	N	1.2
	LTC2	0.75	Circular	1.3	1.4	1.6	3.4	3.7	4.1	2.49	2.78	3.20	N	1.2
	LTC3	0.9	Circular	1.0	1.1	1.2	3.9	4.3	4.8	0.81	1.19	1.72	N	1
	LTC3	0.9	Circular	0.4	0.4	0.4	3.9	4.3	4.8	3.14	3.52	4.05	N	0.7
	LTC4	0.9	Circular	1.9	2.1	2.3	4.9	5.4	6.1	1.49	2.01	2.76	N	1.4
	LTC5	0.6	Circular	0.7	0.8	0.9	23.2	23.5	23.9	0.14	0.42	0.81	N	0.8
	LTC5	0.6	Circular	0.7	0.9	1.0	23.2	23.5	23.9	-0.02	0.26	0.65	Y	0.8
	LTC6	0.9	Circular	1.4	1.6	1.9	36.7	37.0	37.5	0.41	0.67	1.20	N	1.2
	LTC7	0.9	Circular	0.8	1.0	1.1	41.2	41.2	41.3	-0.42	-0.39	-0.35	Y	
	LTC7A	0.9	Circular	0.8	1.0	1.1	43.0	43.1	43.5	-0.08	0.01	0.41	Y	
	LTC8	0.6	Circular	0.8	1.0	1.1	43.7	44.0	44.6	0.41	0.66	1.30	N	0.9
	LTT1C01	0.6	Circular	0.8	1.0	1.1	45.6	46.4	47.7	2.21	2.99	4.25	N	0.9
Wright Road Creek	LWC01	0.9	Circular	0.6	0.7	0.7	9.3	9.4	9.4	-0.18	-0.11	-0.11	Y	
	LWC01	0.9	Circular	0.6	0.6	0.6	9.3	9.4	9.4	-0.24	-0.17	-0.17	Y	
	LWC02	0.6	Circular	0.9	1.1	1.1	10.9	11.0	11.0	-0.10	-0.03	-0.03	Y	
	LWC02	0.6	Circular	0.2	0.3	0.3	10.9	11.0	11.0	-0.21	-0.14	-0.14	Y	
	LWC03	0.9	Circular	0.6	0.7	0.7	12.7	12.7	12.7	-0.21	-0.15	-0.15	Y	
	LWC03	0.9	Circular	0.6	0.7	0.7	12.7	12.7	12.7	-0.16	-0.10	-0.10	Y	
	LWC04	0.9	Circular	0.6	0.7	0.7	13.1	13.2	13.2	-0.26	-0.20	-0.20	Y	
	LWC04	0.9	Circular	0.6	0.7	0.7	13.1	13.2	13.2	-0.24	-0.18	-0.18	Y	
	LWC05	0.9	Circular	0.3	0.3	0.4	14.9	15.0	15.0	-0.51	-0.47	-0.41	Y	
	LWC05	0.9	Circular	0.1	0.1	0.2	14.9	15.0	15.0	-0.31	-0.27	-0.22	Y	
	LWC06	0.5	Circular	0.2	0.2	0.3	15.6	15.7	15.8	0.02	0.09	0.18	N	0.6
	LWC06	0.5	Circular	0.2	0.2	0.3	15.6	15.7	15.8	0.01	0.08	0.17	N	0.6
	LWC07	0.6	Circular	0.2	0.2	0.3	16.3	16.3	16.4	-0.16	-0.11	-0.03	Y	
	LWC07	0.6	Circular	0.2	0.2	0.3	16.3	16.3	16.4	-0.18	-0.12	-0.04	Y	

Note:
1 - See Figure 5-1 for culvert locations
2 - Proposed culvert size assumes hydraulic capacity governed by inlet control. Final sizing should be confirmed during detailed design.

Table A-5: Modelling Results: Future Storage Scenario

Watershed	Link Name[1]	Diameter/ Height (m)	Shape	Max Flow (m^3/s)			Maximum Water Elevation (US) m			Max Surcharge Depth (m)			Collector Road	Highway 14	Meet Criteria?	Proposed Culvert
				Return Period			Return Period			Return Period						Recommended Upgraded Culvert Dia.
				10-Year	25-Year	100-Year	10-Year	25-Year	100-Year	10-Year	25-Year	100-Year				
Nott Brook	LNC01	0.9	Circular	1.9	2.1	2.3	13.9	14.2	14.5	1.50	1.76	2.10	0	Y	N	1.4
	LNC01	0.9	Circular	1.6	1.7	1.9	13.9	14.2	14.5	1.45	1.71	2.05	0	Y	N	1.2
	LNC02	0.8	Circular	0.3	0.4	0.4	27.6	27.6	27.7	-0.36	-0.31	-0.24	Y	0	Y	
	LNC02	0.8	Circular	2.6	2.7	2.9	27.6	27.6	27.7	-0.37	-0.31	-0.25	Y	0	Y	
	LNC03	1.2	Circular	2.9	3.1	3.4	34.0	34.2	34.4	0.73	0.93	1.17	0	0	N	1.6
	LNC06	1.375	Circular	1.1	1.3	1.7	34.5	34.7	35.0	0.45	0.67	0.99	0	0	N	1.2
	LNC08	0.6	Circular	0.4	0.5	0.6	37.0	37.3	37.5	0.12	0.35	0.55	0	0	N	0.7
	LNC08	0.6	Circular	0.0	0.1	0.2	37.0	37.3	37.5	-0.09	0.14	0.34	0	0	Y	0.5
	LNC08	0.6	Circular	0.5	0.6	0.7	37.0	37.3	37.5	0.33	0.56	0.76	0	0	N	0.8
	LNC09A	0.6	Circular	0.3	0.4	0.5	37.5	37.9	38.3	0.10	0.50	0.94	Y	0	N	0.6
	LNC09B	0.8	Circular	0.6	0.8	1.0	37.3	37.6	37.9	-0.06	0.23	0.56	0	0	Y	
	LNC09B2	0.6	Circular	0.3	0.4	0.5	37.5	37.9	38.3	0.30	0.70	1.14	Y	0	N	0.6
	LNC09B2	0.6	Circular	0.3	0.4	0.5	37.5	37.9	38.3	0.17	0.57	1.01	Y	0	N	0.6
	LNC10	1.05	Special	1.0	1.2	1.5	37.8	38.0	38.4	-0.46	-0.23	0.18	0	0	Y	
	LNC11	0.9	Circular	0.6	0.8	1.0	41.0	41.2	41.4	-0.17	-0.02	0.16	Y	0	N	0.8
	LNC12	0.525	Circular	0.1	0.1	0.1	41.2	41.3	41.4	0.16	0.26	0.39	0	0	N	0.5
	LNC13	0.25	Circular	0.1	0.1	0.1	41.7	41.8	41.8	0.54	0.60	0.66	0	0	N	0.5
	LNC14	0.45	Circular	0.5	0.6	0.6	43.4	43.4	43.5	1.30	1.37	1.43	0	0	N	0.8
	LNCO4	0.9	Circular	0.7	0.8	0.9	34.3	34.6	34.9	0.54	0.78	1.09	0	0	N	0.9
	LNCO4	0.9	Circular	1.5	1.6	1.8	34.3	34.6	34.9	0.57	0.81	1.12	0	0	N	1.2
	LNT1C01	0.75	Circular	0.8	0.8	0.8	39.0	39.0	39.0	-0.37	-0.37	-0.37	0	0	Y	
	LNT1C02	0.8	Circular	0.8	0.8	0.8	40.4	40.4	40.4	0.06	0.06	0.06	0	0	N	0.9
	LNT1C03	0.75	Circular	0.8	0.8	0.8	43.8	43.8	43.8	0.14	0.14	0.14	Y	0	N	0.9
	LNT1C04	0.75	Circular	0.8	0.8	0.8	45.7	45.7	45.7	0.15	0.15	0.15	0	0	N	0.9
	LNT1C05	0.75	Circular	0.8	0.8	0.8	46.2	46.2	46.2	0.16	0.16	0.16	0	0	N	0.9
	LNT1C06	0.75	Circular	0.8	0.8	0.8	46.9	46.9	46.9	0.15	0.15	0.15	0	0	N	0.9
	LNT1C07	0.75	Circular	0.8	0.8	0.8	47.2	47.2	47.2	0.37	0.37	0.37	0	0	N	0.9
	LNT1C08	0.75	Circular	0.8	0.8	0.8	47.6	47.6	47.6	0.64	0.64	0.64	0	0	N	0.9
	LNT1C09	0.91	Special	1.0	1.0	1.0	48.3	48.3	48.3	0.48	0.48	0.48	0	0	N	1
	LNT2C01	0.75	Circular	0.8	0.9	1.1	42.0	42.0	42.1	-0.38	-0.34	-0.29	Y	0	Y	
	LNT2C02	0.6	Circular	0.8	0.9	1.1	45.0	45.4	46.0	1.20	1.60	2.26	0	0	N	0.9
	LNT2C03	0.5	Circular	0.8	0.9	1.1	48.8	50.1	52.2	2.99	4.30	6.37	0	0	N	0.9
	LNTW1C01	0.6	Circular	0.1	0.2	0.3	52.1	52.1	52.4	-0.23	-0.18	0.06	0	0	Y	
	LNTW1C01	0.6	Circular	0.1	0.2	0.3	52.1	52.1	52.4	-0.24	-0.19	0.05	0	0	Y	
	LNTW1C02	0.45	Circular	0.2	0.3	0.3	56.6	56.7	56.8	0.14	0.24	0.31	0	0	N	0.6
	LNTW2C01	0.3	Circular	0.1	0.1	0.1	48.5	48.5	48.6	-0.01	0.03	0.09	Y	0	N	0.5
	LNTWC01	0.9	Circular	2.0	2.3	2.6	17.6	18.0	18.5	0.90	1.31	1.84	0	Y	N	1.4
Throup Stream	LTC1	0.9	Circular	1.2	1.3	1.5	2.2	2.3	2.4	0.81	0.91	1.06	0	0	N	1.2
	LTC2	0.75	Circular	1.2	1.3	1.5	3.2	3.4	3.8	2.28	2.54	2.91	0	0	N	1.2
	LTC3	0.9	Circular	1.0	1.0	1.1	3.7	4.0	4.4	0.54	0.88	1.34	0	Y	N	1
	LTC3	0.9	Circular	0.4	0.4	0.4	3.7	4.0	4.4	2.87	3.21	3.67	0	Y	N	0.7
	LTC4	0.9	Circular	1.8	1.9	2.2	4.5	4.9	5.6	1.11	1.56	2.21	0	0	N	1.2
	LTC5	0.6	Circular	0.6	0.6	0.7	23.0	23.1	23.3	-0.07	0.03	0.27	0	0	Y	
	LTC5	0.6	Circular	0.5	0.6	0.8	23.0	23.1	23.3	-0.23	-0.13	0.11	0	0	Y	
	LTC6	0.9	Circular	1.1	1.3	1.5	36.5	36.6	36.8	0.21	0.29	0.50	0	0	N	1.2
	LTC7	0.9	Circular	0.5	0.6	0.7	41.1	41.1	41.1	-0.54	-0.51	-0.49	0	0	Y	
	LTC7A	0.9	Circular	0.5	0.6	0.7	42.8	42.8	42.9	-0.32	-0.26	-0.21	0	0	Y	
	LTC8	0.6	Circular	0.5	0.6	0.7	43.2	43.3	43.4	-0.11	-0.05	0.04	Y	0	N	0.8
	LTT1C01	0.6	Circular	0.5	0.6	0.7	44.0	44.2	44.6	0.56	0.78	1.13	0	0	N	0.8
Wright Road Creek	LWC01	0.9	Circular	0.6	0.7	0.7	9.3	9.4	9.4	-0.18	-0.11	-0.11	0	0	Y	
	LWC01	0.9	Circular	0.6	0.6	0.6	9.3	9.4	9.4	-0.24	-0.17	-0.17	0	0	Y	
	LWC02	0.6	Circular	0.9	1.1	1.1	10.9	11.0	11.0	-0.10	-0.03	-0.03	0	0	Y	
	LWC02	0.6	Circular	0.2	0.3	0.3	10.9	11.0	11.0	-0.21	-0.14	-0.14	0	0	Y	
	LWC03	0.9	Circular	0.6	0.7	0.7	12.7	12.7	12.7	-0.21	-0.15	-0.15	0	0	Y	
	LWC03	0.9	Circular	0.6	0.7	0.7	12.7	12.7	12.7	-0.16	-0.10	-0.10	0	0	Y	
	LWC04	0.9	Circular	0.6	0.7	0.7	13.1	13.2	13.2	-0.26	-0.20	-0.20	Y	0	Y	
	LWC04	0.9	Circular	0.6	0.7	0.7	13.1	13.2	13.2	-0.24	-0.18	-0.18	Y	0	Y	
	LWC05	0.9	Circular	0.3	0.3	0.4	14.9	15.0	15.0	-0.51	-0.47	-0.41	0	Y	Y	
	LWC05	0.9	Circular	0.1	0.1	0.2	14.9	15.0	15.0	-0.31	-0.27	-0.22	0	Y	Y	
	LWC06	0.5	Circular	0.2	0.2	0.3	15.6	15.7	15.8	0.02	0.09	0.18	0	0	N	0.5
	LWC06	0.5	Circular	0.2	0.2	0.3	15.6	15.7	15.8	0.01	0.08	0.17	0	0	N	0.5
	LWC07	0.6	Circular	0.2	0.2	0.3	16.3	16.3	16.4	-0.16	-0.11	-0.03	0	0	Y	
	LWC07	0.6	Circular	0.2	0.2	0.3	16.3	16.3	16.4	-0.18	-0.12	-0.04	0	0	Y	

Note:
1 - See Figure 5-1 for culvert locations
2 - Proposed culvert size assumes hydraulic capacity governed by inlet control. Final sizing should be confirmed during detailed design.

Table A-6: Modelling Results: Future Diversion 1 Scenario

Watershed	Link Name[1]	Diameter/ Height (m)	Shape	Max Flow (m^3/s) Return Period			Maximum Water Elevation (US) m Return Period			Max Surcharge Depth (m) Return Period			Meet Criteria ?	Proposed Culvert Recommended Upgraded Culvert Dia.
				10-Year	25-Year	100-Year	10-Year	25-Year	100-Year	10-Year	25-Year	100-Year		
Nott Brook	LNC01	0.9	Circular	1.96	2.14	2.34	13.9	14.2	14.5	1.52	1.80	2.13	N	1.4
	LNC01	0.9	Circular	1.60	1.75	1.91	13.9	14.2	14.5	1.47	1.75	2.08	N	1.2
	LNC02	0.8	Circular	0.33	0.39	0.45	27.6	27.7	27.7	-0.35	-0.29	-0.23	Y	0.6
	LNC02	0.8	Circular	2.62	2.80	2.97	27.6	27.7	27.7	-0.36	-0.30	-0.24	Y	1.4
	LNC03	1.2	Circular	2.95	3.19	3.42	34.0	34.2	34.5	0.79	0.99	1.22	N	1.6
	LNC06	1.375	Circular	1.30	1.51	1.80	34.6	34.8	35.1	0.55	0.74	1.06	N	1.2
	LNC08	0.6	Circular	0.49	0.55	0.63	37.3	37.4	37.6	0.34	0.47	0.64	N	0.7
	LNC08	0.6	Circular	0.13	0.18	0.23	37.3	37.4	37.6	0.13	0.26	0.43	N	0.5
	LNC08	0.6	Circular	0.61	0.65	0.71	37.3	37.4	37.6	0.55	0.68	0.85	N	0.8
	LNC09A	0.6	Circular	0.42	0.47	0.54	37.8	38.1	38.5	0.49	0.76	1.13	N	0.7
	LNC09B	0.8	Circular	0.81	0.91	1.03	37.6	37.8	38.1	0.22	0.43	0.70	N	0.9
	LNC09B2	0.6	Circular	0.41	0.46	0.52	37.8	38.1	38.5	0.69	0.96	1.33	N	0.7
	LNC09B2	0.6	Circular	0.41	0.46	0.52	37.8	38.1	38.5	0.56	0.83	1.20	N	0.7
	LNC10	1.05	Special	1.24	1.40	1.61	38.0	38.2	38.6	-0.24	-0.01	0.38	Y	1.2
	LNC11	0.9	Circular	0.78	0.91	1.02	41.1	41.3	41.4	-0.04	0.08	0.23	N	0.9
	LNC12	0.525	Circular	0.09	0.09	0.10	41.3	41.4	41.5	0.25	0.33	0.44	N	0.5
	LNC13	0.25	Circular	0.08	0.08	0.08	41.7	41.8	41.8	0.58	0.61	0.67	N	0.5
	LNC14	0.45	Circular	0.55	0.56	0.56	43.4	43.4	43.5	1.35	1.38	1.44	N	0.8
	LNCO4	0.9	Circular	0.76	0.83	0.90	34.4	34.7	35.0	0.63	0.85	1.15	N	0.9
	LNCO4	0.9	Circular	1.51	1.64	1.79	34.4	34.7	35.0	0.66	0.88	1.18	N	1.2
	LNT1C01	0.75	Circular	0.77	0.77	0.77	39.0	39.0	39.0	-0.37	-0.37	-0.37	Y	0.9
	LNT1C02	0.8	Circular	0.77	0.77	0.77	40.4	40.4	40.4	0.06	0.06	0.06	N	0.9
	LNT1C03	0.75	Circular	0.77	0.77	0.77	43.8	43.8	43.8	0.14	0.14	0.14	N	0.9
	LNT1C04	0.75	Circular	0.77	0.77	0.77	45.7	45.7	45.7	0.15	0.15	0.15	N	0.9
	LNT1C05	0.75	Circular	0.77	0.77	0.77	46.2	46.2	46.2	0.16	0.16	0.16	N	0.9
	LNT1C06	0.75	Circular	0.77	0.77	0.77	46.9	46.9	46.9	0.15	0.15	0.15	N	0.9
	LNT1C07	0.75	Circular	0.77	0.77	0.77	47.2	47.2	47.2	0.37	0.37	0.37	N	0.9
	LNT1C08	0.75	Circular	0.78	0.77	0.78	47.6	47.6	47.6	0.64	0.64	0.64	N	0.9
	LNT1C09	0.91	Special	0.96	0.96	0.96	48.3	48.3	48.3	0.48	0.48	0.48	N	1
	LNT2C01	0.75	Circular	0.81	0.92	1.06	42.0	42.0	42.1	-0.38	-0.34	-0.28	Y	0.9
	LNT2C02	0.6	Circular	0.81	0.92	1.06	45.0	45.4	46.1	1.20	1.61	2.27	N	0.9
	LNT2C03	0.5	Circular	0.81	0.92	1.07	48.8	50.2	52.2	2.99	4.34	6.42	N	0.9
	LNTW1C01	0.6	Circular	0.12	0.17	0.32	52.1	52.1	52.4	-0.23	-0.18	0.06	Y	0.5
	LNTW1C01	0.6	Circular	0.12	0.16	0.33	52.1	52.1	52.4	-0.24	-0.19	0.05	Y	0.5
	LNTW1C02	0.45	Circular	0.23	0.27	0.30	56.6	56.7	56.8	0.14	0.24	0.31	N	0.6
	LNTW2C01	0.3	Circular	0.04	0.05	0.06	48.4	48.4	48.5	-0.09	-0.06	-0.02	Y	0.5
	LNTWC01	0.9	Circular	1.96	2.28	2.64	17.5	18.0	18.5	0.88	1.29	1.84	N	1.4
Throup Stream	LTC1	0.9	Circular	1.32	1.43	1.56	2.3	2.4	2.6	0.89	1.01	1.17	N	1.2
	LTC2	0.75	Circular	1.33	1.43	1.57	3.4	3.7	4.1	2.49	2.78	3.20	N	1.2
	LTC3	0.9	Circular	1.02	1.09	1.20	3.9	4.3	4.8	0.81	1.19	1.72	N	1
	LTC3	0.9	Circular	0.41	0.41	0.44	3.9	4.3	4.8	3.14	3.52	4.05	N	0.7
	LTC4	0.9	Circular	1.92	2.10	2.35	4.9	5.4	6.1	1.49	2.01	2.76	N	1.4
	LTC5	0.6	Circular	0.69	0.75	0.85	23.2	23.5	23.9	0.14	0.42	0.81	N	0.8
	LTC5	0.6	Circular	0.72	0.87	1.03	23.2	23.5	23.9	-0.02	0.26	0.65	Y	0.8
	LTC6	0.9	Circular	1.42	1.63	1.90	36.7	37.0	37.5	0.41	0.67	1.20	N	1.2
	LTC7	0.9	Circular	0.84	0.95	1.09	41.2	41.2	41.3	-0.42	-0.39	-0.35	Y	0.9
	LTC7A	0.9	Circular	0.84	0.95	1.08	43.0	43.1	43.5	-0.08	0.01	0.41	Y	0.9
	LTC8	0.6	Circular	0.84	0.95	1.08	43.7	44.0	44.6	0.41	0.66	1.30	N	0.9
	LTT1C01	0.6	Circular	0.84	0.95	1.08	45.6	46.4	47.7	2.21	2.99	4.25	N	0.9
Wright Road Creek	LWC01	0.9	Circular	0.63	0.71	0.71	9.3	9.4	9.4	-0.18	-0.11	-0.11	Y	0.8
	LWC01	0.9	Circular	0.56	0.64	0.64	9.3	9.4	9.4	-0.24	-0.17	-0.17	Y	0.8
	LWC02	0.6	Circular	0.95	1.07	1.07	10.9	11.0	11.0	-0.10	-0.03	-0.03	Y	0.9
	LWC02	0.6	Circular	0.24	0.29	0.29	10.9	11.0	11.0	-0.21	-0.14	-0.14	Y	0.6
	LWC03	0.9	Circular	0.57	0.65	0.65	12.7	12.7	12.7	-0.21	-0.15	-0.15	Y	0.8
	LWC03	0.9	Circular	0.62	0.70	0.70	12.7	12.7	12.7	-0.16	-0.10	-0.10	Y	0.8
	LWC04	0.9	Circular	0.58	0.67	0.67	13.1	13.2	13.2	-0.26	-0.20	-0.20	Y	0.8
	LWC04	0.9	Circular	0.61	0.69	0.69	13.1	13.2	13.2	-0.24	-0.18	-0.18	Y	0.8
	LWC05	0.9	Circular	0.28	0.32	0.39	14.9	15.0	15.0	-0.51	-0.47	-0.41	Y	0.7
	LWC05	0.9	Circular	0.12	0.14	0.18	14.9	15.0	15.0	-0.31	-0.27	-0.22	Y	0.5
	LWC06	0.5	Circular	0.20	0.23	0.28	15.6	15.7	15.8	0.02	0.09	0.18	N	0.5
	LWC06	0.5	Circular	0.20	0.23	0.29	15.6	15.7	15.8	0.01	0.08	0.17	N	0.5
	LWC07	0.6	Circular	0.20	0.24	0.29	16.3	16.3	16.4	-0.16	-0.11	-0.03	Y	0.5
	LWC07	0.6	Circular	0.20	0.23	0.28	16.3	16.3	16.4	-0.18	-0.12	-0.04	Y	0.5

Note:
1 - See Figure 5-1 for culvert locations
2 - Proposed culvert size assumes hydraulic capacity governed by inlet control. Final sizing should be confirmed during detailed design.

Table A-7: Modelling Results: Future Diversion 2 Scenario

Watershed	Link Name[1]	Diameter/ Height (m)	Shape	Max Flow (m^3/s) Return Period			Maximum Water Elevation (US) m Return Period			MaxSurcharge Depth (m) Return Period			Meet Criteria ?	Proposed Culvert Recommended Upgraded Culvert Dia.
				10-Year	25-Year	100-Year	10-Year	25-Year	100-Year	10-Year	25-Year	100-Year		
Nott Brook	LNC01	0.9	Circular	2.0	2.1	2.3	13.9	14.2	14.5	1.52	1.80	2.13	N	1.4
	LNC01	0.9	Circular	1.6	1.8	1.9	13.9	14.2	14.5	1.47	1.75	2.08	N	1.2
	LNC02	0.8	Circular	0.3	0.4	0.4	27.6	27.7	27.7	-0.35	-0.29	-0.23	Y	0.6
	LNC02	0.8	Circular	2.6	2.8	3.0	27.6	27.7	27.7	-0.36	-0.30	-0.24	Y	1.4
	LNC03	1.2	Circular	3.0	3.2	3.4	34.0	34.2	34.5	0.79	0.99	1.22	N	1.6
	LNC06	1.375	Circular	1.3	1.5	1.8	34.6	34.8	35.1	0.55	0.75	1.06	N	1.2
	LNC08	0.6	Circular	0.5	0.6	0.6	37.3	37.4	37.6	0.34	0.47	0.64	N	0.7
	LNC08	0.6	Circular	0.1	0.2	0.2	37.3	37.4	37.6	0.13	0.26	0.43	N	0.5
	LNC08	0.6	Circular	0.6	0.7	0.7	37.3	37.4	37.6	0.55	0.68	0.85	N	0.8
	LNC09A	0.6	Circular	0.4	0.5	0.5	37.8	38.1	38.5	0.49	0.76	1.13	N	0.7
	LNC09B	0.8	Circular	0.8	0.9	1.0	37.6	37.8	38.1	0.22	0.43	0.70	N	0.9
	LNC09B2	0.6	Circular	0.4	0.5	0.5	37.8	38.1	38.5	0.69	0.96	1.33	N	0.7
	LNC09B2	0.6	Circular	0.4	0.5	0.5	37.8	38.1	38.5	0.56	0.83	1.20	N	0.7
	LNC10	1.05	Special	1.2	1.4	1.6	38.0	38.2	38.6	-0.24	-0.01	0.38	Y	1.2
	LNC11	0.9	Circular	0.8	0.9	1.0	41.1	41.3	41.4	-0.04	0.08	0.23	N	0.9
	LNC12	0.525	Circular	0.1	0.1	0.1	41.3	41.4	41.5	0.25	0.33	0.44	N	0.5
	LNC13	0.25	Circular	0.1	0.1	0.1	41.7	41.8	41.8	0.58	0.61	0.67	N	0.5
	LNC14	0.45	Circular	0.6	0.6	0.6	43.4	43.4	43.5	1.35	1.38	1.44	N	0.8
	LNCO4	0.9	Circular	0.8	0.8	0.9	34.4	34.6	35.0	0.64	0.85	1.15	N	0.9
	LNCO4	0.9	Circular	1.5	1.6	1.8	34.4	34.6	35.0	0.67	0.88	1.18	N	1.2
	LNT1C01	0.75	Circular	0.8	0.8	0.8	39.0	39.0	39.0	-0.37	-0.37	-0.37	Y	0.9
	LNT1C02	0.8	Circular	0.8	0.8	0.8	40.4	40.4	40.4	0.06	0.06	0.06	N	0.9
	LNT1C03	0.75	Circular	0.8	0.8	0.8	43.8	43.8	43.8	0.14	0.14	0.14	N	0.9
	LNT1C04	0.75	Circular	0.8	0.8	0.8	45.7	45.7	45.7	0.15	0.15	0.15	N	0.9
	LNT1C05	0.75	Circular	0.8	0.8	0.8	46.2	46.2	46.2	0.16	0.16	0.16	N	0.9
	LNT1C06	0.75	Circular	0.8	0.8	0.8	46.9	46.9	46.9	0.15	0.15	0.15	N	0.9
	LNT1C07	0.75	Circular	0.8	0.8	0.8	47.2	47.2	47.2	0.37	0.37	0.37	N	0.9
	LNT1C08	0.75	Circular	0.8	0.8	0.8	47.6	47.6	47.6	0.64	0.64	0.64	N	0.9
	LNT1C09	0.91	Special	1.0	1.0	1.0	48.3	48.3	48.3	0.48	0.48	0.48	N	1
	LNT2C01	0.75	Circular	0.8	0.9	1.1	42.0	42.0	42.1	-0.38	-0.34	-0.28	Y	0.9
	LNT2C02	0.6	Circular	0.8	0.9	1.1	45.0	45.4	46.1	1.20	1.61	2.27	N	0.9
	LNT2C03	0.5	Circular	0.8	0.9	1.1	48.8	50.2	52.2	2.99	4.34	6.42	N	0.9
	LNTW1C01	0.6	Circular	0.1	0.2	0.3	52.1	52.1	52.4	-0.23	-0.18	0.06	Y	0.5
	LNTW1C01	0.6	Circular	0.1	0.2	0.3	52.1	52.1	52.4	-0.24	-0.19	0.05	Y	0.5
	LNTW1C02	0.45	Circular	0.2	0.3	0.3	56.6	56.7	56.8	0.14	0.24	0.31	N	0.6
	LNTW2C01	0.45	Circular	0.4	0.4	0.4	49.0	49.1	49.2	0.50	0.57	0.67	N	0.7
	LNTWC01	0.9	Circular	2.3	2.6	2.6	17.9	18.4	18.5	1.26	1.74	1.84	N	1.4
Throup Stream	LTC1	0.9	Circular	1.3	1.4	1.6	2.3	2.4	2.6	0.89	1.01	1.17	N	1.2
	LTC2	0.75	Circular	1.3	1.4	1.6	3.4	3.7	4.1	2.49	2.78	3.20	N	1.2
	LTC3	0.9	Circular	1.0	1.1	1.2	3.9	4.3	4.8	0.81	1.19	1.72	N	1
	LTC3	0.9	Circular	0.4	0.4	0.4	3.9	4.3	4.8	3.14	3.52	4.05	N	0.7
	LTC4	0.9	Circular	1.9	2.1	2.3	4.9	5.4	6.1	1.49	2.01	2.76	N	1.4
	LTC5	0.6	Circular	0.7	0.8	0.9	23.2	23.5	23.9	0.14	0.42	0.81	N	0.8
	LTC5	0.6	Circular	0.7	0.9	1.0	23.2	23.5	23.9	-0.02	0.26	0.65	Y	0.8
	LTC6	0.9	Circular	1.4	1.6	1.9	36.7	37.0	37.5	0.41	0.67	1.20	N	1.2
	LTC7	0.9	Circular	0.8	1.0	1.1	41.2	41.2	41.3	-0.42	-0.39	-0.35	Y	0.9
	LTC7A	0.9	Circular	0.8	1.0	1.1	43.0	43.1	43.5	-0.08	0.01	0.41	Y	0.9
	LTC8	0.6	Circular	0.8	1.0	1.1	43.7	44.0	44.6	0.41	0.66	1.30	N	0.9
	LTT1C01	0.6	Circular	0.8	1.0	1.1	45.6	46.4	47.7	2.21	2.99	4.25	N	0.9
Wright Road Creek	LWC01	0.9	Circular	0.6	0.7	0.7	9.3	9.4	9.4	-0.18	-0.11	-0.11	Y	0.8
	LWC01	0.9	Circular	0.6	0.6	0.6	9.3	9.4	9.4	-0.24	-0.17	-0.17	Y	0.8
	LWC02	0.6	Circular	0.9	1.1	1.1	10.9	11.0	11.0	-0.10	-0.03	-0.03	Y	0.9
	LWC02	0.6	Circular	0.2	0.3	0.3	10.9	11.0	11.0	-0.21	-0.14	-0.14	Y	0.6
	LWC03	0.9	Circular	0.6	0.7	0.7	12.7	12.7	12.7	-0.21	-0.15	-0.15	Y	0.8
	LWC03	0.9	Circular	0.6	0.7	0.7	12.7	12.7	12.7	-0.16	-0.10	-0.10	Y	0.8
	LWC04	0.9	Circular	0.6	0.7	0.7	13.1	13.2	13.2	-0.26	-0.20	-0.20	Y	0.8
	LWC04	0.9	Circular	0.6	0.7	0.7	13.1	13.2	13.2	-0.24	-0.18	-0.18	Y	0.8
	LWC05	0.9	Circular	0.3	0.3	0.4	14.9	15.0	15.0	-0.51	-0.47	-0.41	Y	0.7
	LWC05	0.9	Circular	0.1	0.1	0.2	14.9	15.0	15.0	-0.31	-0.27	-0.22	Y	0.5
	LWC06	0.5	Circular	0.2	0.2	0.3	15.6	15.7	15.8	0.02	0.09	0.18	N	0.5
	LWC06	0.5	Circular	0.2	0.2	0.3	15.6	15.7	15.8	0.01	0.08	0.17	N	0.5
	LWC07	0.6	Circular	0.2	0.2	0.3	16.3	16.3	16.4	-0.16	-0.11	-0.03	Y	0.5
	LWC07	0.6	Circular	0.2	0.2	0.3	16.3	16.3	16.4	-0.18	-0.12	-0.04	Y	0.5

Note:
1 - See Figure 5-1 for culvert locations
2 - Proposed culvert size assumes hydraulic capacity governed by inlet control. Final sizing should be confirmed during detailed design.

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Appendix B

Environmental Inventory and Proper Functioning Condition Assessment – CD

PFC Assessment Results

CONTENTS

PFC Assessment Results

Nott Brook PFC Assessment

Nott Brook (Channel A) – Main Channel

Summary of PFC ratings for each reach from mouth (Reach 1) to headwaters (Reach 13).

Reach	PFC Rating	Restoration
1	Proper Functioning Condition	Rainwater management
2	Proper Functioning Condition	Rainwater management, all terrain vehicle management
3	Nonfunctional	Erosion, instream energy dissipation, Invasive species, riparian plantings, exclusionary fencing, rainwater management
4	Functional-at-Risk (No Apparent Trend)	Erosion, instream energy dissipation, Invasive species, mowing, riparian plantings, rainwater management
5	Proper Functioning Condition	Riparian plantings, rainwater management
6	Functional-at-Risk (Downward Trend)	Invasive species, erosion, instream energy dissipation, riparian plantings, exclusionary fencing, education, rainwater management
7	Proper Functioning Condition	Invasive species, riparian plantings, rainwater management
8	Functional-at-Risk (No Apparent Trend)	Invasive species, riparian plantings, daylighting, rainwater management
9	Proper Functioning Condition	Invasive species, riparian plantings, daylighting, instream habitat, rainwater management
10	Proper Functioning Condition	Invasive species, riparian plantings, mowing, daylighting
11	Proper Functioning Condition	Riparian plantings, re-contouring, rainwater management
12	Nonfunctional	Riparian plantings, instream energy dissipation, rainwater management
13	Proper Functioning Condition	Invasive species, rainwater management

Nott Brook A (main channel)

Reach 1: Juan de Fuca Strait outlet to the Tributary (Channel B) confluence.

Rating: Proper Functioning Condition

Reach 1 is approximately 100m long and extends through a relatively undisturbed area from the outlet into Juan de Fuca to the tributary (Channel B) confluence.

The channel is a Rosgen "G6" channel, and is incised, deep, and overwide in places. The reach is very dynamic as it is influenced by tides and is exposed to Juan de Fuca Strait. Piles of large wood are present at the downstream end of this channel collected from high tides and deposited at the mouth. Erosion is evident, but is expected in this location due to its dynamic nature.

The riparian area in this reach is wide, greater than 30m on both sides, and has a diversity of vegetation species. In some areas, the banks of the creek are too steep to support vegetation but the majority of the reach has good cover. Vegetation species present include the following: Douglas fir (*Pseudotsuga menziesii*), Western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), red elderberry (*Sambucus racemosa* ssp. *pubens*), salmonberry (*Rubus spectabilis*), Himalayan blackberry (*Rubus armeniacus*), sword fern (*Polystichum munitum*), common horsetail (*Equisetum arvense*), False lily-of-the-valley (*Maianthemum dilatatum*), skunk cabbage (*Lysichiton americanum*), seashore saltgrass (*Distichlis spicata* var. *spicata*), sedges (*Carex* sp.), and various grasses.

Rating: This reach is in Proper Functioning Condition as it displays the characteristics necessary to be able to withstand high stream flow events. However, some erosion is occurring in the upper portion of the reach.

Recommendations: While it is a dynamic reach as a result of its close proximity to the ocean, upstream management of rainwater will aid in reducing any excessive erosion that may occur.

Lotic Checklist

Name of Riparian-Wetland Area:		**Nott Brook-Main Channel**	
Date:	**09-07-23**	Segment/Reach ID:	**Reach 1A: Juan de Fuca strait outlet to tributary confluence**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen "G6"

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity S
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444130 5356914 to 0444136 5356908

Potential channel type:
The potential Rosgen channel type is Rosgen "G6" to match the landscape setting.

Present channel type:
The present Rosgen channel type is a "G6" channel. It is tidally influenced at its mouth and therefore experiences wave action from Juan de Fuca straight.

Constraints:
No obvious constraints were apparent. The riparian zone is wide and residential properties are well away from the creek and floodplain area.

Potential Restoration:
Some erosion is occurring in the upper portion of this reach. While it is a dynamic reach as a result of its close proximity to the ocean, upstream management of rainwater will aid in reducing any excessive erosion that may occur.

Notes:
1. The channel is incised and does not reach the floodplain above bankfull; however this is not uncommon for "G" channels.
3. The channel is over, and deep. It flows in both directions at the bottom end of the reach as a result of ocean infiltration during high tides. Water concentrates here.
4. The riparian zone is narrowing, portions of the bank are very steep preventing growth in these locations.
5. Erosion is occurring from flows coming from the upstream portions of the watershed and from logs being pushed into the channel mouth from wave action.
11. The channel experience tidal events too and is a dynamic system.
12. More wood in the channel would be expected; it is starting to accumulate especially close to the mouth where logs have been pushed up the beach by waves.
17. Deposition is occurring from tidal action but is to be expected in this marine-influenced area.

Vegetation:

Common Name	**Scientific Name**
Bigleaf maple	*Acer macrophyllum*
Common horsetail	*Equisetum arvense*
Douglas fir	*Pseudotsuga menziesii*
False lily-of-the-valley	*Maianthemum dilatatum*
Grasses	
Himalayan blackberry	*Rubus discolor*
Red Alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Seashore saltgrass	*Distichlis spicata* var. *spicata*
Sedges	*Carex* sp.
Skunk Cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*

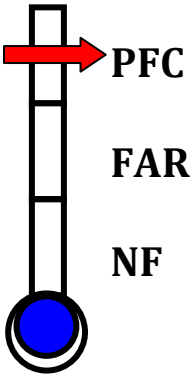
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Reach 2: The tributary (Channel B) confluence to the wetland area downstream of West Coast Road.

Rating: Proper Functioning Condition

Reach 2 is approximately 500m long and includes the area from the confluence with Channel B to the downstream edge of the wetland near West Coast Road. The channel is a Rosgen "C6" and is sinuous and able to access its expansive floodplain.

The channel is located in a large area of a relatively undisturbed wilderness and is not constrained. Residential areas, roads, and other buildings and infrastructure related to human activities are currently not influencing this reach (except what is coming from the upstream portion of the watershed). However, evidence of ATV activity present in the area although currently not adjacent to the creek. This activity should be kept out of the riparian zone so as not to damage this section of Nott Brook.

The riparian area is very wide in this reach, greater than 30m on either side and has a variety of vigorous vegetation. Vegetation species found in this reach include the following: Douglas fir (*Pseudotsuga menziesii*), Western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), Indian plum (*Oemleria cerasiformis*), red elderberry (*Sambucus racemosa* ssp. *pubens*), salmonberry (*Rubus spectabilis*), Himalyan blackberry (*Rubus armeniacus*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), common horsetail (*Equisetum arvense*), False lily-of-the-valley (*Maianthemum dilatatum*), skunk cabbage (*Lysichiton americanum*), sedges (*Carex* sp.), and various grasses.

Rating: Due to its unconstrained nature and expansive riparian, this reach is in Proper Functioning Condition.

Recommendations: In order to maintain this reach in its currently functional condition, ATV activity should be kept out of the riparian area. Other than the ATV management, the reach should be left as is, as it is able to respond to stresses it may experience. As development occurs in the upper watershed rainwater management should be implemented to maintain the health of the downstream sections.

Lotic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**		
Date:	**09-07-23**	Segment/Reach ID:	**Reach 2A: The tributary confluence to the wetland area downstream of West Coast Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen "C6"

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
√			14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444136 5356908 to 0445106 5357260

Potential channel type:
The potential Rosgen channel type is Rosgen "C6" with floodplain access and sinuosity.

Present channel type:
The present Rosgen channel type is a "C6" channel and is in balance with the landscape setting.

Constraints:
No obvious constraints were apparent. The riparian zone is wide and residential properties are well away from the creek and floodplain area.

Potential Restoration:
This reach should be maintained as is. All-Terrain Vehicle (ATV) trails were observed in the vicinity although currently far from the creek and floodplain/riparian area. ATV activity should not be permitted in the riparian area so as to protect the creek from damage.

Vegetation:

Common Name	**Scientific Name**
Bigleaf maple	*Acer macrophyllum*
Common horsetail	*Equisetum arvense*
Douglas fir	*Pseudotsuga menziesii*
False lily-of-the-valley	*Maianthemum dilatatum*
Grasses	
Himalayan blackberry	*Rubus discolor*
Indian Plum	*Oemleria cerasiformis*
Red Alder	*Alnus rubra*
Lady fern	*Athyrium filix-femina*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Sedges	*Carex* sp.
Skunk Cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*

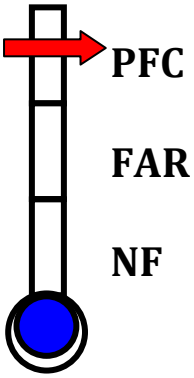
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

T'Sou-Ke First Nation

Reaches on the T'Sou-Ke First Nation lands were not assessed as they are outside the scope of this project.

Reach 3: West Coast Road to Maple Avenue S.

Rating: Nonfunctional

Reach 3 is approximately 890m, through primarily agricultural fields, from West Coast Road to Maple Avenue S. At the downstream end, two large culverts transport flows into a big wetland on T'Sou-Ke First Nation lands below West Coast Road. Upstream of the road, the stream flows through a small area of riparian vegetation before it is replaced by agricultural fields for the majority of the reach.

Through the agricultural fields, the riparian zone is minimal, if present at all, as a result of heavy trampling and grazing from horses. The channel itself through this area is downcut and the banks are eroded. Where the horses have created stream crossings, portions of the adjacent banks have fallen in. Upstream of the culverted stream crossing between pastures, multiple headcuts are forming and eroding the channel base. While clay layers area slowing the erosion progression, they are not preventing it. Furthermore, the channel is eroding around the inlet of the culverts in the pastures.

Upstream of the agricultural fields, the riparian zone is thicker and more diverse in species composition. However, evidence of erosion is still present. Additionally, an old bridge has collapsed (a result of a felled

tree due to a wind storm) that could potentially lead to constriction of the flow through this channel in high flows. A small path is found adjacent to the creek edge and some piles of yard waste are present.

While vegetation species in this reach are diverse, the riparian zone is concentrated in the upper 1/3 rd of the reach, with a small portion near West Coast Road. For the majority of this reach, agricultural grasses are dominant and the riparian zone is less than 2m wide, if it is present at all. The species that are present include the following: Douglas fir (*Pseudotsuga menziesii*), Western red cedar (*Thuja plicata*), Western hemlock (*Tsuga heterophylla*), Bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), Indian plum (*Oemleria cerasiformis*), Laurel sp., red elderberry (*Sambucus racemosa* ssp. *pubens*), salmonberry (*Rubus spectabilis*), Himalayan blackberry (*Rubus discolor*), Scotch broom (*Cytisus scoparius*), sword fern (*Polystichum munitum*), stinging nettle (*Urtica dioica*), common horsetail (*Equisetum arvense*), English ivy (*Hedera helix*), False lily-of-the-valley (*Maianthemum dilatatum*), cattails (*Typha latifolia*), small-flowered bulrush (*Scirpus microcarpus*), and agricultural grasses.

Rating: As a result of the channel morphology, currently a ditch, the heavy erosion, and the minimal riparian-wetland zone, this reach is characterized as Nonfunctional.

Recommendations: Historically, the stream in this location would likely have been a Rosgen "C4" channel. This Rosgen classification ("C4") is the potenial for this reach. However, for this reach to obtain its potential, the erosion must be reduced, the riparian zone widened, and the channel bottom raised.

Opportunities to improve the function of this reach are available. The headcuts should be fixed by installing rock weirs to capture sediment and re-build the channel bottom. Other channel modifications such as in-channel ponds to dissipate energy, and creating floodplain terraces via bank excavation, should also be considered. Exclusionary fencing should be considered to reduce trampling and grazing and allow riparian vegetation to recover. Funding grants may be available to aid in this endeavour. Designated crossings should be installed to allow the horses to access pasture on both sides of the channel without eroding the banks. Once fencing is in place, riparian-wetland vegetation should be planted to provide bank stability. Landowner education, such as a Proper Functioning Condition and Grazing workshop, and other tools for increasing awareness about stream and riparian function and the benefits to the community, should be implemented. This may be an area in which the Streamkeepers could provide support. Future re-development of this part of the watershed may provide the opportunity to protect a corridor through this section of Nott Brook.

Overall, this reach is in poor condition and changes to the channel have been observed recently. Adjacent landowners have noted that although the amount of rain received has been less than normal, the velocity and intensity of the flows through Nott Brook in this area have been increased. This suggests that the upper watershed is supplying more water than historically which may be the result of development that has not adequately implemented rainwater management in the upper watershed. Detention and treatment of rainwater is required to ensure that the channels in this watershed are as functional as possible.

Lotic Checklist

Name of Riparian-Wetland Area:		**Nott Brook-Main Channel**	
Date:	**09-04-23**	Segment/Reach ID:	**Reach 3A: West Coast Road to Maple Avenue S.**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen "C4"

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
	√		8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
	√		9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
	√		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
	√		16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 21' 59.5" W 123° 44' 29.0" to N 48° 22' 19.8" W 123° 44' 03.6"

Potential channel type:
The potential Rosgen channel type is Rosgen "C4" to match the landscape setting.

Present channel type:
The present Rosgen channel type is a ditch that is downcutting and being eroded. The upstream portion of the reach close to Maple Avenue S. is in slightly better condition with more riparian vegetation.

Constraints:
The lower 2/3rds of this reach is heavily trampled by horse activity. Erosion is evident and headcuts are forming as the water cuts through the channel bottom. Riparian vegetation is essentially non-existent for 2/3rds of the reach as well. In the upper portion, riparian vegetation is thicker but residential properties line both sides of the channel.

Potential Restoration:
Opportunities for improving this reach include exclusionary fencing in the horse pasture with a hardened crossing so the horses can cross the channel to other pastures. Landowner education will be beneficial to create awareness about creek and riparian zone function and why they are beneficial for the community. In channel ponds, and rock weirs will help prevent further headcuts and mitigate, to an extent, headcuts that are already present. Excavating floodplain areas by bringing the banks back to a more natural slope will also benefit this reach by improving floodplain access and reducing erosion risk This location may be a good place to involve the streamkeepers and work with landowners.

Notes:
1. The channel is heavily downcut and experiences high flows.
4. The riparian zone is very narrow (although it widens in the upper third of the reach) and the channel is downcut reducing the ability for riparian vegetation growth.
5. Horses are grazing and trampling the banks and rainwater flows are high from impervious areas upstream.

6. Where riparian vegetation is present (primarily in the upstream portion), there is a diverse age-class.
8. Grass is the predominant vegetative species. The upstream 1/3rd has more soil moisture than downstream but not enough for a "yes" answer.
9. The upstream portion has more vegetation.
10. Riparian plants are vigorous where present (minimal). Horses are overgrazing the downstream portion.
11. The channel is heavily downcut and headcuts are present. Vegetation is minimal especially in the lower 2/3rds.
12. The upper section does have some wood but there is not enough for the majority of the reach.
13. Channel is downcut and there is very minimal floodplain; headcuts are present.
16. Multpile headcuts are present and the channel is not vertically stable.
17. Excessive erosion is occurring and there are increased flows from upslope areas.

Vegetation:

Common Name	**Scientific Name**
Bigleaf maple	*Acer macrophyllum*
Cattails	*Typha latifolia*
Common horsetail	*Equisetum arvense*
Douglas fir	*Pseudotsuga menziesii*
English ivy	*Hedera helix*
False lily-of-the-valley	*Maianthemum dilatatum*
Grasses	
Himalayan blackberry	*Rubus discolor*
Indian plum	*Oemleria cerasiformis*
Laurel sp.	
Red Alder	*Alnus rubra*

Common Name	Scientific Name
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Scotch broom	*Cytisus scoparius*
Skunk Cabbage	*Lysichiton americanum*
Small-flowered bulrush	*Scirpus microcarpus*
Stinging nettle	*Urtica dioica*
Sword fern	*Polystichum munitum*
Western hemlock	*Tsuga heterophylla*
Western red cedar	*Thuja plicata*

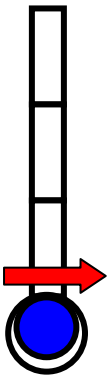
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

_√_ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _√_
No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
_√_ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Reach 4: Sooke Centennial Park (Maple Avenue S.) to the double culverts under Guardian Road crossing

Rating: Functional-at-Risk (No Apparent Trend)

Reach 4 is approximately 390 m long extending from Sooke Centennial Park on Maple Avenue South to where Nott Brook crosses under Guardian Road through two large culverts.

Presently, this channel exhibits Rosgen “G4” characteristics although historically would have likely been a “C” channel with more floodplain access and not as deep (due to downcutting). The channel is currently constrained by roads, culverts, and residential development. As such, the channel form is unlikely to be able change substantially, thereby resulting in a potential Rosgen channel type of “G4” as it is presently. However, this channel is not at its full potential as a result of erosion, constriction by roads and

armoured banks, and lateral scour. While it is attempting to recover by creating some floodplain areas within the deepened channel it will not be able to reach its full potential on its own.

The physical structure of this channel is out of balance with the landscape setting in that the width/depth ratio is too large. The channel has been downcut or dug-out historically, creating a gully-like shape. Additionally, this portion of Nott Brook is receiving more flows than the channel can manage. Consequently, erosion of the banks is evident especially in the area near the culverts under Guardian Road.

Vegetation in the area is diverse although at times the riparian area is narrow. Some of the vegetation species include the following: Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), Western hemlock (*Tsuga heterophylla*), Western red cedar (*Thuja plicata*), bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), Western flowering dogwood (*Cornus nuttallii*), yellow cedar (*Chamaecypars nootkatensis*), Indian plum (*Oemleria cerasiformis*), black hawthorn (*Crataegus douglasii*), Oceanspray (*Holodiscus discolor*), red elderberry (*Sambucus racemosa* ssp. *pubens*), salmonberry (*Rubus spectabilis*), English ivy (*Hedera helix*), False lily-of-the-valley (*Maiathemum dilatatum*), Pacific bleeding heart (*Dicentra formosa*), sword fern (*Polystichum munitum*), skunk cabbage (*Lysichiton americanum*), small-flowered bulrush (*Scirpus microcarpus*), and Pacific water parsely (*Oenanthe sarmentosa*). For a complete list see Nott Brook A Reach 3 Checklist.

Rating: Due to the downcut channel, steeps slopes, and erosion, the channel is assessed to be Functional-at-Risk. However, there is no apparent trend of improvement or degradation for this reach. The channel is stable and has reached a form of equilibrium but is still showing signs of stress (i.e. erosion).

Recommendations: In order to aid this channel in the healing process and change to an upward trend of recovery, the upstream/upslope flows need to be managed. Key areas of management would include detention in the upslope areas to minimize the amount of water coming off roads and impervious surfaces directly into the channel. If the energy of the flows is reduced and the overall amount of water flowing directly into the channel is reduced, the channel will have an increased capability of repairing present damage. Within Sooke Centennial Park mowing is occurring between the path and the channel. This is preventing the riparian area from expanding. Mowing should be reduced between the path and the creek to allow for riparian expansion that will benefit the function and stability of the creek. Anchoring wood in the channel will allow for the accumulation of sediment to build the channel bottom up to reinstate an appropriate width/depth ratio for this reach. Wood will also create habitat microsites and act as barriers to erosion from high velocity flows. IF wood falls into the stream channel it should be left there unless it poses a significant threat of flooding to adjacent residential neighbourhoods both upstream and downstream. Rainwater management in the upper watershed is critical reducing the flows and dissipating the instream energy that is required for the recovery of this reach.

Lotic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**		
Date:	**09-04-23**	Segment/Reach ID:	**Reach 4A: Sooke Centennial Park (Maple Ave S.) to double culverts at Guardian Road crossing**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen “G4”

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 22’ 19.7” W 123° 44’ 03.0” to N 48° 22’ 28.7” W 123° 44’ 05.9”

Potential channel type:
The potential Rosgen channel type is Rosgen “G4” as the channel will unlikely rehabilitate itself enough to return to its historic “C” channel shape as it has been downcut and artificially armoured.

Present channel type:
The present Rosgen channel type is a “G4” but it is not at its full potential due to the presence of erosion, downcutting, steep slopes, and high velocity and quantity flows of water from the upper watershed and upslope areas.

Constraints:
This reach is constrained on either end by three sets of culverts; one set at Maple Avenue South, the next set parallel to Guardian Road, and the third underneath Guardian Road. Additionally, the channel is artificially armoured with large rock in that portion of the reach flowing parallel to Guardian Road. Upslope development has reduced available floodplain access and roads act as dams. Furthermore, this reach is receiving high peak flows with velocities that are not being managed by the stream. As such, erosion is evident especially along the banks just downstream of the Guardian Road cross culverts. Mowing in the park area is reducing the ability of the riparian zone to establish and expand.

Potential Restoration:
Restoration options for this reach are minimal as a result of the numerous constraints on Nott Brook in this area. The channel is attempting to heal itself by creating floodplain areas but these are minimal. To aid in this endeavor, upstream management of flows is essential. This management includes flow being inputed from roadside drainiage. Installing wood in the channel to create small weir systems will help capture sediment and build the channel bottom up as well as provide areas to combat high flows by reducing the energy of the water. Invasive species management should be conducted, especially in the area of Centennial Park. Additionally, mowing in the park should be scaled back to provide more room for riparian vegetation to establish between the creek channel and the path.

Notes:
1. The stream is constricted in portions of this reach. Floodplain that is present is narrow and should be greater to match the size of the channel and the amount of water it receives.
3. The width/depth ratio is too large and channel character indicates it may have been dug-out historically.
4. The riparian area is constrained by Guardian Road and mowing activities in Sooke Centennial Park.
5. Too much water is being moved through this channel as is evidenced by the downcut and widened channel as well as erosion near the culverts under Guardian Road.
11. In areas, the banks are bare and erosion is occurring. Management of upstream and upslope flows will help with this as well as a more established and extensive riparian zone.
12. Wood should be left in the channel if it falls to create habitat microsites, capture sediment, and protect banks from erosion.
13. Eroding and bare banks are present.
15. Lateral scour is visible and especially severe near the outflow from the culverts under Guardian Road.
16. The channel has reached an equilibrium and no downcutting is currently occurring although there is evidence it has in the past.
17. The amount of water being supplied by the watershed is more than the channel can handle, therefore, erosion is occurring.

Vegetation:

Common Name	Scientific Name
Arbutus	*Arbutus menziesii*
Bigleaf maple	*Acer macrophyllum*
Bitter cherry	*Prunus emarginata*
Black hawthorn	*Crataegus douglasii*
Boxwood	*Pachisima myrsinites*
Colts foot	*Petasites frigidus* var. *palmatus*
Common juniper	*Juniperus communis*
Common snowberry	*Symphoricarpos albus*
Deer fern	*Blechnum spicant*
Douglas fir	*Pseudotsuga menziesii*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix*
False lily-of-the-valley	*Maianthemum dilatatum*
Few flowering shooting star	*Dodecatheon pulchellum*
Garry oak	*Quercus garryana*
Grand fir	*Abies grandis*
Grasses	
Indian plum	*Oemleria cerasiformis*

Common Name	Scientific Name
Kinnikinnik	*Arctostaphylos uva-ursi*
Miner's lettuce	*Montia perfoliate*
Oceanspray	*Holodiscus discolor*
Pacific bleeding heart	*Dicentra formosa*
Pacific water parsley	*Oenanthe sarmentosa*
Rattlesnake plantain	*Goodyera oblongifolia*
Red Alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Red flowering currant	*Ribes sanguineum*
Red huckleberry	*Vaccinium parvifolium*
Rhododendron	*Rhododendron macrophyllum*
Salal	*Gaultheria shallon*
Salmonberry	*Rubus spectabilis*
Saskatoon	*Amelianchier alnifolia*
Shore pine	*Pinus contorta*
Sitka mountain ash	*Sorbus sitchensis*
Skunk Cabbage	*Lysichiton americanum*
Small-flowered bulrush	*Scirpus microcarpus*
Stinging nettle	*Urtica dioica*
Sword fern	*Polystichum munitum*
Tall Oregon grape	*Mahonia aquifolium*
Trailing blackberry	*Rubus ursinus*
Trailing yellow violet	*Viola sempervirens*
Vine maple	*Acer circinatum*
Western red cedar	*Thuja plicata*
Western flowering dogwood	*Cornus nuttallii*
Western hemlock	*Tsuga heterophylla*
Western honeysuckle	*Lonicera ciliosa*
Western trillium	*Trillium ovatum*
White Easter lily	*Erythrunium oregonum*
Yellow cedar	*Chamaecypars nootkatensis*

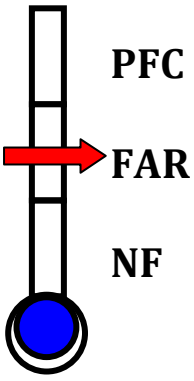
SUMMARY DETERMINATION

___Proper Functioning Condition

_√_ Functional - At Risk

___ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward
___ Downward
_√_ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _√_
No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
_√_ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Reach 5: From the upstream end of the double culverts on Guardian Road to the private access road for 6865 Grant Road.

Rating: Proper Functioning Condition

Reach 5 is approximately 215 m and runs from where Nott Brook daylights upstream of the double culverts under Guardian Road and the trailer park properties to the private access road at 6865 Grant Road.

This section of Nott Brook is a channelized ditch that is in the process of recovering via deposition of sediments and riparian vegetation growth, which is narrowing the excavated channel the width. As such, it is acting more as a wetland/wet meadow than a ditch. Its potential Rosgen channel type would be either a “C6” or an “E” with wetland areas but it is difficult to tell due to modifications of the channel and landscape.

The upslope areas of this reach are saturated and rush and sedge species have extended way upslope. Due to the level of saturation and extent of the rush and sedge community, this reach is a major detention area for water. If this property were to be part of a rezoning or development application this will need to be considered with regard to appropriate land use. Any development on the saturated ground will compress the ground reducing the storage capacity. This in turn will exacerbate issues in downstream reaches.

Two agricultural field abut the channel in this reach and have grass communities, as well as the expanding sedge and rush community. Buildings in this area are distant and upslope on either side (greater than 100m). Other vegetation species aside from grass, rushes, and sedges include the following: Grand fir (*Abies grandis*), Western red cedar (*Thuja plicata*), Blue spruce (*Picea pungens*), red alder (*Alnus rubra*), English holly (*Ilex aquifolium*), creeping buttercup (*Ranunculus repens*), skunk cabbage (*Lysichiton americanum*), small-flowered bulrush (*Scirpus microcarpus*), and Pacific water parsley (*Oenanthe sarmentosa*).

Rating: Due to the fact that the channel is filling in to correct its overwidened state and the presence of a wide riparian community, this reach is in Proper Functioning Condition.

Recommendations: This is a very important area for Nott Brook due to its water storage and detention capabilities. In order to maintain this function, wide setbacks should be considered if the area is developed, in order to include the extensive floodplain. Instream ponds/wetlands could be designed in order to continue detention, as well as provide fish habitat. As mentioned above, this storage capacity of this piece of Nott Brook is essential for helping to protect the downstream reaches of Nott Brook that area already showing degradation due to increased water flows. As such, any rezoning or development applications should be considered carefully to insure this function is not damaged.

Lotic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**		
Date:	**09-04-23**	Segment/Reach ID:	**Reach 5A: Upstream end of double culverts at Guardian Road to the private access road for 6865 Grant Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen “C6 or E6” with wetlands/ponds

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 22' 26.2" W 123° 44' 02.6" to N 48° 22' 34.7" W 123° 43' 59.7"

Potential channel type:
The potential Rosgen channel type is Rosgen "C6" or "E6" with wetlands/ponds.

Present channel type:
The present channel type is cannot be classified as a Rosgen type as it has been channelized into a ditch. However, it is in the process of filling in thereby narrowing and healing. As such, it is acting more as a channelized wetland than a ditch.

Constraints:
This reach is constrained on either end by culverts. Additionally, a small portion of the reach is located underground from Guardian Road underneath the trailer park properties to where Nott Brook daylights at the tree line. The upstream portion of the reach is located on agricultural lands and has been ditched.

Potential Restoration:
Restoration opportunities include the potential for creating in-stream ponds for detention and fish habitat. Currently, this area provides a lot of storage with water close to the surface upslope of the channel as well. As such, this will need to be taken into account if this property is ever part of a rezoning or development application.

Notes:
3. The channel morphology is not as it should be as it is over wide and too straight.
17. There is deposition occurring here but in this case that is a good thing as the channel is narrowing, and therefore, healing itself, by filling in.

Vegetation:

Common Name	**Scientific Name**
Blue spruce	*Picea pungens*
Common rush	*Juncus effusus*
Creeping buttercup	*Ranunculus repens*
English holly	*Ilex aquifolium*
Grand fir	*Abies grandis*
Grasses	
Pacific water parsley	*Oenanthe sarmentosa*
Red Alder	*Alnus rubra*
Rush sp.	*Juncus* ssp.
Sedges	*Carex* ssp.
Skunk Cabbage	*Lysichiton americanum*
Small-flowered bulrush	*Scirpus microcarpus*
Western red cedar	*Thuja plicata*

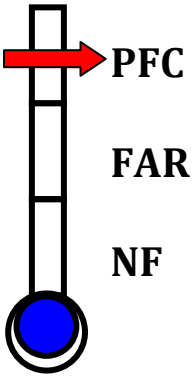
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Reach 6: 6865 Grant Road to Grant Road Crossing

Rating: Functional-at-Risk (Downward Trend)

Reach 6 is approximately 250 m long and extends from the downstream boundary of 6865 Grant Road to where Nott Brook crosses Grant Road. This reach flows parallel to Grant Road behind a relatively new subdivison at 6865 Grant Road. A portion of the land adjacent to the south (left) bank has been set aside as park dedication and fenced.

The current Rosgen channel type is a “C6” as would be expected in this landscape setting. However, while the potential is a “C6”, this reach is at a low successional status, as discussed below.

At the downstream end of the reach, a culvert transports flows under a new access road that serves the western section of the new development. This downstream portion of the reach is downcut and exposed tree roots are visible. In the mid- and upper-portions of the reach, downcutting is not occurring. However, in the mid-section riparian encroachment is occurring, including trampling and recreational activities within the riparian park area. A rock wall was installed to mark the boundary between the private property and park, however, the park area is being utilized as an extended backyard space for resident. As a result, riparian vegetation is sparse in this section and growth is being hampered by the trampling. Between the mid- and upper portion, another driveway and culvert is present. In this location a ditch enters the downstream side of the culvert transporting roadside drainage into Nott Brook. The upper portion of the reach is in the best condition with a diverse community of well established riparian vegetation and accessible floodplain characteristic of a “C6” channel.

While the vegetation in this reach is diverse overall, portions of the channel, such as the downstream portion of the reach, have a sparse understorey. Additionally, through the mid-section, the riparian zone is

reduced as a result of trampling and mowing. This portion is part of a park dedication so there is potential for the riparian zone to be expanded, especially on the south side of the channel. Vegetation species in this reach include the following: Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), Western red cedar (*Thuja plicata*), bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), Indian plum (*Oemleria cerasiformis*), salmonberry (*Rubus spectabilis*), Himalayan blackberry (*Rubus discolor*), English holly (*Ilex aquifolium*), lady fern (*Athyrium filix-femina*), sword fern (*Polystichum munitum*), common horsetail (*Equisetum arvense*), Daphne (*Daphne* ssp.), false lily-of-the-valley (*Maianthemum dilatatum*), skunk cabbage (*Lysichiton americanum*), and grasses.

Rating: Due to the downcutting channel at the bottom end, riparian encroachment in the mid-portion, and the risk of degradation due to upslope development activities have resulted in a rating of Functional-at-Risk with a downward trend.

Recommendations: Further degradation can be prevented and restoration efforts implement to ensure that this reach does not become Nonfunctional. Planting of native riparian vegetation should be initiated between the rock wall of 6865 Grant Road and the creek and between the creek and the fence on the south side. This will widen the extent of the riparian zone providing more stability to the channel as well as improving filtration and sediment capture to improve water quality and a reduced erosion risk.. Mowing activities on the south side of the channel should cease. Exclusionary fencing should be considered especially on the north bank where the trampling is occurring. Neighbourhood education including signage could explain to residents the importance of riparian zones in terms of creek function and watershed health. Other activities that would benefit this reach are: removing a old sediment fence in the channel and invasive species (e.g. English holly, Daphne, and Himalayan blackberry).

Lotic Checklist

Name of Riparian-Wetland Area:		**Nott Brook-Main Channel**	
Date:	**09-04-23**	Segment/Reach ID:	**Reach 6A: 6865 Grant Road to Grant Road crossing**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen “C6”

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 22' 34.7" W 123° 43' 59.7" to N 48° 22' 41.2" W 123° 43' 51.8"

Potential channel type:
The potential Rosgen channel type is Rosgen "C6" with a wider riparian wetland zone.

Present channel type:
The present channel type is a Rosgen "C6" but is not at its full potential due to a narrow riparian zone, some erosion and downcutting in the lower reaches, and riparian encroachment from a neighbouring development causing trampling.

Constraints:
This reach is constrained on either end by culverts along with a third culvert array in the middle of the reach. Trampling from activites associated with residents of the neighbouring development has reduced the ability of vegetation to grow and inputs sediment into the channel. The downstream portion of the channel is downcut and eroding dropping the water table and hindering the ability of a thick riparian zone to establish.

Potential Restoration:
Restoration activities for this reach should include native riparian planting especially in the park dedication zone. Exclusionary fencing should be considered to prevent trampling. Educational signage would be beneficial as well to educated adjacent landowners about creek function, the importance of riparian zones, and the damaging effects of trampling. Some garbage and left over silt fencing is located in the channel and should be removed. Grass should not be mowed to the edge of the creek/riparian zone but should be pulled back to allow for further expansion of the riparian zone.

Notes:
1. The floodplain is inundated in relatively frequent events in all areas except for the downstream portion which is downcut.
3. Sinuosity, width/depth, and gradient are in balance except for that small portion that is straigtened.
5. There is a risk for the upland watershed to contribute to riparian degradation from upstream development. Erosion and sediment control as well as comprehensive stormwater/rainwater management plans should be mandatory.
11. Adequate vegetation is present except for the downstream portion where downcutting is evident and where trampling is occurring.
16. The system is vertically stable except where downcutting has occurred in the downstream portion.
17. The stream is at risk from upslope development and the lower portion is scoured. Management of upslope areas especially in the event of development will need to be carefully observed in order to prevent damage to this reach.

Vegetation:

Common Name	Scientific Name
Bigleaf maple	*Acer macrophyllum*
Common horsetail	*Equisetum arvense*
Daphne	*Daphne* ssp.
Douglas fir	*Pseudotsuga menziesii*
English holly	*Ilex aquifolium*
False lily-of-the-valley	*Maianthemum dilatatum*
Grand fir	*Abies grandis*
Grasses	
Himalayan blackberry	*Rubus discolor*
Indian Plum	*Oemleria cerasiformis*
Lady fern	*Athyrium filix-femina*
Red Alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Skunk Cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*

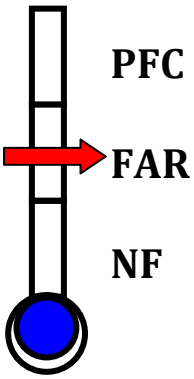
SUMMARY DETERMINATION

___Proper Functioning Condition

_√_ Functional - At Risk

___ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward

_√_ Downward

___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

(Revised 1998) (7/12/04)

FAR with a downward trend: at risk from upslope development and heavy scour and downcutting at downstream end.

Reach 7: Grant Road to where the tributary enters from the East (6790 Grant Road)

Rating: Proper Functioning Condition

Reach 7 is approximately 156 m in length and extends from Grant Road, upstream through 6790 Grant Road, to where a small tributary enters on the left (east) bank. The Rosgen channel type for this reach is a “C6” as a result of its gradient, sinuosity, and floodplain presence and accessibility. While the potential Rosgen channel type is also a “C6”, this reach is not at its full potential.

The downstream portion of the reach the creek crosses through two sets of culverts. One under a driveway into a newly developed single-family residential subdivision (Gatewood), and the second set underneath Grant Road. The presence of these culverts restricts the natural stream development by controlling the sinuosity and lateral movement. Upstream of the culverts, two large red alder trees are the stabilizing mechanism for the channel bottom at an elevation drop (step/pool). This location should be monitored as damage or removal of the trees could result in the formation of a headcut leading to erosion and downcutting of the channel.

Upstream of the red alders, the stream widens out into a small pond area. Easily accessible floodplain has been created benefiting the stream in terms of water storage potential and energy dissipation. However, this pond-like area has been utilized as a dump site for many household wastes including appliances such as a washing machine, lawnmower, and dishwasher, among other trash that may impact water quality.

Further upstream, the channel narrows and a small tributary enters from the left bank marking the upstream reach break. This tributary is eroding and is a likely source of sediment input to Nott Brook.

Vegetation in this reach is diverse, abundant, and vigorous. Species include the following: Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), Indian plum (*Oemleria cerasiformis*), hardhack (*Spirea douglasii* ssp. *douglasii*), Himalayan blackberry (*Rubus discolor*), Salmonberry (*Rubus spectabilis*), Common snowberry (*Symphoricarpos albus*), dull Oregon grape (*Mahonia nervosa*), sword fern (*Polystichum munitum*), Scotch broom (*Cytisus scoparius*), Canadian thistle (*Cirsium arvense*), English holly (*Ilex aquifolium*), English ivy (*Hedera helix*), Common dandelion (*Taraxacum officinale*), Common horsetail (*Equisetum arvense*), skunk cabbage (*Lysichiton americanum*), False lily-of-the-valley (*Maianthemum dilatatum*), fringecup (*Tellima grandiflora*), Pacific water parsley (*Oenanthe sarmentosa*), sedges (*Carex* sp.), and grasses.

Rating: Despite the reach having been utilized as a garbage dump, the presence of invasive species, and the potential threat of a headcut if the red alders fail, the reach contains enough functional attributes to be in Proper Functioning Condition (at a low level).

Recommendations: In order to maintain and improve the Proper Functioning Condition status, garbage should be removed, an invasive species management plan be implemented followed by planting native riparian vegetation.

This reach is also part of a piece of property (former golf course) that will likely undergo future development. Rainwater management (detention and treatment) and restoration of the channel and riparian area could become part of a redevelopment plan.

Lotic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**		
Date:	**09-04-23**	Segment/Reach ID:	**Reach 7A: Grant Road to where the tributary enters from the East (6790 Grant Road)**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen "C6"

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
√			14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 22' 41.2" W 123° 43' 51.8" to N 48° 22' 45. 6" W 123° 43' 45.5"

Potential channel type:
The potential Rosgen channel type is Rosgen "C6" with floodplain access, sinuosity, and a slightly narrower channel width.

Present channel type:
The present channel type is a Rosgen "C6" but is not at its full potential due to an unofficial garbage dump and invasive species.

Constraints:
This reach is constrained at the downstream end by Grant Road and an adjacent driveway where the stream is culverted. Additionally, a large amount of garbage in the channel, including appliances and car parts are affecting the overall health of this reach.

Potential Restoration:
The garbage should be removed to prevent any further implications in terms of water quality. Additionally, invasive species removal and control, especially of Himalayan blackberry, English ivy, Scotch broom, English holly, and Daphne should be conducted before they become too abundant and uncontrollable. At the downstream portion of the reach, two red alder trees are stabilizing a drop in elevation. This stabilization needs to be maintained in order to prevent a head cut from moving up the channel that would threaten the stability of the reach and those above.

Notes:
5. No excessive erosion or deposition observed.
16. Two alder trees are protecting the vertical stability of this reach where the roots systems are intertwined at an elevation change in the downstream section. If these trees removed a headcut will occur leading to erosion and potential gullyization.
17. The small pond upstream, part of Reach 7, acts as a shock absorber.

Vegetation:

Common Name	**Scientific Name**
Bigleaf maple	*Acer macrophyllum*
Canadian thistle	*Cirsium arvense*
Common dandelion	*Taraxacum officinale*
Common horsetail	*Equisetum arvense*
Common snowberry	*Symphoricarpos albus*
Douglas fir	*Pseudotsuga menziesii*
Dull Oregon grape	*Mahonia nervosa*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix*

Common Name	Scientific Name
False lily-of-the-valley	*Maianthemum dilatatum*
Fringecup	*Tellima grandiflora*
Grand fir	*Abies grandis*
Grasses	
Hardhack	*Spiraea douglasii ssp. douglasii*
Himalayan blackberry	*Rubus discolor*
Indian Plum	*Oemleria cerasiformis*
Pacific Water Parsley	*Oenanthe sarmentosa*
Red Alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Scotch broom	*Cytisus scoparius*
Sedge sp.	*Carex* ssp.
Skunk Cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*

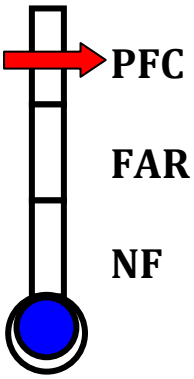
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Reach 8: Upstream of Grant Road where tributary enters from the east to Otter Point Road

Rating: Functional-at-Risk (No Apparent Trend)

This reach is approximately 180 m long, extending from where the small tributary enters Nott Brook on the east side upstream to Otter Point Road. This reach is located on property that was a former golf course. As such, the channel has been heavily modified by ditching, straightening, and culverting in order to drain the property. What once would likely have been a Rosgen "C6" channel is presently a ditch although it has some remnant "C" characteristics.

A large area of undeveloped property exists adjacent to the Nott Brook channel providing accessible floodplain and anecdotal evidence suggests that the area floods yearly up over the banks.

At the upstream end of the reach a culvert conveys water underneath Otter Point Road while the downstream portion of the reach is managed by an old dam structure. This old dam structure has collapsed and the channel blocked with debris creating a small pond area. Culverts are also present in the mid-portion of the channel likely used historically to allow for golf carts to cross Nott Brook. In some locations these culverts have collapsed, are impeding flows and causing the channel to create its own pathway.

Evidence of erosion is present and can be attributed to the unnatural physical character and lack of riparian vegetation making the reach unable to manage the water flows it is experiencing. The vegetation here is composed primarily of turf grass with some areas of riparian vegetation. The overall, the riparian vegetation requirements are not met for this reach. Vegetation species include: Grand fir (*Abies grandis*), western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), Indian plum (*Oemleris cerasiformis*), hardhack (*Spirea douglasii* ssp. *douglasii*), Himalayan blackberry (*Rubus discolor*), sword fern (*Polystichum munitum*), common horsetail (*Equisetum arvense*), Scotch broom (*Cytisus scoparius*), skunk cabbage (*Lysichiton americanum*), grasses, sedges (*Carex* sp.), and Pacific water parsley (*Oenanthe sarmentosa*).

Rating: Due to the sparse riparian vegetation, erosion and collapsing infrastructure, this reach was determined to be Functional at Risk. No apparent trend is associated with because the reach appears stable but in poor condition.

Recommendations: Redevelopment of this former golf course may provide an excellent opportunity to provide rainwater management (detention and treatment) and restoration of the channel and riparian zone. Options for restoration include the creation of a rainwater management facility in the large expanse of open area on the site to help protect downstream areas. For example, a large pond could be created upslope of the channel where the land begins to rise near Otter Point Road. Areas that are presently in culverts, collapsed or otherwise, should be daylighted and recontoured to match adjacent channel and landscape characteristics. Debris such as pipes and wires should be removed and a gate installed near Otter Point Road to prevent access to vehicles that are eroding sediments and degrading water quality. Additionally, invasive species control (Scotch broom and yellow flag iris) and riparian planting should be conducted to improve the quantity and quality of the riparian wetland area. A conceptual plan for rainwater management and channel/riparian restoration should be been prepared for the site to best utilize the site.

Lotic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**		
Date:	**09-04-23**	Segment/Reach ID:	**Reach 8A: From where the tributary enters Nott Brook from the East to Otter Point Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen "C6"

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√	√		9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
	√		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 22' 45.7" W 123° 43' 47.8" to N 48° 22' 45. 6" W 123° 43' 45.5"

Potential channel type:
The potential Rosgen channel type is Rosgen "C6" with floodplain access and sinuosity.

Present channel type:
The present channel type is a straightened ditch with remnant Rosgen "C6" characteristics.

Constraints:
Past activity as a golf course has altered the landscape which presently has minimal vegetation. Additionally, portions of the channel are located within culverts, the majority of which are in bad condition even to the point of collapse in some cases. Structures are present at the inlet and outlet in the form of a culvert and dam structure respectively.

Potential Restoration:
This location provides a good opportunity for lots of detention as the area surrounding this reach is not developed. Onsite detention would be feasible and beneficial. Portions of the channel that are within intact and degraded culverts should be daylighted to provide more opportunity for floodplain access and water storage capability. The outlet structure at the bottom of the small pond needs to be improved as it is currently crumbling. Riparian planting should occur but only after detention initiatives have been decided to avoid having to replant multiple times. Bridge debris, pipes, and tires should be removed and a gate installed at the access point to prevent vehicles from tearing up grass and creating a sediment source to Nott Brook.

Notes:
1. Yearly flooding does occur.
3. The channel has been straightened, ponds added, and culverts installed altering stream balance within the landscape setting.
4. The riparian wetland area is limited and is mowed preventing natural cultivation of riparian vegetation.
6. While there are at least two age classes the vegetation community is minimal.
9. There is lots of turf grass present and while some locations do have appropriate riparian cover it is not consistent.
11. The old golf course activity has resulted in section of the channel having only turf grass. In other locations vegetation is present but are not the right type of plant community.
12. The channel does require some large wood although not a large amount. Currently there is none present and past land use has limited the supply potential.
13. There is lots of accessible floodplain present.
15. The channel is straightened.
16. The channel is vertically stable helped along by the structurally cohesive clay layer.

Vegetation:

Common Name	Scientific Name
Common horsetail	*Equisetum arvense*
Grand fir	*Abies grandis*
Grasses	
Hardhack	*Spiraea douglasii ssp. douglasii*
Himalayan blackberry	*Rubus discolor*
Indian Plum	*Oemleria cerasiformis*
Pacific Water Parsley	*Oenanthe sarmentosa*
Red Alder	*Alnus rubra*
Scotch broom	*Cytisus scoparius*
Sedge sp.	*Carex* ssp.
Skunk Cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*
Yellow flag iris	*Iris pseudacorus*

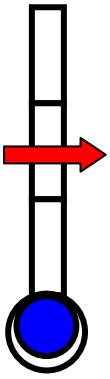
SUMMARY DETERMINATION

___Proper Functioning Condition

_√_ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
_√_ Not Apparent

(Revised 1998) (7/12/04)

Reach 9: Pond upstream of Otter Point Road

Rating: Proper Functioning Condition

Reach 9 of Nott Brook A consists of a pond and its inlet and outlet structures, this is a lentic (pond/wetland) site. This reach is located immediately upstream of Otter Point Road, near the Sooke Municipal Hall, on a former golf course.

The pond is approximately 0.25 hectares and was created to suit the requirements of the past golf course use. Two inlet channels enter from the north and northwest sides of the pond, one from the vicinity of the municipal hall and the other from the direction of Townsend Road. The inlet channel from the municipal hall is connected via a culvert under the grass surrounding the pond. This channel would be a good candidate for daylighting. The other inlet channel is the main channel of Nott Brook. The outlet channel directs flow from the pond and upper watershed downstream under Otter Point Road in a culvert.

The pond itself has an unnatural shoreline likely as a result of modification due to golf course activity. The shore of the pond is essentially bare of vegetation except for mowed grass and patchy areas of cattails (*Typha latifolia*), small-flowered bulrush (*Scirpus microcarpus*), common rush (*Juncus effusus*), silverweed (*Potentilla anserine* ssp*. pacifica*), red alder (*Alnus rubra*), Lombardy poplar (*Populus nigra*), a weeping willow (*Salix babylonica*), and yellow flag iris (*Iris pseudacorus*). As a result, there is little shade, cover or habitat complexity along the shoreline or in the pond. Additionally, the shoreline is muddy in places where Canadian geese are trampling the banks and instigating the movement of sediment into the pond. This has resulted in the pond having a turbid water quality.

Rating: Despite the pond having some unnatural character, it still possesses the attributes necessary for it to be identified as a system in Proper Functioning Condition. However, this is a system at the lower end of the PFC scale as a result of its lack of vegetation and habitat complexity. Additionally, it is important to note that natural surface and subsurface flow patterns have been altered historically by the implementation of culverts, roads, and drainage management for the golf course.

Recommendations: A number of opportunities are present to improve the functional condition of the pond, the ownership is with the District of Sooke and a large amount of space is available within the park area. The shoreline of the pond should be re-contoured to include terraces upon which aquatic riparian vegetation can establish. In conjunction with this, wood should be added both along the shoreline of the pond to create microhabitats for fish and other species, as well as to maintain bank stability. Wood that extends above the surface of the water would also be beneficial for bird perches. Invasive species management should be conducted to remove the yellow flag iris before it spreads to other locations along Nott Brook. Lombardy poplar and weeping willow should also be removed and replaced with native riparian species (trees, shrubs and shoreline plants). Riparian trees will provide shade and may help improve water temperatures, trees, shrubs and other native plants will stabilize the banks as well as filter and capture pollutants and sediment. Altering mowing practices to leave a larger riparian area will allow riparian vegetation to establish benefiting pond function. The inlet channel from the municipal hall should be daylighted and the culverts removed.

Lentic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**		
Date:	**09-04-24**	Segment/Reach ID:	**Reach 9A: Pond upstream of Otter Point Road including inlet and outlet channels**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Yes	No	N/A	HYDROLOGICAL
√			1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events
√			2) Fluctuation of water levels is not excessive
√			3) Riparian-wetland area is widening or has achieved potential extent
√			4) Upland watershed is not contributing to riparian-wetland degradation
√			5) Water quality is sufficient to support riparian-wetland plants.
	√		6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e. hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities)
√			7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)

Yes	No	N/A	VEGETATION
√			8) There is a diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			9) There is a diverse composition of riparian-wetland vegetation (for maintenance/recovery)
√			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g. storm events, snowmelt)
√			12) Riparian-wetland plants exhibit high vigor
	√		13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows
		√	14) Frost or abnormal hydrologic heaving is not present
	√		15) Favorable microsite condition (i.e. woody material, water temperature, etc.) is maintained by adjacent site characteristics

Yes	No	N/A	EROSION DEPOSITION
√			16) Accumulation of chemicals affecting plant productivity/composition is not apparent
√			17) Saturation of soils (i.e. ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils
√			18) underlying geologic structure/soil material/permafrost is capable of restricting water percolation
√			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)
√			20) Islands and shoreline characteristics (i.e. rocks, coarse and/or coarse woody material) are adequate to dissipate wind and wave event energies

Remarks

GPS: N 48° 22' 51.2" W 123° 43' 45.6" to N 48° 22' 54.0" W 123 43' 41.3"

Constraints: The vegetation along the bank is primarily grass which is mowed consistently. Additionally, this pond has been modified historically to suit golf course activity.

Potential Restoration: Recontouring and terracing of the shoreline will create a pond with more natural characteristics. Additionally, planting the pond edges with native riparian species will improve bank stability as well as water quality especially in terms of temperature balance. Invasive species such as weeping willow, Lombardy poplar, and yellow flag iris should be removed in order to promote the growth of native riparian vegetation. The inlet channel from the vicinity of the municipal hall should be daylighted and the culvert removed.

Notes:
3. Widening of the riparian zone is occurring around the pond where vegetation is trying to grow. However, mowing is preventing extensive growth.
5. The water quality is not suitable for fish as it is turbid. The presence of Canadian geese stir up sediment as well as input sediment through trampling activities on the banks.
6. Culverts are present directing flow in and out of the pond. The inlet channel geomorphology has been changed and the landscape is set-up to drain water as a result of its past use as a golf course.
9. More diversity in vegetation would be beneficial.
11. There is no evidence of erosion.
13. More riparian cover is necessary to improve this reach. The western edge is made up of grasses only.
15. This reach needs shade. There is almost no shade thereby negatively impacting water temperatures.
20. Vegetation is minimal. If the pond was bigger wind and wave event energies would be more of a problem in terms of erosion.

Vegetation:

Common Name	**Scientific Name**
Cattail	*Typha latiflia*
Common rush	*Juncus effusus*
Grasses	
Lombardy poplar	*Populus nigra*
Red alder	*Alnus rubra*
Silverweed	*Potentilla anserine* ssp. *pacifica*
Small-flowered bulrush	*Scirpus microcarpus*
Sword fern	*Polystichum munitum*
Weeping willow Yellow flag iris	*Salix babylonica* *Iris pseudacorus*

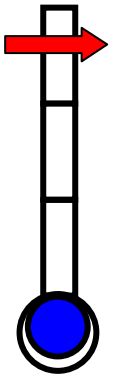
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



PFC

FAR

NF

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Reach 10: upstream of Nott Brook pond to the wetland at 2170 Townsend Road.

Rating: Proper Functioning Condition

Reach 10 is approximately 140m in length extending upstream from the pond to the beginning of a small wetland area near 2170 Townsend Road. This channel has been straightened and ditched, likely to accommodate golf course activity. In one location, approximately half way along the reach, a cart path crosses the channel over top of a collapsed culvert. This culvert should be removed and the channel daylighted in this location.

While it is unclear whether this reach would have been lentic or lotic historically, its preset channel character is a ditch that is filling in and therefore cannot be defined under Rosgen channel classification. However, the potential for this reach is a linear wetland, potentially with a Rosgen "E" channel.

As a result of the ditching and straightening, the sinuosity, width depth ratio, and gradient are not in balance with the landscape setting. However, the riparian vegetation is beginning to establish along the channel and developing characteristics to better match the landscape setting. The deposition in the channel is corresponding with the widening inward of the riparian zone further benefiting the function of the channel. Due to the expanse of the available land surrounding this reach, there is ample of floodplain available for the channel to dissipate any high-energy flows it may receive. This floodplain access should be maintained as floodplains are important for storing water and protecting downstream areas from flooding and erosion.

The vegetation present in this reach is vigorous and the riparian zone is expanding inwards. There is potential for the riparian zone to expand outwards if mowing activity ceases adjacent to the channel. The vegetation currently in the area include the following: Red alder (*Alnus rubra*), native willow (*Salix* sp.), India plum (*Oemleria cerasiformis*), Black hawthorn (*Crataegus douglasii*), red elderberry (*Sambucus racemosa* ssp. *pubens*), salmonberry (*Rubus spectabilis*), hardhack (*Spirea douglasii* ssp. *douglasii*), Himalayan blackberry (*Rubus discolor*), sword fern (*Polystichum munitium*), Common rush (*Juncus effusus*), Pacific water parsley (*Oenanthe sarmentosa*), Common horsetail (*Equisetum arvense*), Scotch broom (*Cystisus scoparius*), yellow flag iris (*Iris pseudacorus*), and grasses.

Rating: Despite the channel being ditched and straightened, the process of recover is proceeding and as a result, Reach 10 is in Proper Functioning Condition. As such, the channel should be left to develop in naturally.

Recommendations: In order to maintain and improve the condition, the first initiative should be to move the mowing boundary further away from the channel by at least 10 meters. This will prevent the mowing of riparian wetland plants and allow for the riparian area to expand outwards. If appropriate riparian vegetation does not establish, recontouring of the banks and native riparian vegetation plantings should be conducted. Addtionally, invasive species such as Scotch broom, Himalayan blackberry, and yellow flag iris should be removed. The collapsed culvert should also be removed along with sediment fence material that has been left installed near this culvert.

As an education resource, this reach is a great example of the recovery process that is natural for aquatic areas to go through as they adapt to changes in the surrounding landscape. This reach is highly accessible and would be a good place to take elementary and high school students for education related to stream and wetland function. Furthermore, setting up a Photopoint Monitoring station will allow the district to track changes in this reach over time.

Lotic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**		
Date:	**09-04-24**	Segment/Reach ID:	**Reach 10A: Inlet to large pond upstream of Otter Point Road to 2170 Townsend Road wetland**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous
Potential Channel Characteristics: linear wetland with an “E” channel.

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
		√	12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
	√		14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity S
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** 0446091 5358999 to 0446206 5359005

Potential channel type:
The potential Rosgen channel type is a linear wetland perhaps with an “E” channel snaking through it.

Present channel type:
The present channel type cannot be defined by Rosgen characteristics. The channel here is characteristic of a ditch that is filling in and healing itself to better match the landscape setting.

Constraints:
Mowing of the vegetation adjacent to the channel is preventing the riparian zone from widening outward to its full extent.

Potential Restoration:
The channel should be left as is and allowed to fill in. A linear wetland will likely develop which is capable of storing water. Mowing of the vegetation adjacent to the channel should be pulled back from the channel a further 5 metres so wetland plants will no longer be part of the mowing regime. Additionally, excavating the left bank, upslope from the channel and vegetation, would create a pool area and widen the wetland area. Where the cart path crosses the channel, the old culvert should be removed daylighting the stream, and left over silt fences should be removed. An invasive species control plan should be implemented and the yellow-flag iris and Scotch broom removed.

Notes:
3. Although it has been ditched and straightened, the channel is healing well by filling and vegetating inwards.
4. The riparian area is widening inwards and would be widening outward if mowing was not occurring so close to the channel.
13. There is lots of accessible floodplain present.

Vegetation:

Common Name	Scientific Name
Black hawthorn	*Craaegus douglasii*
Common horsetail	*Equisetum arvense*
Common rush	*Juncus effusus*
Grasses	
Hardhack	*Spiraea douglasii ssp. douglasii*
Himalayan blackberry	*Rubus discolor*
Indian Plum	*Oemleria cerasiformis*
Pacific Water Parsley	*Oenanthe sarmentosa*
Red Alder	*Alnus rubra*
Red Elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Scotch broom Sedge sp. Skunk Cabbage Sword fern Western Hemlock Willow sp. Yellow flag iris	*Cytisus scoparius* *Carex* ssp. *Lysichiton americanum* *Polystichum munitum* *Tsuga heterophylla* *Salix* ssp. *Iris pseudacorus*

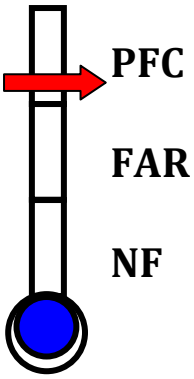
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Nott Brook A Reach 11: Wetland area 2170 Townsend Road.

Rating: Proper Functioning Condition

Reach 11 is a small wetland covering approximately 0.19 hectares and extends along the west side of the former golf course property between 2164 and 2184 Townsend Road. The largest section of this wetland seems to be concentrated around 2170 Townsend Road.

A very moist area, this location is saturated at the surface despite natural surface and subsurface flow patterns being altered by nearby roadways and residential house placement requiring water diversion and management. Degradation has occurred due to dumped garbage, which is currently being removed by the present landowner, and by in-filling activities. Some exposed soils are present but vegetation is growing quickly.

The vegetation present is diverse and includes the following species: grand fir (*Abies grandis*), western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), willow (*Salix* sp.), salmonberry (*Rubus spectabilis*), trailing blackberry (*Rubus ursinus*) lady fern (*Athyrium filix-femina*), sword fern (*Polystichum munitium*), common horsetail (*Equisetum arvense*), false lily-of-the-valley (*Maianthemum dilatatum*), fringecup (*Tellima grandiflora*), skunk cabbage (*Lysichiton aericanum*), slough sedge (*Carex obnupta*), and Pacific water parsley (*Oenanthe sarmentosa*).

Rating: Overall, this reach possesses the characteristics of a system in Proper Functioning Condition, however the reach is constrained by several factors.

Recommendations: Maintenance and improvement this condition will require a number of initiatives to be implemented. First, a retaining wall for the fill on the residential property should be constructed to represent a clear boundary for the wetland area. There is also the potential for creating a pond in the back corner of 2170 Townsend Road that would be beneficial for habitat creation for birds and amphibians, as well as an area for water storage. The landowner was amenable to this idea which would make this project an example of resident and district cooperation for the improvement of Nott Brook watershed. Riparian plantings are also a recommended in the areas of exposed soils and in the disturbed areas around the fill.

Lentic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**		
Date:	**09-04-24**	Segment/Reach ID:	**Reach 11A: Wetland area 2170 Townsend Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Yes	No	N/A	HYDROLOGICAL
√			1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events
√			2) Fluctuation of water levels is not excessive
√			3) Riparian-wetland area is widening or has achieved potential extent
√			4) Upland watershed is not contributing to riparian-wetland degradation
√			5) Water quality is sufficient to support riparian-wetland plants.
	√		6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e. hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities)
		√	7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)

Yes	No	N/A	VEGETATION
√			8) There is a diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			9) There is a diverse composition of riparian-wetland vegetation (for maintenance/recovery)
√			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g. storm events, snowmelt)
√			12) Riparian-wetland plants exhibit high vigor
√	√		13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows
		√	14) Frost or abnormal hydrologic heaving is not present
√			15) Favorable microsite condition (i.e. woody material, water temperature, etc.) is maintained by adjacent site characteristics

Yes	No	N/A	EROSION DEPOSITION
√			16) Accumulation of chemicals affecting plant productivity/composition is not apparent
√			17) Saturation of soils (i.e. ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils
√			18) underlying geologic structure/soil material/permafrost is capable of restricting water percolation
√			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)
		√	20) Islands and shoreline characteristics (i.e. rocks, coarse and/or coarse woody material) are adequate to dissipate wind and wave event energies

Remarks

GPS: UTM 10 0446139 5359095 to 0446206 5359013

Constraints:
Private residential properties line the east, north, and south edges of the wetland area. Fill is encroaching from the eastern edge.

Potential Restoration:
Filling should be stopped and a retaining wall installed to make clear boundary for the wetland. There is the opportunity to create a pond in this area for improved storage and detention of water as well as amphibian and bird habitat. It is recommended that the municipality work with the landowner on this.

Notes:
3. Large trees are present.
6. The road and houses act as berms altering the drainage patterns of this area.
13. Some exposed soils are present but vegetation is growing quickly. Management practices will reduce the extent of exposed soils (already minimal).
15. Wood is present that acts to create micosite conditions.

Vegetation:

Common Name	Scientific Name
False Lily of the Valley	*Maianthemum dilatum*
Fringecup	*Tellima grandiflora*
Grand fir	*Abies grandis*
Lady fern	*Athyrium filix-femina*
Pacific water-parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Skunk cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Slough sedge	*Carex obnupta*
Trailing blackberry	*Rubus ursinus*
Western red cedar	*Thuja plicata*
Willow sp.	*Salix* ssp.

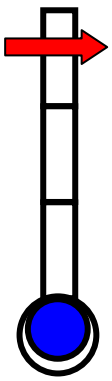
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



PFC

FAR

NF

Trend for Functional - At Risk:
___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?
___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Nott Brook A Reach 12: Channel between the wetland at 2170 Townsend Road and Townsend Road

Rating: Nonfunctional

Reach 12 is approximately 50m and extends from the top of the wetland at 2170 Townsend Road to the Townsend Road culvert. This channel is a ditch with a small Rosgen "G" channel forming in its base. This rivulet forming within the ditch is a result of soft base materials being eroded from high velocity flows entering the small ditch from larger roadside ditches parallel to Townsend Road. As such, there more water moving through the channel than it is adapted for at its size.

Landowners abutting the channel say high and fast flows occur in this channel especially during storm events. These neighbours are concerned about back yard flooding and have noted an increase in the channel flows since clearing occurred across the street for construction of the Sooke Child, Youth, and Family Centre.

Rating: Riparian vegetation is non-existent in this reach and mowed grass covers the entire area. Riparian vegetation, along with wood in the channel would be expected for this kind of system but is not present. This lack of vegetation, wood, and augmented flows have resulted in a Nonfunctional rating for this reach.

Recommendations: Improvements for this reach include planting the channel with sedges and rushes to provide stability and begin riparian vegetation establishment. The channel could be re-contoured to include step-pool morphology that would be expected for this type of landscape. Additionally, appropriate rainwater management is necessary in the upper watershed to reduce the flows entering this channel from roadside ditches.

Lotic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**		
Date:	**09-04-24**	Segment/Reach ID:	**Reach 12A: From edge of wetland at 2179 Townsend Rd. to Townsend Rd. culvert**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: "B6" with step pools

Yes	No	N/A	HYDROLOGICAL
		√	1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
	√		6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
	√		7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
	√		8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
	√		9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
	√		10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
	√		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** 0446206 / 5359005 (UTM) to N 48° 22' 54.4" W 123° 43' 32.1"

Potential channel type:
The potential Rosgen channel type is a "B6" with step pools in a coniferous/deciduous forest canopy and riparian shrubs.

Present channel type:
The present channel type is a ditch with a narrow Rosgen "G6" forming in the bottom.

Constraints:
This reach of Nott Brook is constrained by the presence of residential properties lining both banks as well as Townsend Road at the upstream end. The culvert under Townsend Road, along with the culverts running parallel to the road, direct flow into the ditch. While at the time of assessment very little water was flowing in this reach, nearby residents observe fast flows here during with winter months. Anecdotal evidence suggests that the majority of this flow comes from run-off from the road rather than from Reach 12 of Nott Brook on the east side of Townsend Road.

Potential Restoration:
The potential for restoration here is minimal as a result of the constraints mentioned above. However, it would be possible to re-dig the channel and install step weirs all the way down the channel to help manage the energy of the fast, flashy flows the channel receives. Additionally, planting sedges and other small shrubs will stabilize the banks while not encroaching extensively onto the adjacent residential properties. The vegetation will also function to evaporate and store water.

Notes:
1. Although this attribute is not applicable in this case, flooding of the small channel within the ditch does occur during flashy flow events.
3. The landscape setting suggests a B-channel should be present but that is not the case therefore, the sinuosity, width/depth ratio and gradient are not in balance.
4. The riparian area consists of mowed grass.
5. Road drainage send flashy flows through this reach.
10. There is no riparian zone.
12. This system should have wood but as there is no riparian vegetation, there is no supply.
13. The channel is not eroding on the banks but the system is flashy. Some downcutting has occurred creating a rivulet in the bottom of the ditch.
16. While it is not evident that downcutting is currently happening, this area should be monitored to ensure that it remains vertically stable.
17. There is too much water for the size of the channel. This is evidenced by the rivulet present in the bottom of the ditch.

Vegetation:

Common Name	Scientific Name
Lawn grass	

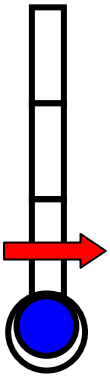
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

_√_ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _√_
No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
_√_ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Nott Brook A Reach 13: 2191 Townsend Road

Rating: Proper Functioning Condition

Reach 13 of Nott Brook is the uppermost reach of the watershed. Near the eastern edge of 2191 Townsend Road is the watershed divide between Nott Brook Watershed and Throup Watershed.

This wooded wetland/wet meadow area currently covers an area of approximately 0.65 hectares. The upper wetland consists of pockets of water and some areas of barely defined channel. The downstream end of the wooded wetland contains defined channels and ends in a culvert that directs flow under Townsend Road to the lotic channel in Reach 11. Neighbours to the site in the area indicated that Reach 11 receives high water flows, but that most of the water does not come from Reach 12 but comes instead from roadside ditches.

Vegetation in this Reach 12 is diverse with large wood both standing and felled by wind in the wetland area. Vegetation species provide good cover and include the following species: Grand fir (*Abies grandis*), Douglas fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa* ssp. *pubens*), thimbleberry (*Rubus parviflorus*), lady fern (*Athyrium filix-femina*), sword fern (*Polystichum munitum*), Daphne (*Daphne* sp.), English ivy (*Hedera helix*), false lily-of-the-valley (*Maianthemum dilatatum*), fringecup (*Tellima grandiflora*), foam flower (*Tiarella trifoliata*), meadow buttercup (*Ranunculus acris*), stink currant (*Ribes bracteosum*), Pacific bleeding heart (*Dicentra formosa*), western trillium (*Trillium ovatum*), yellow wood violet (*Viola glabella*), skunk cabbage (*Lysichiton americanum*), Pacific water parsely (*Oenanthe sarmentosa*), and sedges (*Carex* sp.).

Rating: With the abundance of vegetation and absence of erosion and other concerns, this reach is in Proper Functioning Condition.

Recommendations: At this time, the only restoration recommendation is to manage for invasive species such as English ivy and Daphne. However, this piece of property is part of a rezoning application. If changes are to occur onsite, rainwater management will need to be a top priority so runoff in roadside ditches is not increased, to prevent additional negative effects on Nott Brook downstream.

Lentic Checklist

Name of Riparian-Wetland Area:	**Nott Brook-Main Channel**
Date: **09-04-24**	Segment/Reach ID: **Reach 13A: 2191 Townsend Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**

Yes	No	N/A	HYDROLOGICAL
√			1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events
√			2) Fluctuation of water levels is not excessive
√			3) Riparian-wetland area is widening or has achieved potential extent
√			4) Upland watershed is not contributing to riparian-wetland degradation
√			5) Water quality is sufficient to support riparian-wetland plants.
√			6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e. hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities)
√			7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)

Yes	No	N/A	VEGETATION
√			8) There is a diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			9) There is a diverse composition of riparian-wetland vegetation (for maintenance/recovery)
√			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g. storm events, snowmelt)
√			12) Riparian-wetland plants exhibit high vigor
√			13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows
		√	14) Frost or abnormal hydrologic heaving is not present
√			15) Favorable microsite condition (i.e. woody material, water temperature, etc.) is maintained by adjacent site characteristics

Yes	No	N/A	EROSION DEPOSITION
√			16) Accumulation of chemicals affecting plant productivity/composition is not apparent
√			17) Saturation of soils (i.e. ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils
√			18) underlying geologic structure/soil material/permafrost is capable of restricting water percolation
√			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)
		√	20) Islands and shoreline characteristics (i.e. rocks, coarse and/or coarse woody material) are adequate to dissipate wind and wave event energies

Remarks

GPS: N 48° 22' 54.4" W 123° 43' 32.1" to N 48 22' 58.5" W 123 43' 26.4"

Constraints: The constrains for this reach include Townsend Road on the west, the Sooke Child, Youth and Family Care on the south, and a residential subdivision on the north.

Potential Restoration: Invasive species removal especially of English ivy and Daphne should be conducted to prevent further spread. This property is subject to a rezoning application.

Notes:
7. A culvert is present at the downstream end of the reach under Townsend Road.
13. The banks have lots of vegetative cover on the south side and no erosion is evident.
This reach is not a classic lentic structure. It is more of a forested woodland/wetland and has only small pockets of moist areas at the time of assessment.

Vegetation:

Common Name	**Scientific Name**
Bigleaf maple	*Acer macrophyllum*
Daphne	*Daphne* ssp.
English ivy	*Hedera helix*
False Lily of the Valley	*Maianthemum dilatum*
Foamflower	*Tiarella trifoliata*
Fringecup	*Tellima grandiflora*
Grand fir	*Abies grandis*
Lady fern	*Athyrium filix-femina*
Meadow buttercup	*Ranunculus acris*
Pacific bleeding heart	*Dicentra Formosa*
Pacific water-parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Skunk cabbage	*Lysichiton americanum*
Stink currant	*Ribes bracteosum*
Sword fern	*Polystichum munitum*
Sedge	*Carex* ssp.
Thimbleberry	*Rubus parviflorus*
Western red cedar	*Thuja plicata*
Western trillium	*Trillium ovatum*

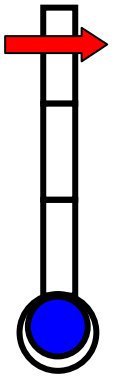
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Nott Brook Tributary (Channel B)

Summary of PFC ratings for each reach from mouth (Reach 1) to headwaters (Reach 5).

Reach	PFC Rating	Restoration
1	Nonfunctional	Invasive species, erosion, instream energy dissipation, riparian plantings, rainwater management
2	Nonfunctional	Invasive species, erosion, instream energy dissipation, riparian plantings, rainwater management
3	Proper Functioning Condition	Invasive species, riparian plantings, exclusionary fencing
4	Proper Functioning Condition	Invasive species, rainwater management
5	Proper Functioning Condition	Riparian plantings, rainwater management

Reach 1: Confluence with Nott Brook Main Channel A to West Coast Road

Rating: Nonfunctional

Reach 1 is approximately 400m long and includes the section of the channel from the tributary's confluence with the main Nott Brook channel upstream to West Coast Road. The channel in this location is a deep ditch. Historically, the landscape suggests that the channel here would have been a "C6" with accessible floodplain, sinuosity, and much shallower depth. The "C6" channel type is also representative of the potential for this reach. However, extensive restoration, including channel reconstruction would be required to reach this.

The channel is heavily constrained by residential properties on the left bank and a road and sewage treatment plant on its right bank. There is evidence of historical degradation (erosion) and as high peak flows are conducted through the channel scouring is occurring. The channel appears to be stable but does not show characteristics of a highly functioning channel. The straightness of the channel and lack of complexity means it is acting primarily as a conduit of water, rather than as a functional creek.

The vegetation in this reach is diverse, however, its growth is restricted by the deepness of the channel, as well as the residential properties and roads in the vicinity. As a result of the constraints, the riparian corridor is only about 1m wide for the majority of the reach. Near the confluence with the main Nott Brook channel downstream of the sewage treatment plant, the riparian area is wider. Vegetation species present include: Douglas fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa* ssp*. pubens*), common snowberry (*Symphoricarpos albus*), Himalayan blackberry (*Rubus armeniacus*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), Scotch broom (*Cytisus scoparius*), reed canary grass (*Phalaris arundinacea*), and marsh skullcap (*Scutellaria galericulata*).

Rating: As a result of its constrained, straightened, and deepened nature, this reach is in Nonfunctional condition.

Recommendations: In order to recreate a functional channel in this location, the creek would need to be relocated and/or rebuilt in order to overcome its present nonfunctional morphology. While this reach presents an opportunity, it is not a high priority because it is near the bottom of the watershed and is therefore, impacted by what is occurring upstream. As such, upstream reaches would need to be managed first in order to protect any work conducted at the bottom of the watershed. Additionally, the channel is currently stable and does not present a high risk of further degradation.

Lotic Checklist

Name of Riparian-Wetland Area:		**Nott Brook Trib to A**	
Date:	**09-07-23**	Segment/Reach ID:	**Reach 1: Confluence with Nott Brook main channel to West Coast Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen “C6”

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
	√		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity S
?	**?**		16) System is vertically stable (*not downcutting*)
√	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444136 5356908 to 0444881 5357465

Potential channel type:
The potential Rosgen channel type is Rosgen "C6" with floodplain access and sinuosity.

Present channel type:
The present Rosgen channel type is a ditch.

Constraints:
This reach is constrained by West Coast Road at the upstream end, residential fences/properties along the left bank and the road to the Sooke sewage treatment plant along its right bank.

Potential Restoration:
Restoration activities would involve rebuilding or relocating the creek channel so as to design its morphology to match that of a functioning "C" channel that would be in balance with the landscape setting. While an opportunity, it is of low priority as the space is so confined and the channel seems to be stable at present.

Notes:
1. The channel is ditched and is therefore deepened.
3. The channel is straightened and deepened.

4. The riparian area is constrained by the road, houses, and sewage treatment plant area.
5. The channel is historically degraded and receives high peak flows.
12. Vegetation growth is constrained by the roads, houses, and sewage treatment plant.
13. The creek cannot access its floodplain as it has been deepened and straightened. Therefore, it is functioning simply to convey water.
16. It is unknown whether the system is vertically stable as access was possible at only two entry points. In those locations it seemed to be vertically stable.
17. The channel can convey the water that is being delivered but is in not in balance as a natural stream would be. The channel is stable but is not going to heal because of ditching and because of flows it is experiencing.

Vegetation:

Common Name	Scientific Name
Bigleaf maple	*Acer macrophyllum*
Common snowberry	*Symphoricarpos alba*
Douglas fir	*Pseudotsuga menziesii*
Grasses	
Himalayan blackberry	*Rubus discolor*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Reed Canary Grass	*Phalaris arundinacea*
Red Alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Scotch broom	*Cytisus scoparius*
Sword fern	*Polystichum munitum*

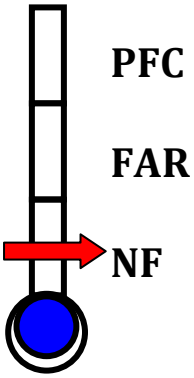
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

_√_ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Reach 2: West Coast Road to the top of 7126 West Coast Road

Rating: Nonfunctional

Reach 2 is approximately 160m long extending from the West Coast Road crossing to the upstream side of 7126 West Coast Road. The channel here has been excavated and as a result is deeper and wider than would be expected for the landscape setting. Currently, the stream is a Rosgen "G6" that is functioning as a ditch. The potential Rosgen channel type is a "C6" with a raised channel bottom, sinuosity, floodplain access, and a wider riparian-wetland area.

Erosion is visible within the channel and past downcutting has exposed a clay layer. High flows have eroded away all the softer channel materials and the remaining channel bottom is the more cohesive sediments that are more difficult to erode (i.e. clay). Despite the harder substrate, erosion is still actively occurring in this reach.

This reach is constrained on both sides by residential and community property and West Coast Road at the downstream end.

While vegetation species in this location are diverse, most of them are colonizing the top edge of the banks with few on the banks and adjacent to the channel. As a result, the banks are not stable and erosion is evident. Vegetation species present include the following: Douglas fir (*Psuedotsuga menziesii*), grand fir (*Abies grandis*), Western hemlock (*Tsuga heterophylla*), Western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), willow sp. (*Salix* ssp.), crab apple (*Malus* ssp.), Pacific ninebark (*Physocarpus capitatus*), Indian plum (*Oemleria cerasiformis*), red elderberry (*Sambucus racemosa* ssp. *pubens*), salmonberry (*Rubus spectabilis*), Himalayan blackberry (*Rubus armeniacus*), common snowberry (*Symphoricapos albus*), English holly (*Ilex aquifolium*), English ivy (*Hedera helix*), Scotch broom (*Cytisus scoparius*), sword fern (*Polystichum munitum*), skunk cabbage (*Lysichiton americanum*), Pacific bleeding heart (*Dicentra formosa*), False lily-of-the-valley (*Maianthemum dilatatum*), small-flowered bulrush (*Scirpus microcarpus*), ornamentals, and grasses.

Rating: Due to its present channel characterstics and resulting ditch functionality, as well as the erosion and downcutting, this reach is in Nonfunctional condition.

Recommendations: Restoration opportunities are present, especially adjacent to the Sooke Baptist Church, for improving function in this reach. Riparian zone restoration could occur in this location in the form of planting native riparian species and removing invasive species (i.e. Himalayan blackberry, Scotch broom, English holly, and English ivy). Additionally, in the space between the buildings and the channel, a lawn is present. Here, it would be beneficial to create a bioswale to capture and detain water that is currently flowing off Church property. Presently, water from the roof leaders enters a pipe that flows directly into the Nott Brook tributary, the downspouts of these roof leaders should be disconnected and directed to a bioswale or collected in cisterns. This would alleviate a small portion of the flows from impervious surfaces into the channel.

Lotic Checklist

Name of Riparian-Wetland Area:	**Nott Brook Trib to A**		
Date: **09-04-23**		Segment/Reach ID:	**Reach 2: West Coast Road to the top of 7126 West Coast Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen “C6”

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444896 5357500 to 0444981 5357648

Potential channel type:
The potential Rosgen channel type is Rosgen "C6" with floodplain access and a raised channel bottom.

Present channel type:
The present Rosgen channel type is a "G6" as a result of downcutting and excavation. It functions like a ditch.

Constraints:
This reach is constrained by West Coast Road at its downstream end and by adjacent residential and community property. Furthermore, past excavation and downcutting have made a gully-like reach that no longer suits the landscape setting.

Potential Restoration:
Restoration opportunities include rainwater management facilities such as a bioswale on the Church side of the creek. There is an open grassy area that would provide water storage, filtration, and energy dissipation. Additionally, roof leaders from the Church buildings should be disconnected and diverted to a swale or roof water could be collected in cisterns with overflow to a swale.

Notes:
3. A "G" channel would not be expected here. The channel is a straight, downcut, over-excavated ditch.
4. Mowed lawn is close to the edge, erosion is occurring.
5. Erosion is occurring as a result of the changed geomorphology.
11. In places, the banks are bare. Appropriate vegetation communities are present but they are not in the channel. Banks are being undercut but would likely show more erosion events if not for the clay material of the banks.
13. Energy dissipation is not occurring and the clay bank are showing wear.
15. This channel has been dug.
16. The channel shows evidence of being downcut in the past but is currently in stable condition because of the clay.
17. This reach is functioning only to convey water. Erosion is occurring and past downcutting is evident. The flow of water will continue to erode the banks where there is less clay.

Vegetation:

Common Name	**Scientific Name**
Common snowberry	*Symphoricarpos albus*
Crab apple	*Malus ssp.*
Douglas fir	*Pseudotsuga menziesii*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix*
False lily-of-the-valley	*Maianthemum dilatatum*
Grand fir	*Abies grandis*
Grasses	
Himalayan blackberry	*Rubus discolor*
Indian plum	*Oemleria cerasiformis*
Ornamentals	*various*
Pacific bleeding heart	*Dicentra formosa*
Pacific ninebark	*Physocarpus capitatus*
Red Alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp*. pubens*
Salmonberry	*Rubus spectabilis*
Scotch broom	*Cytisus scoparius*
Skunk Cabbage	*Lysichiton americanum*
Small-flowered bulrush	*Scirpus microcarpus*
Sword fern	*Polystichum munitum*
Western hemlock	*Tsuga heterophylla*

Common Name	Scientific Name
Western red cedar	*Thuja plicata*
Willow sp.	*Salix ssp.*

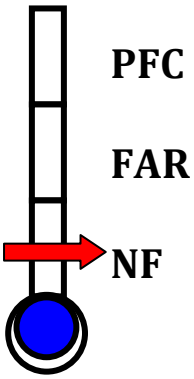
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

_√_ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Reach 3: Top of 7126 West Coast Road to 7166 West Coast Road

Rating: Proper Functioning Condition

Reach 3 extends for 100 m from 7126 to 7166 West Coast Road. The channel in this location is a Rosgen "E6", a narrow, shallow, grassy channel.

The channel alternates from pockets of wetland, to a defined channel, to a more lentic area. However, a channel exists throughout and is, therefore, classified as a lotic (creek) system.

Grass from the agricultural field extends to the edge of the bank on the west side but the eastern bank has a wider riparian-wetland zone. The vegetation species are diverse in both type and age and consist of the following: Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), red alder (*Alnus rubra*), Indian plum (*Oemleria cerasiformis*), Pacific ninebark (*Physocarpus capitatus*), salmonberry (*Rubus spectabilis*), common snowberry (*Symphoricarpos albus*), English holly (*Ilex aquifolium*), Canadian thistle (*Cirsium arvense*), Scotch broom (*Cytisus scoparius*), sword fern (*Polystichum munitum*), skunk cabbage (*Lysichiton americanum*), Pacific water parsley (*Oenanthe sarmentosa*), and grasses.

Rating: Overall, the channel is in good condition and is representative of its potential as an"E6". Historically, it would have showed more characteristics of a Rosgen "C6" as indicated by the landscape setting. However, it is presently in Proper Functioning Condition.

Recommendations: In order to maintain this PFC rating, exclusionary fencing should be considered in order to keep livestock out of the channel and prevent grazing, trampling of both the banks and roots of the riparian vegetation. The most effective use of fencing would be installed outside of the treeline to protect tree roots from trampling. Invasive species management and native riparian planting will also promote a healthier, wider riparian zone that is appropriate for habitat values and the stability of the channel and banks.

Lotic Checklist

Name of Riparian-Wetland Area:	**Nott Brook Trib to A**		
Date:	**09-04-23**	Segment/Reach ID:	**Reach 3: 7126 West Coast Road to 7166 property pin**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen "E6, C6"

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
√			14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444981 5357648 to 0444998 5357710

Potential channel type:
The potential Rosgen channel type is Rosgen "E6" or "C6".

Present channel type:
The present Rosgen channel type is an "E6" and is a narrow, grassy channel.

Constraints:
Agricultural activity occurs adjacent to the channel but does not seem to be causing any serious issues. There is the opportunity for trampling to begin degrading the channel if a barrier is not created between the grassy area and the stream.

Potential Restoration:
Fencing and planting will insure that the stream banks and stream function are protected from trampling and riparian encroachment. Exclusionary fencing should be installed outside of the treeline to protect the roots of the trees and vegetation that stabilize the banks so they are not killed unintentionally.

Notes:
4. Agricultural activity is occurring close to the edge but the riparian zone is widening inward.

Vegetation:

Common Name	**Scientific Name**
Canada thistle	*Cirsium arvense*
Common snowberry	*Symphoricarpos albus*
Douglas fir	*Pseudotsuga menziesii*
English holly	*Ilex aquifolium*
Grand fir	*Abies grandis*
Grasses	
Indian plum	*Oemleria cerasiformis*
Pacific ninebark	*Physocarpus capitatus*
Pacific water parsley	*Oenanthe sarmentosa*
Red Alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Scotch broom	*Cytisus scoparius*
Skunk Cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*

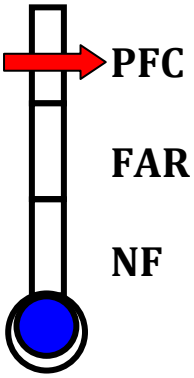
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_(except for grazing and grass growing to edge)

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Reach 4: 7166 West Coast Road to the gravel road off of Maple Avenue S.

Rating: Proper Functioning Condition

Reach 4 extends from 7166 West Coast Road, near where a tributary enters from the west, behind residential and agricultural properties to a gravel road off Maple Avenue S. This reach is lentic (wetland) with standing water at, or near, the surface, and does not have a defined channel, except where one has been excavated at the top end of the reach.

This reach has a diverse composition and age class for native riparian species and has only a few invasive species. The vegetation community present is vigorous and includes the following species: Grand fir (*Abies grandis*), Western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), Indian plum (*Oemleria cerasiformis*), salmonberry (*Rubus spectabilis*), English holly (*Ilex aquifolium*), lady fern (*Athyrium filix-femina*), sword fern (*Polystichum munitum*), false lily-of-the-valley (*Maianthemum dilatum*), Pacific bleeding heart (*Dicentra formosa*), common horsetail (*Equisetum arvense*), skunk cabbage (*Lysichiton americanum*), Pacific water parsley (*Oenanthe sarmentosa*), and sedges (*Carex* ssp).

Rating: This reach is an important piece of the Nott Brook system as it currently functions to store water and dissipate the energy of flows coming through as a result of its wide floodplain area. It is currently in Proper Functioning Condition and should be maintained as is.

Recommendations: Removal of English holly is the only recommendation for this reach. However, rezoning applications are present along Maple Avenue South and consequences of development,

especially in terms of rainwater management, should be considered in order to protect the Nott Brook watershed.

Lentic Checklist

Name of Riparian-Wetland Area:	**Nott Brook Trib to A**		
Date:	**09-04-23**	Segment/Reach ID:	**Reach 4: 7166 West Coast Road to the gravel road off Maple Avenue S.**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Yes	No	N/A	HYDROLOGICAL
√			1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events
√			2) Fluctuation of water levels is not excessive
√			3) Riparian-wetland area is widening or has achieved potential extent
√			4) Upland watershed is not contributing to riparian-wetland degradation
√			5) Water quality is sufficient to support riparian-wetland plants.
√			6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e. hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities)
		√	7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)

Yes	No	N/A	VEGETATION
√			8) There is a diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			9) There is a diverse composition of riparian-wetland vegetation (for maintenance/recovery)
√			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g. storm events, snowmelt)
√			12) Riparian-wetland plants exhibit high vigor
√			13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows
		√	14) Frost or abnormal hydrologic heaving is not present
√			15) Favorable microsite condition (i.e. woody material, water temperature, etc.) is maintained by adjacent site characteristics

Yes	No	N/A	EROSION DEPOSITION
√			16) Accumulation of chemicals affecting plant productivity/composition is not apparent
√			17) Saturation of soils (i.e. ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils
√			18) underlying geologic structure/soil material/permafrost is capable of restricting water percolation
√			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)
		√	20) Islands and shoreline characteristics (i.e. rocks, coarse and/or coarse woody material) are adequate to dissipate wind and wave event energies

Remarks

GPS: UTM 0444998 5357710 to 0445327 5357953

Constraints:
There are few constraints for this area other than private property and one small access road near the top end of the reach. Upstream portions along Maple Avenue South are up for rezoning. As such, implications to the function of the stream systems should be considered under these applications.

Potential Restoration:
There are no restoration recommendations for this reach due to its present good condition. It should be maintained as is because it is a functioning rainwater management area. Invasive species should be monitored, and when observed, removed.

Notes:
7. No structures are present.
14. Concerns regarding frost are minimal to non-existent.
20. Wind/wave events do not occur due to the protected nature of this reach. Additionally, there is not a large expanse of open water.

Vegetation:

Common Name	**Scientific Name**
Common horsetail	*Equisetum arvense*
English holly	*Ilex aquifolium*
False Lily of the Valley	*Maianthemum dilatum*
Grand fir	*Abies grandis*
Indian plum	*Oemleria cerasiformis*
Lady fern	*Athyrium filix-femina*
Pacific bleeding heart	*Dicentra formosa*
Pacific water-parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Sedges	*Carex* ssp.
Skunk cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*

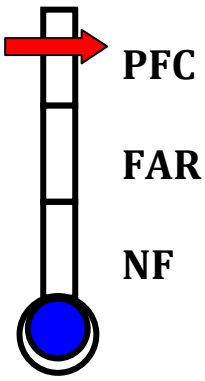
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Reach 5: Wetland area either side of Maple Avenue S.

Rating: Proper Functioning Condition

Reach 5 is the wetland area on both sides of Maple Avenue S. Downstream of Maple Avenue S. a small channel, approximately 1.5m in width, has been excavated although it does not connect to the culvert that crosses under Maple Avenue S.

Both portions of this reach are constrained by residential properties, driveways, Maple Avenue S., and the culvert under the road that may be blocked. This area is at the headwaters of the tributary and it does not experience high flows. For most of the year, water does not flow through the culvert and the upstream area acts as a detention and storage location. Downstream of the road, the excavated channel did contain water, likely collected via groundwater from upslope areas.

Vegetation in this area is less diverse than Reach 4 and the downstream portion adjacent to the excavated channel would benefit from planting additional riparian-wetland species. However, the riparian-wetland area is widening inward. Vegetation species that are present include: western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), salmonberry (*Rubus spectabilis*), lady fern (*Athyrium filix-femina*), sword fern (*Polystichum munitum*), common horsetail (*Equisetum arvense*), daffodils (*Narcissus* ssp.), skunk cabbage (*Lysichiton americanum*), Pacific water parsley (*Oenanthe sarmentosa*), and sedges (*Carex* ssp.).

Rating: This reach is in Proper Functioning Condition.

Recommendations: This reach should be protected and allowed to continue to function in its current state. Additional detention could be created within the reach by installing a small outlet structure on the channel at the downsteam portion of the reach. Riparian plantings in the downstream section would

create a wider riparian zone. Also important to note are the sections along Maple Avenue S. that subject to rezoning. Rezoning of properties along Maple Avenue should ensure that rainwater management is implemented as a part of new development to protect the functioning of these reaches of the Nott Brook watershed.

Lentic Checklist

Name of Riparian-Wetland Area:	**Nott Brook Trib to A**		
Date:	**09-04-23**	Segment/Reach ID:	**Reach 5: Wetland area either side of Maple Avenue South**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Yes	No	N/A	HYDROLOGICAL
√			1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events
√			2) Fluctuation of water levels is not excessive
√			3) Riparian-wetland area is widening or has achieved potential extent
√			4) Upland watershed is not contributing to riparian-wetland degradation
√			5) Water quality is sufficient to support riparian-wetland plants.
√			6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e. hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities)
	√		7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)

Yes	No	N/A	VEGETATION
√			8) There is a diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			9) There is a diverse composition of riparian-wetland vegetation (for maintenance/recovery)
√			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g. storm events, snowmelt)
√			12) Riparian-wetland plants exhibit high vigor
√			13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows
		√	14) Frost or abnormal hydrologic heaving is not present
√			15) Favorable microsite condition (i.e. woody material, water temperature, etc.) is maintained by adjacent site characteristics

Yes	No	N/A	EROSION DEPOSITION
√			16) Accumulation of chemicals affecting plant productivity/composition is not apparent
√			17) Saturation of soils (i.e. ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils
√			18) underlying geologic structure/soil material/permafrost is capable of restricting water percolation
√			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)
√			20) Islands and shoreline characteristics (i.e. rocks, coarse and/or coarse woody material) are adequate to dissipate wind and wave event energies

Remarks

GPS: UTM 0445327 5357953 to 0445488 5358116

Constraints:
Maple Avenue South acts as a dam in the middle of the reach separating the upstream and downstream portions. The culver under Maple Avenue South is an added constriction that may be blocked. Furthermore, an excavated channel exists in the downstream portion of this reach.

Potential Restoration:
A small weir or outlet structure could be installed at the downstream end of the wetland to build up the water level a bit as well as give some control. This will add to the detention capability of the reach for future proofing upcoming development.

Recommendation: Sooke should look into purchasing properties that are adjacent to the streams similar to what the District of Saanich has been doing.

Notes:
3. The riparian-wetland area is widening although yards do come close to the riparian zone in places.
6. Overall, surface/subsurface flow patterns have not been changed, despite the presence of Maple Avenue S. as this area receives water from adjacent slopes.
7. The culvert under Maple Ave S. may be blocked. A detention area has been created upstream. Some water still moves through.

Vegetation:

Common Name	**Scientific Name**
Common horsetail	*Equisetum arvense*
Daffodils	*Narcissus* ssp.
Lady fern	*Athyrium filix-femina*
Pacific water-parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Sedges	*Carex* ssp.
Skunk cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*

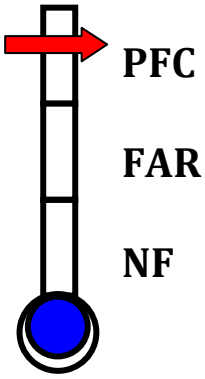
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Trend for Functional - At Risk:
___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?
___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Maple Avenue North (Channel C)-Tributary to Nott Brook

Reach	PFC Rating	Restoration
Detention Pond	N/A	Riparian and aquatic planting plantings; safety of outlet structure
1	Nonfunctional	Remove amouring, instream energy dissipation, riparian plantings, rainwater management, education
2	Functional-at-Risk (Downward Trend)	Instream energy dissipation, erosion, riparian plantings, rainwater management, education
Detention Pond	N/A	Riparian and aquatic planting plantings

Detention Pond: Maple Avenue North

Rating: N/A

The stormwater detention pond at Maple Avenue North has recently been excavated and cleared of vegetation. Native aquatic and riparian species should be planted to allow filtration of runoff that is received by the pond. Additionally, the outlet structure from the pond has been modified and may present a safety risk, should anyone fall into the pond near the outlet during a storm event.

Reach 1: Maple Avenue North, from 2134 Maple Avenue North to 2178 Maple Avenue North.

Rating: Nonfunctional

Reach 1 is approximately 175 m long and extends from 2134 Maple Avenue North to 2178 Maple Avenue North. This is an excavated channel that has been armoured for its entire length by rock. Therefore the Rosgen channel characteristic assessment cannot be applied. However, the potential Rosgen channel type is a "B3" due to the slope and character of the landscape setting. Reaching this potential will require restoration activities as discussed below.

The area surrounding the armoured channel is landscaped as part of residential development. The vegetation in this reach is sparse and landscaping and armouring prevents the widening of riparian-wetland zone. Species in this reach include the following: Western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), weeping willow (*Salix babylonica*), bamboo, dead-nettle (*Lamium* ssp.), and yellow flag iris (*Iris pseudacorus*). Sedges (*Carex* ssp.) and cattails (*Typha latifolia*) are also present but only within a small constructed wetland on one residential property.

The upland watershed is contributing nutrients, as indicated by the presence of algae growth in the downstream detention pond, along with increased flow. The flows are such that more erosion would likely

be visible were it not so heavily armoured. Bare soils are present in some locations and erosion is evident in these locations.

Rating: The constraining armouring and lack of riparian vegetation, make this reach Nonfunctional.

Recommendations: Restoration activites include homeowner education about watershed, stream, and riparian zone function, as well as rainwater management. Additionally, riparian plantings should replace the rock amouring over time, however this must be done cautiously because of the high stream flows that occur due to development in the upper watershed. Rainwater management in the upper watershed is essential to improve conditions in this reach, as well as in reaches downstream in the main channel of Nott Brook.

Lotic Checklist

Name of Riparian-Wetland Area:	**Maple Avenue N. Trib to Nott Brook**
Date: **09-04-24**	Segment/Reach ID: **Reach 1: Maple Avenue North-downstream**
ID Team Observers:	**Cori Barraclough, Brian LaCas, and Lehna Malmkvist**

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen "B3"

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
	√		6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
	√		7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
	√		8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
	√		9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
	√		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 22' 36.6" W 123° 44' 26.7" to N 48° 22' 44.0" W 123° 44' 23.6"

Potential channel type:
The potential Rosgen channel type is a Rosgen "B3".

Present channel type:
The present Rosgen channel type is a ditch that has been armoured in place and landscaped around.

Constraints:
This reach is constrained by its armouring and by the lack of riparian vegetation.

Potential Restoration:
Restoration initiatives should begin with neighbourhood education about watersheds, streams, stream function, and riparian zone. Additionally, to improve the character of the channel, native riparian planting should occur in conjunction with removing rocks. This should be conducted in stages so as to insure channel stability is maintained by vegetation and/or rock. One stormwater management wetland has filled in and is subsequently in need of maintenance.

Notes:
3. While sinuosity, width/depth ratio and gradient are in balance with landscape setting but has been armoured in place.
4. Landscaping and armouring prevents the expansion of the riparian-wetland zone.
5. Degradation is occurring via nutrient input (as evidence by algae presence) and by increased flows.
9. Riparian vegetation is minimal, rocks are withstanding the high streamflow events.
10. The riparian vegetation, although minimal, is vigorous.
11. There is not enough vegetative cover, however, the channel is stable as a result of artificial armouring.
13. The artificial armouring dissipates energy.
17. Increased flows mean the steam is not in balance with the water being supplied by the watershed; however, the channel is stable as a result of the armouring.

Vegetation:

Common Name	**Scientific Name**
Bamboo	
Cattails (in stormwater wetland only)	*Typha latifolia*
Dead-nettle	*Lamium* ssp.
Ornamentals	*various*
Red alder	*Alnus rubra*
Sedges (in stormwater wetland only)	*Carex* ssp.
Weeping willow	*Salix babylonica*

Common Name	Scientific Name
Western red cedar	*Thuja plicata*
Yellow flag iris	*Iris pseudacorus*

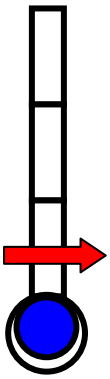
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

_√_ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _√_
No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
_√_ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Reach 2: Maple Avenue North, from 2195 Maple Avenue North to 2226 French Road South

Rating: Functional-at-Risk (Downward Trend)

Reach 2 is approximately 220 m long and extends from 2195 Maple Avenue North to 2226 French Road South. The channel is presently a Rosgen "B4" channel which is the same as its potential. However, the channel has not reached its full potential due to trampling, brush clearing, erosion, flashy flows, and garbage.

Erosion is occurring in some areas of the stream due to increased flows and the channel that is not capable of accommodating them. A native riparian zone is present, however trampling, bush clearing, and heavy shade are preventing establishment and maturation of riparian vegeation. Additionally, garbage and yard waste is being dumped within this reach.

The vegetation community is diverse in both age class and composition, however it is sparse along the banks, an not capable of providing full protection from erosion. The species present include: Douglas fir (*Pseudotsuga menziesii*), Western red cedar (*Thuja plicata*), Red alder (*Alnus rubra*), salmonberry (*Rubus spectabilis*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), Pacific bleeding heart (*Dicentra formosa*), and sedges (*Carex* sp).

Rating: As a result of erosion, trampling, high flows, and present landscape management, this reach is Functional-at-Risk with a downward trend.

Recommendations: In order to improve this reach, neighbourhood education, especially around land use activities and rainwater management will be necessary. Signage and education should include watershed, stream, and riparian zone function, as well as how landuse activities can impact these. Upstream/upslope rainwater management will be required to manage and reduce the high flows that are

causing erosion in the channel. Additionally, native riparian planting will benefit this reach. For planting to be successful, trampling will need to be stopped and areas of the canopy may need to be opened to allow more sunlight through for young plants to establish.

Lotic Checklist

Name of Riparian-Wetland Area:	**Maple Avenue N. Trib to Nott Brook**
Date: **09-04-24**	Segment/Reach ID: **Reach 2: Maple Avenue North-upstream**
ID Team Observers:	**Cori Barraclough, Brian LaCas, and Lehna Malmkvist**

Potential Riparian-Wetland Vegetation: coniferous/deciduous
Potential Channel Characteristics: Rosgen "B4"

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
	√		9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
	√		14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 22' 44.0" W 123° 44' 23.6" to N 48° 22' 44.9" W 123° 44' 22.6"

Potential channel type:
The potential Rosgen channel type is a Rosgen "B4".

Present channel type:
The present Rosgen channel type is a "B4" but it is not at its full potential. Trampling and clearing of vegetation as well as inputs of nutrients and sediment are impacting the function of this creek.

Constraints:
This reach is constrained by trampling, vegetation removal, flashy flows, garbage, and erosion.

Potential Restoration:
Restoration initiatives will involve neighbourhood education about watershed, stream, and riparian function as well as rainwater management. Signage is recommended to make more visible the functions that the stream is performing. Native riparian planting will benefit this reach by stabilizing the banks. The vegetation may need to be managed to provide more light for riparian establishment. Upstream rainwater management is also necessary to manage increased flows that are causing erosion in the channel.

Notes:
4. The channel is too shady and too much brush has been removed impacting the widening and extent of the riparian-wetland area.
5. Degradation is occurring as a result of flashy flows, erosion, and water quality issues (i.e. nutrient inputs, garbage, and fine sediment).
9. Erosion is actively occurring.
11. Erosion is actively occurring therefore, there is not enough vegetative cover.
10. The riparian vegetation, although minimal, is vigorous.
13. In some areas channel characteristcs are dissipating energy but in other sections the channel is not capable of dissipating energy and erosion is occurring.
17. Too much water is being supplied by the watershed and the channel is showing evidence of erosion.

Vegetation:

Common Name	**Scientific Name**
Douglas fir	*Pseudotsuga menziesii*
Lady fern	*Athyrium filix-femina*
Pacific bleeding heart	*Dicentra formosa*
Red alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Sedges	*Carex* ssp.
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*

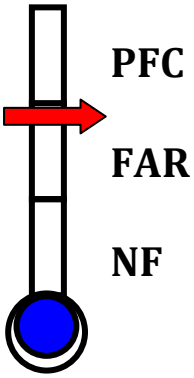
SUMMARY DETERMINATION

___Proper Functioning Condition

_√_ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
_√_ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Detention Pond: Stone Ridge Estates

Rating: N/A

A former (irrigation?) pond has been converted to a detention at Stone Ridge Estates. It has recently been excavated and the north and west sides cleared of vegetation. Some native species have been planted on the banks, however it is inadequeate to provide the riparian functions required. Native aquatic and riparian species should be planted on the banks and within the pond to allow filtration of runoff that is received by the pond from the cleared areas in the upper watershed.

Throup Stream PFC Assessments

Throup Stream Reach 1: Belvista Place to Sooke Road

Rating: Proper Functioning Condition

Reach 1 of Throup Stream extends for approximately 60m from its outlet at Belvista Place upstream to Sooke Road. The creek is located in an agricultural field area and has multiple channels. Sections of this reach have been excavated for drainage, including the portion through the middle of the field, which is aligned with the culverts under the highway.

The present channel type is a Rosgen “E6” except where it is excavated. However, the excavated portions are currently depositional areas where vegetation is establishing, effectively narrowing these channels closer to the form of a

more natural “E” channel. This portion of Throup Stream is constrained by Sooke Road to the north and Belvista Place to the south. Despite this, there is enough space for the channel to move laterally in a natural manner. As a result of these constraints, and the evidence of excavation, this reach is not at its full potential (a more fully developed “E6”).

The vegetation in this reach is impeded to a certain extent due to salt inundation as a result of the proximity to the ocean. As such, the vegetation in the area immediately adjacent to the channel and within the channel is dominated by salt-tolerant species while other less tolerant vegetation border the reach. The vegetation observed include the following: Western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), Indian plum (*Oemleria cerasiformis*), salmonberry (*Rubus spectabilis*), Himalayan blackberry (*Rubus armeniacus*), red elderberry (*Sambucus racemosa*), Nootka rose (*Rosa nutkana*), sword fern (*Polystichum munitum*), Scotch broom (*Cytisus scoparius*), stinging nettle (*Urtica dioica*), Cinquefoil (*Potentilla ssp.*), rushes (*Juncus* ssp.), seashore saltgrass (*Distichlis spicata* var*. spicata*), sea arrow grass (*Triglochin maritimum*), and various grasses.

Rating: This reach is in Proper Functioning Condition, however it is at the lowest level due to the constraints described. The vegetation is as expected for a salt-influenced area and it is presently widening inwards. Additionally, within the oldfield area, the channel has the opportunity to meander and move laterally which is consistent with “E” channel morphology.

Recommendations: In terms of restoration, this channel is recovering, and the channels are narrowing by filling in both with sediment and with vegetation. This should be allowed to proceed, and along with maturing vegetation, a more natural “E” channel will form improving this reach’s functional status. Litter should be removed from the site and any wood in the channel should be left to allow microsite habitats to develop. Additionally, riparian plantings would assist in the accelerated restoration of this reach. Native riparian species chosen will need to be salt-tolerant due to the close proximity to the ocean and tidal influence. A small log-weir could be installed immediately upstream of the culvert under Belvista Place at the confluence of the central channel and the two channels coming from the east and west. This will allow more water to pool in this location and a small wetland to develop. Additionally, the outfall culvert to the marine environment has extensive erosion around the headwall and likely requires bank stabilization to maintain the culvert.

Lotic Checklist

Name of Riparian-Wetland Area:		**Throup Stream**	
Date:	**09-04-22**	Segment/Reach ID:	**Reach 1: Belvista Place to Sooke Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: salt marsh with native riparian shrubs upslope Potential Channel Characteristics: “E6”

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√	√		4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
		√	12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 22’ 58.3” W 123° 42’ 23.3” to N 48° 22’ 59.6” W 123° 42’ 23.9”

Potential channel type:
The potential Rosgen channel type is an “E6” due to the low gradient and presence of multiple channels.

Present channel type:
The present channel type is a Rosgen “E6” except where the channel has been excavated through the middle of the field in-line with the culverts. This excavated portion is currently trying to narrow itself back to a more natural “E” form.

Constraints:
This portion of Throup Stream is constrained by Sooke Road to the north and Belvista Place to the south. However, there is area for the channel to move laterally in a natural manner due to location of the field.

Potential Restoration:
This channel is already attempting to narrow itself by filling in both with sediment and with vegetation. This should be allowed to happen in order for a more natural “E” channel to form improving this reach’s functional status. Litter should be picked up although any wood in the channel should be left to create microsite habitat. Additionally, some riparian planting would help to improve the creek function at a faster

rate. Native riparian species chosen will need to be salt-tolerant due to the close proximity to the ocean and tidal influence. A small log-weir could be installed just upstream of the culver under Belvista Place where the central channel meets up with 2 channels coming from the east and west. This will allow more water to pool in this location.

Notes:
3. The portions of the channel that have not been dug meet this attribute; however, the majority of this reach has been excavated.
4. The riparian area is inhibited by salt presence from tidal influence. Native riparian species are growing in depressions but agricultural grasses are the majority. Given times, the native area will begin to widen more.
5. There is no evidence of erosion.
10. What riparian species are present are vigorous. Given time to recover, the riparian area will widen.
16. The system is stable and the culverts dictate the elevation.
17. The upstream wetland is the first location of deposition and, as such, there is little deposition in Reach 1.

Vegetation:

Common Name	Scientific Name
Agricultural grasses	
Cinquefoil	*Potentilla ssp.*
Himalayan blackberry	*Rubus discolor*
Indian Plum	*Oemleria cerasiformis*
Nootka Rose	*Rosa nutkana*
Red alder	*Alnus rubra*
Red Elderberry	*Sambucus racemosa*
Rush	*Juncus ssp.*
Salmonberry	*Rubus spectabilis*
Scotch Broom	*Cytisus scoparius*
Sea Arrow Grass Seashore saltgrass Stinging Nettle Sword fern Western Red Cedar	*Triglochin maritimum* *Distichlis spicata* var. *spicata* *Urtica dioica* *Polystichum munitum* *Thuja plicata*

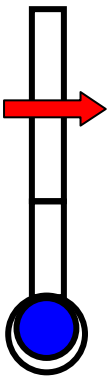
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?
___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Throup Stream Reach 2: Sooke Road to the north end of the skunk cabbage wetland

Rating: Proper Functioning Condition

Reach 2 extends for about 195m from Sooke Road upstream to the north end of the skunk cabbage wetland. This reach consists of multiple, narrow channels in a low gradient setting. As a result, the Rosgen channel type is an "E6". The potential channel type is also an "E6" and this reach is functioning in excellent condition.

Sooke Road constrains the reach on the south side and directs the channel through culverts. However, upstream of Sooke Road Throup Stream has an extensive floodplain and is able to meander across the wide valley bottom and, overall, the reach is not constrained.

The vegetation growth in this reach is mature and vigorous and represents a fully functional "E" type community. Vegetation species include the following: Douglas fir (*Pseudotsuga menziesii*), Western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), salmonberry (*Rubus spectabilis*), dull Oregon grape (*Mahonia nervosa*), sword fern (*Polystichum munitum*), Lady fern (*Athyrium filix-femina*), bracken fern (*Pteridium aquilinum*), common horsetail (*Equisetum arvense*), stink currant (*Ribes bracteosum*), silverweed (*Potentilla anserina* ssp. *pacifica*), cattail (*Typha latifolia*), skunk cabbage (*Lysichiton americanum*), Pacific water parsley (*Oenanthe sarmentosa*), seashore saltgrass (*Distichlis spicata* var. *spicata*), rushes (*Juncus* ssp.), and sedges (*Carex* ssp.).

Rating: This reach is at a high level of Proper Functional Condition.

Recommendations: This reach does not require any restoration. This reach should be protected and maintained as is to allow it to perform its natural functions.

Lotic Checklist

Name of Riparian-Wetland Area:		**Throup Stream**	
Date:	**09-04-22**	Segment/Reach ID:	**Reach 2: Sooke Road to north end of skunk cabbage field**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: sedges and rushes with coniferous/deciduous forest in upslopes Potential Channel Characteristics: "E6"

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
		√	12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 22’ 58.3” W 123° 42’ 23.3” to N 48° 23’ 07.1” W 123° 42’ 30.4”

Potential channel type:
The potential Rosgen channel type is an “E6” with multiple channels that are narrow and deep in a low gradient setting.

Present channel type:
The present channel type is a classic Rosgen “E6” in very good condition.

Constraints:
Sooke Road constrains this reach on the south side and directs the channel outlets through culverts. However, the area upstream of Sooke Road is expansive and the reach is not constrained.

Potential Restoration:
This reach is in extremely good condition and does not require any restoration. This reach should be left as is to allow it to perform its natural functions. If excavation has occurred in the past it should no longer be allowed. There is enough space in this location for water to access its floodplain and does not pose a flood risk.

Notes:
12. Some wood is present; however, it is not necessary for the functioning of the reach. If wood does enter the system it should be left to create microsite habitat areas.

Vegetation:

Common Name	Scientific Name
Bracken fern	*Pteridium aquilinum*
Cattail	*Typha latifolia*
Common horsetail	*Equisetum arvense*
Douglas Fir	*Pseudotsuga menziesii*
Dull Oregon grape	*Mahonia nervosa*
Lady fern	*Athyrium filix-femina*
Pacific Water Parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Rush	*Juncus* ssp.
Salmonberry	*Rubus spectabilis*
Seashore saltgrass	*Distichlis spicata* var. *spicata*
Sedges	*Carex* ssp.
Silverweed	*Potentilla anserina* ssp. *pacifica*
Stink Currant	*Ribes bracteosum*
Skunk Cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Western Red Cedar	*Thuja plicata*

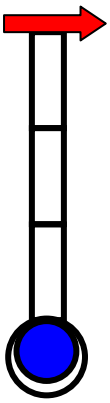
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



PFC

FAR

NF

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?
___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

Throup Stream Reach 3: North end of the skunk cabbage field to the culvert under the ROW adjacent to the ball diamond

Rating: Proper Functioning Condition

Reach 3 is approximately 95m long from the north end of the skunk cabbage field to the culvert array near the baseball diamond. North of the skunk cabbage wetland, the channel widens and has one main channel instead of multiple channels. The channel is sinuous, the gradient is low, and the floodplain is accessible. As a result, the channel was determined to have a Rosgen "C5" classification.

Constraints for this reach are present in the form of two culverts at the upstream end of the reach as well as a road right-of-way (ROW) that acts as a dike at the reach break. Additionally, some trampling is occurring adjacent to the channel particularly near the baseball field. Garbage is present near the culverts and the culvert coming from the direction of the ball diamond does have some iron bacteria discolouring (reddish-brown colour). It is unknown what is causing the presence of bacteria.

While plant communities are appropriate for this type of stream channel, there is a lack of large wood that would be expected for this reach. The vegetation composition of this reach consists of the following: Red alder (*Alnus rubra*), salmonberry (*Rubus spectabilis*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), common horsetail (*Equisetum arvense*), large-leaved avens (*Geum macrophyllum*), stink currant (*Ribes bracteosum*), skunk cabbage (*Lysichiton americanum*), and Pacific water parsley (*Oenanthe sarmentosa*).

Rating: The reach is stable and exhibits characteristics that indicate it is in Proper Functioning Condition such as sinuosity, accessible floodplain and balance erosion and sediment deposition.

Recommendations: Restoration within this reach should include an invasive species management and control plan to remove the Japanese knotweed, hogweed, and bamboo before they begin to negatively impact the native riparian vegetation community. Areas where large sections of invasive species are removed should be replanted with native riparian vegetation.

Lotic Checklist

Name of Riparian-Wetland Area:		**Throup Stream**	
Date:	**09-04-22**	Segment/Reach ID:	**Reach 3: N end skunk cabbage field to culvert under ROW adjacent to ball diamond**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: "C5"

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
	√		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
	√		14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 23' 07.1" W 123° 42' 30.4" to N 48° 23' 07.2" W 123° 42' 32.0"

Potential channel type:
The potential Rosgen channel type is a "C5" with a coniferous/deciduous forest canopy and riparian shrubs.

Present channel type:
The present channel type is a Rosgen "C5" with an appropriate vegetation canopy and accessible floodplain.

Constraints:
The constraints to the development of this reach are in the form of two culverts at the upstream end of the reach as well as a road right-of-way (ROW) that acts as a dike. Additionally, some trampling is occurring adjacent to the channel especially upstream near the ball field.

Potential Restoration:
While this reach is in good condition, the trampling should be controlled so as to prevent increasing damage to the banks and the vegetation. Native riparian planting would be beneficial in the trampled areas to start the restoration process. Coniferous trees should be planted in order to ensure that enough large wood will be available for maintenance and recovery purposes over time. Removal of the grocery cart and other garbage near the culverts should be conducted.

Notes:
5. Some signs of degradation are present including garbage in the channel and iron bacteria discolouring the channel from the culvert on the left bank. It is unknown what is causing the presence of bacteria.
7. While diverse composition of vegetation is present in this reach, there is only one type of tree, red alder. Conifers would help the channel to reach maturity and ensure it's continued functional condition.
12. While young red alder are present they do not provide an adequate source of woody material. As a "C" channel, this reach does require wood for maintaining stability and continuing natural stream processes. Planting conifers will help this.
13. More wood will be useful to maintain channel stability and protect against erosion as the substrate material is a fine-textured substrate (sand and silt).
14. Point bars are just beginning to form and are not revegetating at this point in time.
17. Some deposition is occurring by the culverts but the amount is what would be expected due to a change in gradient and the presence of the culverts. Note: Upstream erosion is occurring so the presence of an increasing sediment load should be monitored.

Vegetation:

Common Name	**Scientific Name**
Common horsetail	*Equisetum arvense*
Lady fern	*Athyrium filix-femina*
Large-Leaved Avens	*Geum macrophyllum*
Pacific Water Parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Stink Currant Skunk Cabbage Sword fern	*Ribes bracteosum* *Lysichiton americanum* *Polystichum munitum*

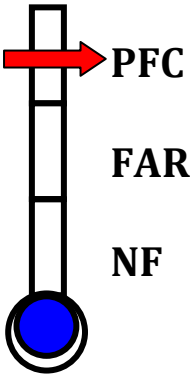
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Throup Stream Reach 4: Culvert under ROW adjacent to baseball diamond to upstream property line of 2190 Drennan St.

Rating: Functional-At-Risk with a downward trend

Reach 4 is approximately 280m long and extends upstream from the culvert near the ball diamond to 2190 Drennan St. Overall, the reach exhibits Rosgen "C4" channel characteristics; however, constraints are present, especially in the upper section of the reach. On the south bank, the slope is steep and a residential subdivision extends near to the top of the bank. On the north bank, a berm, likely constructed as part of historic land clearing activity, is reducing floodplain accessibility. Excessive erosion is occurring in the upper part of this reach (downcutting of the channel). The channel bottom is deepening and there is no floodplain access to dissipate erosive energy from high streamflow events. Adjacent to the channel at the downstream end is a large sediment detention pond, that appears to have been constructed as part of the land clearing activities on the site. As a result of the erosion and landscape constraints, this reach is not at its potential "C4" morphology.

The vegetation species in this reach are diverse and appropriate for the reach character, however the vegetative cover is insufficient to dissipate energy and protect banks from erosive forces. Additionally, invasive species are present which exclude native riparian species and further impede bank protection function. The vegetation community consists of the following species: Douglas fir (*Pseudotsuga menziesii*), Western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), Indian plum (*Oemleria cerasiformis*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa* ssp. *pubens*), Himalayan blackberry (*Rubus armeniacus*), English holly (*Ilex aquifolium*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), common horsetail (*Equisetum arvense*), large-leaved avens (*Geum macrophyllum*), stink currant (*Ribes bracteosum*),

fringecup (*Tellima grandiflora*), false-lily-of-the-valley (*Maianthemum dilatatum*), meadow buttercup (*Ranunculus acris*), skunk cabbage (*Lysichiton americanum*), Pacific water parsley (*Oenanthe sarmentosa*), and sedges (*Carex* ssp.). As erosion continues and the channel deepens, the adjacent water table will lower in elevation becoming inaccessible to the existing bank stabilizing, native riparian vegetation.

Rating: As a result of the erosion in the upper reach and the lack of native riparian vegetative cover, this reach is Functional-At-Risk with a downward trend.

Recommendations: Potential opportunities for restoration are present throughout the reach. In the upper portion of the reach large wood and weirs should be introduced in order to allow the downcutting channel to begin to rebuild the channel bottom. Invasive species removal should be conducted and native riparian vegetation planted to aid in improving the stability of the channel banks. Upstream and upslope rainwater management will be required to reduce increased rainwater inputs from development in the watershed.

Lotic Checklist

Name of Riparian-Wetland Area:		**Throup Stream**	
Date:	**09-04-22**	Segment/Reach ID:	**Reach 4: Culvert under ROW adjacent to ball diamond to upstream property line of 2190 Drennan St.**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: “C4”

Yes	No	N/A	HYDROLOGICAL
√	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
	√		14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
	√		16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 23’ 07.2” W 123° 42’ 32.0” to N 48° 23’ 02.1” W 123° 42’ 43.0”

Potential channel type:
The potential Rosgen channel type is a “C4” with a coniferous/deciduous forest canopy and riparian shrubs.

Present channel type:
The present channel type is a Rosgen “C4” with the lower portion of the reach exhibiting functional “C” character. However, the upstream portion of the reach is in declining condition due to channel erosion and decreased access to floodplain.

Constraints:
The upper portion of the reach is constrained on the right bank by a residential subdivision and on the left bank by an old berm reducing access to floodplain as floodplain areas have been reduced. Additionally, erosion is taking a toll on the channel which is downcutting in the upper portion. Just upstream of the footbridge a small headcut may be forming. Placing a weir or log here will prevent the headcut from fully forming.

Potential Restoration:
For the upper portion of the reach large wood and weirs should be introduced in order to allow the downcutting channel to build its base back up. If this is not done, the channel will continue to downcut eventually reducing the ability of vegetation to grow as the water table will drop. In the meantime, invasive species removal of vegetation such as English holly should be conducted to allow native riparian vegetation full access to the area to help with the stability of the channel. Upstream and upslope rainwater management will be required to reduce increased rainwater inputs from development in the watershed.

Notes:
1. While the lower portion of the reach has access to floodplain the upper portion does not as the channel has deepened.
3. Sinuosity and gradient are appropriate; however, the width-depth ration is altered in the upstream portion of the reach where the stream banks are too deep.
4. The riparian area is narrowing as banks are eroding. Further loss is expected if the channel continues to downcut lowering the elevation of the water table.
5. High peak flows and increased runoff have cause downcutting and widening of the channel.
6. There are few conifers in this system which are concentrated in the lower portion of the reach.
7. Invasive buttercup is taking over. A comprehensive removal plan will be required to ensure bank stability is maintained.
9. The channel is downcutting in the upstream portion.
11. While the lower portion has enough vegetation, the majority of this reach does not and erosion is evident in the downcutting channel.
12. The lower portion of the reach has enough wood but the upstream portion does not. The amount of conifers present decrease once leaving the ball diamond area.
13. Erosion is occurring in the upstream portion.
14. The channel is continually scoured and substrate is cobbly.
16. The channel is downcutting in the upstream portion.
17. Excessive erosion is occurring due to increased flow through the watershed. Evidence of deposition is seen in the lower portion of this reach as well as downstream of the culverts in Reach 3.

Vegetation:

Common Name	**Scientific Name**
Bigleaf Maple	*Acer macrophyllum*
Common horsetail	*Equisetum arvense*
Douglas Fir	*Pseudotsuga menziesii*
English holly	*Ilex aquifolium*
False Lily of the Valley	*Maianthemum dilatatum*
Fringecup	*Tellima grandiflora*
Himalayan blackberry	*Rubus armeniacus*
Indian Plum	*Oemleria cerasiformis*
Lady fern	*Athyrium filix-femina*
Large-Leaved Avens	*Geum macrophyllum*
Meadow Buttercup	*Ranunculus acris*
Pacific Water Parsley	*Oenanthe sarmentosa*
Red Alder	*Alnus rubra*
Red Elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Sedge sp. Stink Currant Skunk Cabbage Sword fern Western Hemlock	*Carex* ssp. *Ribes bracteosum* *Lysichiton americanum* *Polystichum munitum* *Tsuga heterophylla*

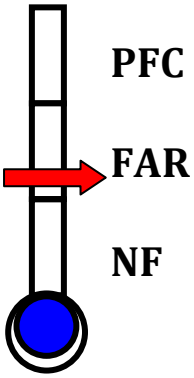
SUMMARY DETERMINATION

___Proper Functioning Condition

_√_ Functional - At Risk

___ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward

_√_ Downward

___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _√_

No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
_√_ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Throup Stream Reach 5: 2190 Drennan St. to Charter's Road

Rating: Nonfunctional

Reach 5 is approximately 170m long and extends upstream from 2190 Drennan St. to Charter's Road crossing. This reach is found within a gully and has steep slopes along both banks. This reach exhibits excessive erosion and a downcutting channel. As a result, the Rosgen channel classification is a "G4". The potential for this reach is a Rosgen "B4" and the discrepancy indicates that this reach is not in balance with the surrounding landscape characteristics.

The upstream section of the reach is constrained by Charter's Road. Drainage flows are causing heavy erosion resulting in the water carving its way deeper and deeper into the channel bottom. As a result, the water table is dropping making it more difficult for stabilizing native riparian vegetation to grow, thereby further reducing bank stability. Progressive headcuts throughout the reach have resulted in the severely downcut state of the channel. In some sections the channel is more than two metres below the top of the bank. Erosion has cut down through the sediment layers of the channel bottom and has exposed the clay at the base.

The vegetation in this reach is diverse, however the vegetative cover is insufficient to provide the root structure required to stabilize the banks. Additionally, as the water table continues to drop as a result of the eroding channel, the native riparian vegetation may not be able to access the water needed for continued establishment, leaving banks unprotected, further compounding the erosion problem. The vegetation species that are present include the following: Western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa* ssp. *pubens*), common horsetail (*Equisetum arvense*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), stinging nettle (*Urtica dioica*), fringecup (*Tellima grandiflora*),

stink currant (*Ribes bracteosum*), meadow buttercup (*Ranunculus acris*), and Pacific bleeding heart (*Dicentra formosa*).

Rating: Due to the severe downcutting, active erosion, and sparse stabilizing riparian vegetation, this reach is rated as Nonfunctional.

Recommendations: Improvement of the functional capacity of this channel will require weirs and other sediment capturing structures to be installed to dissipate energy within the channel and encourage the rebuilding of the channel bottom. Native riparian vegetation should be planted along the channel to aid in stabilization. At the culvert under Charter's Road, sediment ponds should be constructed on either side of the culvert, to slow the movement of the water and absorb some of the erosive energy.

Lotic Checklist

Name of Riparian-Wetland Area:		**Throup Stream**	
Date:	**09-04-22**	Segment/Reach ID:	**Reach 5: 2190 Drennan St. to Charter's Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous
Potential Channel Characteristics: "B4"

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
	√		9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
	√		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
	√		16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 23' 02.1" W 123° 42' 43.0" to N 48° 23' 01.6" W 123° 42' 52.0"

Potential channel type:
The potential Rosgen channel type is a "B4" with step-pool morphology to match the gradient and landscape setting.

Present channel type:
The current channel type is a Rosgen "G4" as a result of serious downcutting and gullyization of the channel.

Constraints:
The upstream section of the reach is constrained by Charter's Road. Additionally, high flows are causing heavy erosion resulting in the water carving its way deeper and deeper into the channel bottom. As a result, the water table is dropping making it more difficult for appropriate stabilizing vegetation to grow thereby reducing bank stability even more. Progressive headcuts all the way up the reach have led to the severely downcut state the channel is currently in.

Potential Restoration:
In order to improve the functional capacity of this channel, weirs and other sediment capturing structures should be implemented to encourage the raising of the channel base. Additionally, step pools should be built in to the channel to create more locations where the energy of water can be absorbed thereby protecting stream banks from high velocity flows and subsequent excessive erosion. At the culvert under Charter's Road, shock absorbers in the form of sediment ponds on either side of the culvert, will help to slow the movement of the water and absorb some of the erosive energy.

Notes:
1. The channel is deeply downcut.
3. The headcuts and subsequent downcutting of the channel have caused the sinuosity, width/depth ratio, and gradient to be out of balance with the landscape setting.
4. The channel is eroding resulting in a narrowing of the riparian area by a retreating water table and collapsing banks.
5. High peak flows and increased runoff have cause downcutting and widening of the channel.
8. Ground water in the slopes is feeding the riparian area. The water table is dropping due to the downcutting in the channel.
9. Appropriate vegetation is unable to grow immediately along the bank due to the downcut channel.
11. As with question 9, vegetation is hampered from growing immediately along the banks as a result of the heavily eroded channel.
12. Species present are not appropriate as indicated by the heavy erosion that is occurring. More conifers would be beneficial.
13. Channel characteristics are not able to dissipate energy as is evident by the heavy erosion occurring.

14. Not applicable for “B” of “G” channels.
15. Channel is confined within the gully.
16. The channel is not vertically stable as is exemplified by the progressive headcuts that have moved up the channel. Additionally, erosion is still progressing.
17. Excessive erosion is occurring due to increased flow through the watershed.

Vegetation:

Common Name	Scientific Name
Bigleaf Maple	*Acer macrophyllum*
Common horsetail	*Equisetum arvense*
Fringecup	*Tellima grandiflora*
Lady fern	*Athyrium filix-femina*
Meadow Buttercup	*Ranunculus acris*
Pacific Bleeding Hear	*Dicentra formosa*
Red Alder	*Alnus rubra*
Red Elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Stinging Nettle Stink Currant Sword fern Western Hemlock	*Urtica dioica* *Ribes bracteosum* *Polystichum munitum* *Tsuga heterophylla*

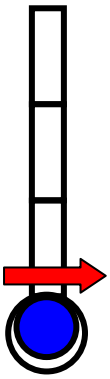
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

_√__ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _√_
No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
_√_ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Throup Stream Reach 6: Charter's Road to concrete wall upstream of Brandford Road

Rating: Functional-At-Risk with a downward trend

Reach 6 is approximately 300m long extending upstream from Charter's Road through residential areas and adjacent to another playing field area up to the concrete wall upstream of Brandford Road. The channel is slightly downcut, floodplain utilization is minimal, and erosion and riparian infringement are occurring. The downstream portion of the reach has steep slopes on either side and is in a gully. The upstream portion of the reach is not within a gully structure. As such, overall, the reach exhibits Rosgen "Cb4" characteristics. While the potential Rosgen morphology for this reach is also "Cb4" the reach is not at its potential as a result of the constraints.

Upstream of Brandford Road the channel is lined on its right bank with rip-rap. Some trampling and riparian infringement such as log piles, garbage, and lawns, are present as a result of the close proximity of residential and public areas. Additionally, at the top of the reach, Throup Stream is found within a culvert underneath an old-style residential subdivision and then in ditches upstream of the subdivision. The headwaters of Throup Stream have been heavily altered. These constraints impede the functioning of the creek by concentrating runoff and increasing flows and velocities in the creek channel.

The vegetation community in this reach consists of the following species: Douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), Western red cedar (), Western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), Indian plum (*Oemleria cerasiformis*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa* ssp. *pubens*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), deer fern (*Blechnum spicant*), stinging nettle (*Urtica dioica*), stink currant (*Ribes bracteosum*), creeping Jenny (*Lysimachia nummularia*), daphne (*Daphne* ssp.), English ivy (*Ilex aquifolium*), foamflower (*Tiarella trifoliata*), false lily-of-the-valley (*Maianthemum dilatatum*), meadow buttercup (*Ranunculus acris*), Pacific bleeding heart (*Dicentra formosa*), and periwinkle (*Vinca minor*). Vegetation in this reach is diverse, however, along the channel banks it is sparse and there is not enough present to dissipate energy and provide root structure to stablise the banks. Additionally, other stream characteristics such as rocks, overflow channels, and woody material are not adequate to protect banks. Invasive species are also present which exclude the native riparian species.

Due to the erosion, riparian infringement, and other constraints mentioned above, this reach is Functional-at-Risk with a downward trend.

Improvements to the status of this reach may be accomplished by exclusionary fencing, especially along the playfield to reduce trampling and keeping garbage out of the channel. Additionally, the Brandford Park boundary should be defined to ensure park boundaries are visible. A perched culvert is present at Brandford Road and rocks or a flume should be used to halt erosion at this site. Homeowner education should be conducted especially in locations where properties abut the creek channel along Brandford Road. Invasive species such as the daphne should be removed before they become a dominant species in the understory. Within Brandford Park, just upstream of Brandford Road, a small pond could be created to dissipate some of the energy currently being absorbed by downstream reaches that are not capable of managing these flows.

Above this reach the headwaters of Throup Stream are ditches and stormdrains that comprise the drainage for the developed areas in the watershed. Some rainwater management facilities are present for newer developments, but the rainwater management is insufficient to manage the runoff from all of the developed areas and has resulted in degrading Throup Stream.

Lotic Checklist

Name of Riparian-Wetland Area:		**Throup Stream**	
Date:	**09-04-22**	Segment/Reach ID:	**Reach 6: Charter's Road the concrete wall upstream of Brandford Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: "Cb4"

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
	√		16) System is vertically stable (*not downcutting*)
√	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** N 48° 23' 01.6" W 123° 42' 52.0" to N 48° 23' 05.7" W 123° 43' 20.6"

Potential channel type:
The potential Rosgen channel type is a "Cb4" to match the gradient and landscape setting.

Present channel type:
The current channel type is a Rosgen "Cb4" with localized areas of erosion and riparian infringement.

Constraints:
Upstream of Brandford Road the channel is lined on its right bank with rip-rap. Additionally, at the top of the reach Throup Stream is in a culvert underneath an old-style residential subdivision. Some trampling issues and riparian infringement such as log piles, gargbage, and lawns from land-owners adjacent to the creek.

Potential Restoration:
Exclusionary fencing should be considered especially along the ball park access points for safety as well as a means of reducing trampling and keeping garbage out of the channel. Brandford Park boundary should be defined to insure park boundaries are visible. A perched culvert is present at Brandford Road and rocks or a flume should be used to break this drop. Homeowner education should be conducted especially in locations where properties abut the creek channel along Brandford Road. Invasive species such as the Daphne should be removed before they become a more pronounced issue. Within Brandford Park, just upstream of Brandford Road, a pond could be created to aid in detention and remove some of the energy pressures being absorbed by downstream reaches which are no longer capable of managing these flows.

Notes:
1. The channel is slightly downcut and floodplain utilization is minimal.
3. Overall the channel is in balance with the landscape; however, some areas of slight downcutting are present.
4. Some channel erosion is present and land use activities, such as trampling, lawn, and private structures, are compromising the riparian zone.
5. Increased peak flows, trampling and the land use activities mentioned above are contributing to the degradation of this reach.
11. Trampling and land use activities are reducing riparian cover.
12. Species present are not appropriate as indicated by the heavy erosion that is occurring. More conifers would be beneficial.
13. Channel characteristics are not adequate to dissipate energy. Floodplain is minimally accessed and erosion is occurring in areas.
14. No point bars were present.
16. Downcutting is occurring.
17. Erosion and deposition are occurring and while so far are being balanced, they are becoming more pronounced and will become an issue. As such, this reach needs attention.

Vegetation:

Common Name	Scientific Name
Bigleaf Maple	*Acer macrophyllum*
Creeping Jenny	*Lysimachia nummularia*
Daphne	*Daphne* ssp.
Deer Fern	*Blechnum spicant*
Douglas Fir	*Pseudotsuga menziesii*
English Ivy	*Ilex aquifolium*
False Lily of the Valley	*Maianthemum dilatatum*
Foamflower	*Tiarella trifoliata*
Grand Fir	*Abies grandis*
Indian Plum	*Oemleria cerasiformis*
Lady fern	*Athyrium filix-femina*
Meadow Buttercup	*Ranunculus acris*
Pacific Bleeding Heart	*Dicentra formosa*
Periwinkle	*Vinca minor*
Red Alder	*Alnus rubra*
Red Elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Stinging Nettle	*Urtica dioica*
Stink Currant	*Ribes bracteosum*
Sword fern	*Polystichum munitum*
Western Hemlock	*Tsuga heterophylla*
Western Red Cedar	*Thuja plicata*

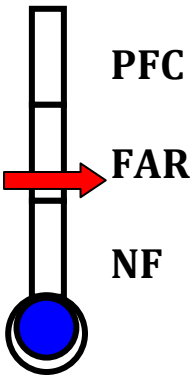
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward

_√_ Downward

___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Wright Road Creek PFC Assessments

Wright Road Creek Reach 1: Sooke Harbour to the upstream property boundary of 1729 Whiffin Spit Road

Rating: Proper Functioning Condition

Reach 1 of Wright Road Creek extends for approximately 50m from the outlet into Sooke Harbour to the upstream property boundary of 1729 Whiffin Spit Road. This reach is tidally influenced and does not have a characteristic Rosgen channel morphology. The channel has been modified and has armoured banks in the form of large rocks on both banks for the entire length of the reach. At the upstream reach break a small headcut is present that shows prevention strategies i.e. wooden boards that have been placed in front of the cut in an attempt to prevent further erosion.

The vegetation in the area immediately adjacent to the channel and within the channel is dominated by salt-tolerant species. Vegetation in this reach includes the following: Grand fir (*Abies grandis*), bigleaf maple (*Acer macrophyllum*), salmonberry (*Rubus spectabilis*), Himalayan blackberry (*Rubus armeniacus*), common snowberry (*Symphoricarpos albus*), red-flowering currant (*Ribes sanguineum*), naked broomrape (*Orobanche uniflora*), entire-leaved gumweed (*Grindelia integrifolia*), dunegrass (*Elymus mollis*), seashore saltgrass (*Distichlis spicata* var. *spicata*), sea asparagus (*Salicornia virginica*), sea plantain (*Plantago maritime* ssp. *juncoides*), and various grasses. The upslope areas are composed of mainly lawn and the landscape contour suggests that the area may have been filled in the past.

Rating: Despite the armoured banks and altered morphology, this reach is in Proper Functioning Condition. The vegetation is what would be expected for a salt-influenced area and erosion activity is also consistent with location. The small headcut at the upstream reach break is a concern and should be prevented from becoming larger.

Recommendations: Restoration opportunities for this reach include planting the upland to create shading and using weirs to create tidal pools for habitat enhancement.

Lotic Checklist

Name of Riparian-Wetland Area:		**Wright Creek**	
Date:	**09-07-23**	Segment/Reach ID:	**Reach 1: Sooke Harbour to upstream property boundary 1729 Whiffin Spit Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: salt marsh/coniferous-deciduous upstream Potential Channel Characteristics: Rosgen “E6” channel

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
		√	9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
		√	11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
		√	12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0445763 5356980 to 0445717 5356993

Potential channel type:
The potential Rosgen channel type is Rosgen "E" to match the landscape setting.

Present channel type:
The present Rosgen channel type cannot be defined in terms of Rosgen classification. It is tidally influenced and has a wide mouth that opens into Sooke Harbour. The channel has been altered anthropogenically and has rip-rap armouring the banks on both sides. The adjacent land is high compared to the surrounding area indicating it is likely fill.

Constraints:
The channel is overwide and is constrained by rip-rap armouring along both banks. Due to its proximity to sea-water, vegetation species are required to be salt tolerant.

Potential Restoration:
This reach is a low priority for restoration; however, restoration activities could include planting a section of the upland area to create shade, narrowing the channel to create fish rearing habitat, installing weirs to create tidal pool areas.

Notes:
1. The channel is tidal, so at high tides bankfull is inundated.
3. The channel is overwide in comparison to what would be expected in this landscape. It has created its own sinuosity.
4. Salt impedes vegetation growth and the gradient prevents a high water table to support obligate riparian species on the banks. The vegetation that is present is widening inward.
6. New recruitement is occurring and the vegetation is perennial and non-woody as would be expected for salt marsh areas.
8. The reach is tidally influenced so moisture character alters as tides ebb and flow.
9. The channel is not eroding, partially as a result of rip-rap armouring on both banks. The channel is tidally influenced so has a different community of plants than other riparian areas.
11. Same comments as **9**.
1**2**. Large wood is not required for this type of system.
13. Rip-rap armours both sides of the channel.

Vegetation:

Common Name	**Scientific Name**
Bigleaf maple	*Acer macrophyllum*
Common snowberry	*Symphoricarpos albus*
Dunegrass	*Elymus mollis*
Entire-leaved gumweed	*Grindelia integrifolia*
Grand fir	*Abies grandis*
Grasses	Various non-native
Himalayan blackberry	*Rubus armeniacus*
Naked broomrape	*Orobanche uniflora*
Red-flowering currant	*Ribes sanguineum*
Salmonberry	*Rubus spectabilis*
Sea asparagus	*Salicornia virginica*
Sea plantain	*Plantago maritime* ssp. *juncoides*
Seashore saltgrass	*Distichlis spicata* var. *spicata*

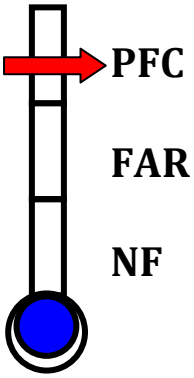
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Wright Road Creek Reach 2: Upstream property boundary of 1729 Whiffin Spit Road to the tributary confluence

Rating: Functional-at-Risk (Downward Trend)

Reach 2 extends for about 80m from 1729 Whiffin Spit Road to the tributary confluence (where the main channel takes a sharp right turn if looking upstream). The creek is heavily constrained from activities on residential properties on both banks, as well as channelisation that has occurred. The channel is a ditch and it does not have a potential Rosgen channel classification as it is too heavily modified and constrained to classify.

The channel itself is heavily eroded, especially in the upstream section adjacent to the western red cedar hedge. Erosion has cut through the banks and channel bottom to the clay layer. The downstream section is in better condition and has some sinuosity. A headcut is present at the downstream reach break and it should be managed to prevent further erosion of this reach. On the left bank residential materials such as crab traps and other scraps are piled up immediately adjacent to the channel.

The vegetation growth in this location is impeded by the steep banks, piled materials, and exposed clay soils. The vegetation community in the vicinity includes the following: Douglas fir (*Pseudotsuga menziesii*), Western red cedar (*Thuja plicata*), Garry oak (*Quercus garryana*), Sitka mountain ash (*Sorbus sitchensis*), bigleaf maple (*Acer macrophyllum*), Indian plum (*Oemleria cerasiformis*), willow sp. (*Salix* ssp.), Himalayan blackberry (*Rubus armeniacus*), English holly (*Ilex aquifolium*), Scotch broom (*Cytisus scoparius*), Daphne (*Daphne laureola*), English ivy (*Hedera helix*), English daisy (*Bellis perennis*), Orchard morning glory (*Convolvulus arvensis*), sword fern (*Polystichum munitum*), and grasses. Numerous invasive species are present which threaten the integrity of the already impeded riparian area.

Rating: Overall, this reach is characterized as Functional-at-Risk with a downward trend as a result of the erosion, minimal riparian area, invasive species, and ditched character.

Recommendations: Options for restoration include installing a rock weir at the confluence with the tributary to aid in energy dissipation, invasive species removal, removing piled materials from the left bank and planting with native riparian vegetation.

Lotic Checklist

Name of Riparian-Wetland Area:		**Wright Creek**	
Date:	**09-07-23**	Segment/Reach ID:	**Reach 2: Upstream property boundary 1729 Whiffin Spit Road to tributary confluence**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous-deciduous
Potential Channel Characteristics: Rosgen "N/A" –improved ditch

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
	√		8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
	√		9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
	√		12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
	√		16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

GPS: UTM 0445717 5356993 to 04456575 55356985

Potential channel type:
The potential channel type for this reach is an improved ditch. Re-creating a functional channel in this location would be extremely difficult due to the lack of space and degree of degradation.

Present channel type:
The current channel type is a ditch.

Constraints:
The channel is downcut and eroded to the clay layer and is bound on one side by piles of materials such as crab traps and on the other by a row of western red cedar trees. Both sides of the creek in this reach are residential properties. A headcut is present at the downstream reach break.

Potential Restoration:
The headcut should be stabilized to prevent it eroding up the channel. A rock weir could be installed at the confluence with the tributary to aid in dissipating energy prior to it flowing down the straightened, eroded main channel, invasive species removal and control should be conducted as well as the removal of the materials stored on the edge of the left bank.

Notes:
1. The channel is deep and shows evidence of being dug-out historically.
3. The channel is too deep and has been straightened likely to ensure water movement is concentrated within the ditch between the two property boundaries.
4. The vegetation community is not at its potential extent as it is impeded by invasives as well as erosion of the channel.
5. There is evidence of high peak flows and heavy erosion and downcutting has occurred in the majority of the reach.
7. Lots of invasive species are present especially in the lower portion of the reach on both banks.
8. The dominant vegetation are Himalayan blackberry and western redcedar, neither of which are water obligates. This suggests the water table has dropped and soil moisture characteristics altered.
9. Western red cedar trees present provide strong root masses.
11. While cedars are present, there are not enough of them to prevent erosion. Erosion is occurring in the channel and has downcut so much that the clay layer is exposed.
1**2**. The channel has no wood in it presently and is likely subject to clearing as a result of the close proximity of residential properties and flooding concerns. The small number of cedar trees would be the only source of large wood for this channel. While typically, wood would be expected in this type channel, it is not recommended here due to the potential for it to lead to flooding.
15. The channel is ditched; however, lateral stream movement is not a concern here.
16. This reach is vertically stable now because it has already downcut to the clay layer.
17. Excessive erosion has occurred in this reach as is evidenced by the headcut at the downstream end and by the exposed clay layer.

Vegetation:

Common Name	Scientific Name
Bigleaf maple	*Acer macrophyllum*
Daphne	*Daphne laureola*
Douglas fir	*Pseudotsuga menziesii*
English daisy	*Bellis perennis*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix*
Garry oak	*Quercus garryana*
Grasses	Various non-native
Himalayan blackberry	*Rubus armeniacus*
Indian plum	*Oemleria cerasiformis*
Orchard morning-glory	*Convolvulus arvensis*
Scotch broom	*Cytisus scoparius*
Sitka mountain-ash	*Sorbus sitchensis*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*
Willow sp.	*Salix* ssp.

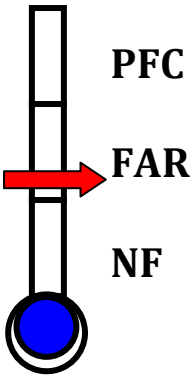
SUMMARY DETERMINATION

___Proper Functioning Condition

_√_ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _√_
No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
_√_ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
_√_ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Wright Road Creek Reach 3: The tributary confluence to Whiffin Spit Road

Rating: Proper Functioning Condition

Reach 3 of Wright Road Creek extends from the tributary confluence, upstream for 390m to where the channel crosses Whiffin Spit Road. The majority of the reach, except for a small section between Wright Road and Nordin Road, is heavily constrained within a narrow area between residential properties and roadways. The channel in some places is overly widened and deepened, but in other sections it has access to its floodplain and is sinuous showing Rosgen "C" channel characteristics. As a result, the channel is classified as a Rosgen "C4" channel with a small wetland area. The channel has a low gradient but still shows evidence of scour indicating it receives energetic water flows that it may be at risk in the long-term.

The vegetation in this reach is diverse but it does have a large number of invasive species such as Japanese knotweed and bamboo that have tendencies to be very aggressive. As such, these should be managed before they out-compete stabilizing riparian species. The vegetation composition of this reach consists of the following: Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), Western red cedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis*), bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), arbutus (*Arbutus menziesii*), willow sp. (*Salix* ssp.), Indian plum (*Oemleria cerasiformis*), oceanspray (*Holodiscus discolor*), red elderberry (*Sambucus racemosa* ssp*. pubens*), salmonberry (*Rubus spectabilis*), thimbleberry (*Rubus parviflorus*), Himalayan blackberry (*Rubus armeniacus*), Bamboo, Japanese knotweed (*Polygonum cuspidatum*), Hogweed (*Heracleum mantegazzianum*), English holly (*Ilex aquifolium*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), Orchard morning glory (*Convolvulus arvensis*), Canada thistle (*Cirsium arvense*), common horsetail (*Equisetum arvense*), marsh skullcap (*Scutellaria galericulata*), English ivy (*Hedera helix*), English daisy (*Bellis perennis*), creeping buttercup (*Ranunculus repens*), fringecup (*Tellima grandiflora*), skunk cabbage (*Lysichiton americanum*), Pacific water parsley (*Oenanthe sarmentosa*), sedges (*Carex* ssp.), and grasses.

Rating: Currently, the reach is stable and exhibits characteristics that indicate it is in Proper Functioning Condition. However, it also shows evidence in some sections that it may be receiving more energy from high flow events than it can manage effectively over the long-term. As such, the reach is at risk if further development occurs in the watershed without appropriate rainwater management.

Recommendations: Restoration within this reach should include an invasive species management and control plan, particularly to remove the knotweed, hogweed, and bamboo before they begin to negatively impact the stabilizing structure of the riparian vegetation. Areas where large sections of invasive species are removed should be replanted with native riparian vegetation.

NOTE: Along Nordin Road, new development is occurring. At the time of assessment, the area alongside the creek where new culverts have been installed had exposed soils on the slopes to the creek. This area poses a risk to the creek in terms of transportation of excess materials in to the channel, especially as winter rains begin. Locations of exposed soils near the creek should be seeded to prevent the migration of the soils to the creek. Additionally, erosion and sediment control plans would be beneficial for all development sites adjacent to the creek systems to prevent negative inputs into these waterways.

Lotic Checklist

Name of Riparian-Wetland Area:	**Wright Creek**		
Date:	**09-07-23**	Segment/Reach ID:	**Reach 3: The tributary confluence to Whiffin Spit Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous-deciduous Potential Channel Characteristics: Rosgen "C4"

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 04456575 55356985 to 0445368 5357146

Potential channel type:
The potential channel type for this reach is a Rosgen "C4" with sinuosity and floodplain access as would be expected in this form of landscape setting.

Present channel type:
The current channel type is a "C4" with some small wetland areas.

Constraints:
Invasive species such as Japanese knotweed and bamboo are present in this reach negatively impacting native riparian growth. Additionally, construction activities pose a threat in terms of sediment movement into the Wright Creek channel. The reach is segmented by road crossing and associated culverts and residential properties line the creek although generally speaking riparian buffers are present.

Potential Restoration:
Invasive species removal and control should occur immediately to prevent the spread of the Japanese knotweed and other invasives. Additionally, erosion and sediment control methods should be implemented at the development on Nordin Road to prevent currently exposed soils from migrating into the creek during rainy periods.

Notes:
1. The majority of the reach does inundate floodplain above bankfull, however, some sections such as the portion adjacent to Whiffin Spit Road do not.
3. The channel is too wide; however, overall the channel is in balance with the landscape setting.
5. The channel is too deep where the culverts are and there is some scour indicating evidence of more water than the channel can manage effectively.
7. Lots of invasive species are present.
11. The areas immediately adjacent to the culverts do not have enough vegetation to prevent erosion from the water being concentrated through the culverts.
17. There is evidence of scour especially where the culverts are. The channel is stable at this point but there is evidence that the reach may be transporting more water than it can manage over the long term. The channel is at risk if further development occurs without appropriate rainwater management.

Vegetation:

Common Name	**Scientific Name**
Arbutus	*Arbutus menziesii*
Bamboo	
Bigleaf maple	*Acer macrophyllum*
Canada thistle	*Cirsium arvense*

Common Name	Scientific Name
Common horsetail	*Equisetum arvense*
Creeping buttercup	*Ranunculus repens*
Douglas fir	*Pseudotsuga menziesii*
English daisy	*Bellis perennis*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix*
Fringecup	*Tellima grandiflora*
Grand fir	*Abies grandis*
Grasses	Various
Himalayan blackberry	*Rubus armeniacus*
Hogweed	*Heracleum mantegazzianum*
Indian plum	*Oemleria cerasiformis*
Japanese knotweed	*Polygonum cuspidatum*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Oceanspray	*Holodiscus discolor*
Orchard morning-glory	*Convolvulus arvensis*
Pacific water parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Sedges	*Carex* ssp.
Sitka spruce	*Picea sitchensis*
Skunk cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Thimbleberry	*Rubus parviflorus*
Western red cedar	*Thuja plicata*
Willow sp.	*Salix* ssp.

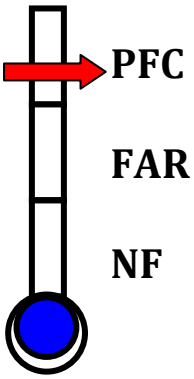
SUMMARY DETERMINATION

_√_Proper Functioning Condition (low scale)

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Wright Road Creek Reach 4: Whiffin Spit Road to the pond at 1791 Marathon Lane

Rating: Proper Functioning Condition

Reach 4 is approximately 135m long and extends upstream from Whiffin Spit Road to the large pond at 1791 Marathon Lane. This reach is low in gradient, has a narrow obvious channel portion, and a larger floodplain accessibility area. It shows characteristics of a channelized wetland, likely as a result of the presence of residential properties on either side of this reach that have constrained a former wetland to create the existing channel.

Residential properties area a constraining factor on this reach. Lawns, fences, and other materials, such as grass clippings exist in close proximity to the creek and, encroach upon the riparian zone. However, the vegetation in the riparian zone is vigorous and extends further on the left bank than the right bank. The vegetation community consists of the following species: Grand fir (*Abies grandis*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), Pacific willow (*Salix lucida* ssp*. lasiandra*), Indian plum (*Oemleria cerasiformis*), Nootka rose (*Rosa nutkana*), salmonberry (*Rubus spectabilis*), Himalayan blackberry (*Rubus armeniacus*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), Orchard morning glory (*Convolvulus arvensis*), creeping buttercup (*Ranunculus repens*), forget-me-not (*Myosotis laxa*), false lily-of-the-valley (*Maianthemum dilatatum*), marsh skullcap (*Scutellaria galericulata*), skunk cabbage (*Lysichiton americanum*), duckweed (*Lemna* ssp.), slough sedge (*Carex obnupta*), beaked sedge (*Carex rostrata*), dagger-leaved rush (*Juncus ensilfolius*), rushes (*Juncus* ssp.), sedges (*Carex* ssp.), Pacific water parsley (*Oenanthe sarmentosa*), and various grasses.

Rating: This reach of mixed lentic/lotic character is currently in Proper Functioning Condition (low scale) despite the riparian encroachment along the right bank.

Recommendations: In order to improve the functioning of this reach, native riparian planting would be beneficial especially in the locations where lawn extends to the channel. Landowner cooperation would be necessary as it would involve private property. Additionally, this could be a may have potential for detention of runoff from upstream areas, because of its low gradient. However, flooding risk would have to be assessed for the close proximity houses.

Lotic Checklist

Name of Riparian-Wetland Area:	**Wright Creek**		
Date:	**09-07-23**	Segment/Reach ID:	**Reach 4: Whiffin Spit Road to the pond at 1791 Marathon Lane**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous-deciduous Potential Channel Characteristics: Rosgen “N/A”- channelized wetland

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0445368 5357146 to 0445266 5357138

Potential channel type:
The potential channel type cannot be defined under Rosgen character as it a channelized wetland.

Present channel type:
This reach is a channelized wetland.

Constraints:
Residential properties are located almost immediately adjacent to the creek channel especially on the south bank. Additionally, previous excavation/anthropogenic activity has altered the channel form and created a lotic system in what would have historically been lentic.

Potential Restoration:
Native riparian vegetation planting would be beneficial especially in the sections where lawn is immediately adjacent to the channel. This planting would require resident cooperation and approval. There is the potential for a detention/wetland area near the top end of the reach where a lot with not buildings is present. However, flooding would have to be controlled for as flooding concerns have been discussed just upstream of this location within the last decade.

Notes:
3. This reach shows evidence of excavation.

Vegetation:

Common Name	**Scientific Name**
Beaked sedge	*Carex rostrata*
Bigleaf maple	*Acer macrophyllum*
Creeping buttercup	*Ranunculus repens*
Dagger-leaved rush	*Juncus ensilfolius*
Duckweed	*Lemna* ssp.
False Lily of the Valley	*Maianthemum dilatatum*
Forget-me-not	*Myosotis laxa*
Grand fir	*Abies grandis*
Grasses	Various
Himalayan blackberry	*Rubus armeniacus*
Indian plum	*Oemleria cerasiformis*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Nootka rose	*Rosa nutkana*
Orchard morning-glory	*Convolvulus arvensis*
Pacific water parsley	*Oenanthe sarmentosa*
Pacific willow	*Salix lucida* ssp. *lasiandra*
Red alder	*Alnus rubra*
Rushes	*Juncus* ssp.
Salmonberry	*Rubus spectabilis*
Sedges	*Carex* ssp.
Skunk cabbage	*Lysichiton americanum*
Slough sedge	*Carex obnupta*
Sword fern	*Polystichum munitum*

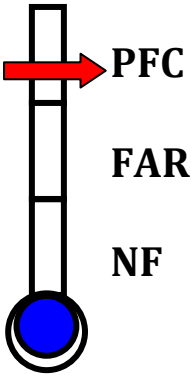
SUMMARY DETERMINATION

_√_Proper Functioning Condition (low scale)

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Wright Road Creek Reach 5: Pond at 1791 Marathon Lane

Rating: Proper Functioning Condition

Reach 5 is approximately 65m long and consists of a large pond divided by a bridged driveway. The upstream reach break is at the upstream property line of 1791 Marathon Lane where the defined pond terminates into a forested wetland area.

The pond has an artificial shoreline and has a driveway spanning across its centre. A native riparian zone does not exist as a result of the heavily manicured landscape where lawn extends to the edge of the shoreline. Some deposition is occurring in the pond and it is no longer being flushed out as often as it used to, according to the landowners. The possible reasons for this are unclear as to whether it could be the result of decreased water flow, water being backed up from downstream flows, or a decrease in the amount of rainfall.

The diversity of vegetation in this reach is low, most of the vegetation is non-native, non-riparian ornamental species in addition to lawn, cattail (*Typha latifolia*), common horsetail (*Equisetum arvense*), duckweed (*Lemna* ssp.), and skunk cabbage (*Lysichiton americanum*).

Rating: Despite the lack of riparian vegetation and the artificial shoreline, the functional characteristics of the pond are enough for it to be characterized as Proper Functioning Condition. However, it is at a very low scale due to the lack of vegetation.

Recommendations: Options for improvement would be to plant native riparian vegetation along the shoreline; however, this must be conducted with homeowner cooperation.

NOTE: This reach is the location of a stormwater pipe that flows onto 1791 Marathon Lane and then into the pond. The management of sewage along Marathon Lane is via septic tanks/fields and there have been occurrences in the past where septic has infiltrated the stormwater pipe. As a result, this septic material ends up in the ponds and, therefore, in Wright Road Creek.

Lentic Checklist

Name of Riparian-Wetland Area:	**Wright Creek**		
Date:	**09-07-23**	Segment/Reach ID:	**Reach 5: Ponds at 1791 Marathon Lane**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Yes	No	N/A	HYDROLOGICAL
√			1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events
√			2) Fluctuation of water levels is not excessive
	√		3) Riparian-wetland area is widening or has achieved potential extent
√			4) Upland watershed is not contributing to riparian-wetland degradation
√			5) Water quality is sufficient to support riparian-wetland plants.
√			6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e. hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities)
√			7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)

Yes	No	N/A	VEGETATION
	√		8) There is a diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
	√		9) There is a diverse composition of riparian-wetland vegetation (for maintenance/recovery)
√			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics
		√	11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g. storm events, snowmelt)
		√	12) Riparian-wetland plants exhibit high vigor
		√	13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows
√			14) Frost or abnormal hydrologic heaving is not present
	√		15) Favorable microsite condition (i.e. woody material, water temperature, etc.) is maintained by adjacent site characteristics

Yes	No	N/A	EROSION DEPOSITION
√			16) Accumulation of chemicals affecting plant productivity/composition is not apparent
√			17) Saturation of soils (i.e. ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils
√			18) underlying geologic structure/soil material/permafrost is capable of restricting water percolation
√			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)
√			20) Islands and shoreline characteristics (i.e. rocks, coarse and/or coarse woody material) are adequate to dissipate wind and wave event energies

Remarks

GPS: UTM 0445266 5357138 to 0445210 5357136

Constraints:
This pond is heavily manicured with ornamental vegetation species and lawn to the edge of the banks, as such, riparian vegetation is essentially non-existent. The pond is armoured around its entire circumference. Additionally, a pipe that collects stormwater off of Marathon Lane flows down a slope into the pond. Occasionally, this pipe is infiltrated by septic overflows thus resulting in septic flows also infiltrating Wright Creek.

Potential Restoration:
This reach would benefit from native riparian plantings as it has virtually no riparian vegetation. However, this would require homeowner cooperation as the ponds are entirely on private property. Further investigation should be conducted in the winter to observe flows which are no longer capable of flushing out the pond.

Notes:
1. Lawn goes to the edge of the pond.
2. There is no evidence of shoreline erosion.
3. The riparian area is being mowed, is composed of primarily lawn and ornamental vegetation.
4. The pond is silting in, and no longer flushing as has in previous years as water levels have been dropping. Plant material is accumulating. Further investigation should be conducted in the winter to observe flows.
6. The pond has an artificial shoreline and a driveway crossing it about mid-reach.
8. There is little riparian vegetation.
10. Few riparian species are present, it is heavily managed/maintained. Possible the pond may be experiencing a backwater effect from downstream as the gradient is so shallow.
11. Not applicable as the banks are armoured.
12. Riparian plants are essentially non-existent.
13. The banks are armoured.
15. There is no vegetative cover and no wood present.
19. Some deposition is occurring but this is not unusual as the gradient is shallow and energy is reduce upon hitting the open water.
20. The shoreline is armoured.

Vegetation:

Common Name	Scientific Name
Cattail	*Typha latifolia*
Common horsetail	*Equisetum arvense*
Duckweed	*Lemna* ssp.
Lawn	
Ornamentals	Various
Skunk cabbage	*Lysichiton americanum*

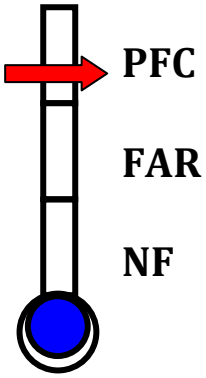
SUMMARY DETERMINATION

_√_Proper Functioning Condition (low PFC because of lack of vegetation)

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Wright Road Creek Reach 6: Wetland at 7093 West Coast Road

Rating: Proper Functioning Condition

Reach 6 consists of a forested wetland that extends for approximately 60m between the upstream property boundary of 1791 Marathon Lane and the upstream property boundary of 7093 West Coast Road. The wetland does extend beyond the upstream property boundary of 7093 West Coast Road but that area is within the T'Souke First Nation lands and is outside the scope of this project. However, conditions are likely similar as the tree canopy and understory vegetation are similar beyond the property boundary.

This reach is lentic (wetland) and spreads out over a wide area. The only constraint for this reach is the cul-de-sac of Marathon Lane which borders the south-east corner of the wetland. Currently, this area functions as a natural water detention and storage area. Although there was no flow at the time of assessment, the soils were very moist and small, shallow surface water pools were present.

Vegetation in this reach is well-developed and includes the following species: Douglas fir (*Pseudotsuga menziesii*), Western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), willow sp. (*Salix* ssp.), red elderberry (*Sambucus racemosa* ssp*. pubens*), salmonberry (*Rubus spectabilis*), lady fern (*Athyrium filix-femina*), Skunk cabbage (*Lysichiton americanum*), beaked sedge (*Carex rostrata*), and Pacific water parsley (*Oenanthe sarmentosa*).

Rating: This reach is in Proper Functioning Condition. Currently, there are no restoration requirements for this reach.

Recommendations: This reach should be protected as it provides an important natural storage and detention area for runoff. Any filling, constraining, or building in it will result in a reduced capacity for the wetland to perform this function that protects downstream reaches.

Lentic Checklist

Name of Riparian-Wetland Area:	**Wright Creek**		
Date:	**09-07-23**	Segment/Reach ID:	**Reach 6: Wetland at 7093 West Coast Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Yes	No	N/A	HYDROLOGICAL
√			1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events
√			2) Fluctuation of water levels is not excessive
√			3) Riparian-wetland area is widening or has achieved potential extent
√			4) Upland watershed is not contributing to riparian-wetland degradation
√			5) Water quality is sufficient to support riparian-wetland plants.
√			6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e. hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities)
		√	7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)

Yes	No	N/A	VEGETATION
√			8) There is a diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			9) There is a diverse composition of riparian-wetland vegetation (for maintenance/recovery)
√			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g. storm events, snowmelt)
√			12) Riparian-wetland plants exhibit high vigor
√			13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows
√			14) Frost or abnormal hydrologic heaving is not present
√			15) Favorable microsite condition (i.e. woody material, water temperature, etc.) is maintained by adjacent site characteristics

Yes	No	N/A	EROSION DEPOSITION
√			16) Accumulation of chemicals affecting plant productivity/composition is not apparent
√			17) Saturation of soils (i.e. ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils
√			18) underlying geologic structure/soil material/permafrost is capable of restricting water percolation
√			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)
√			20) Islands and shoreline characteristics (i.e. rocks, coarse and/or coarse woody material) are adequate to dissipate wind and wave event energies

Remarks

GPS: UTM 0445210 5357136 to 0445174 5357096

Constraints:
Currently this reach is not constrained. The buildings on the property are well away from the edge of the wetland and while Marathon Lane does encroach upon the wetland, this has not affected the functioning of this reach.

Potential Restoration:
This reach should be maintained as is. Presently it is a great natural water storage and detention area. Filling, compressing, or building upon it will greatly reduce the water storage and detention capability putting more pressure on the downstream reaches.

Notes:
7. No structures such as dams or spillways are present.

Vegetation:

Common Name	Scientific Name
Beaked sedge	*Carex rostrata*
Douglas fir	*Pseudotsuga menziesii*
Lady fern	*Athyrium filix-femina*
Pacific water-parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Skunk cabbage Western hemlock	*Lysichiton americanum* *Tsuga heterophylla*
Willow sp.	*Salix* ssp.

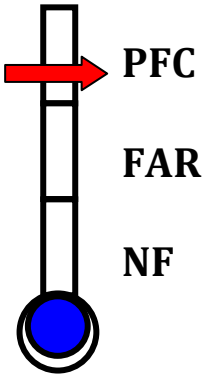
SUMMARY DETERMINATION

_√_Proper Functioning Condition (low PFC because of lack of vegetation)

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Trend for Functional - At Risk:
___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?
___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Ella Stream PFC Assessment

Summary of PFC ratings for each reach in Ella Stream from mouth (Reach 1) to headwaters (Reach 9).

Reach	PFC Rating	Restoration
1	PFC	Invasive species, large wood
2	Functional-at-Risk (Downward Trend)	Erosion, rainwater management
3	Functional-at-Risk (Downward Trend)	Invasive species, erosion, instream energy dissipation, rainwater management
3a	Proper Functioning Condition	Invasive species
4	Nonfunctional	Invasive species, erosion, instream energy dissipation, riparian plantings, rainwater management
5	Nonfunctional	Invasive species, erosion, instream energy dissipation, riparian plantings, rainwater management
6	Functional-at-Risk (Downward Trend)	Invasive species, erosion, instream energy dissipation, riparian plantings, rainwater management
7	Proper Functioning Condition	Invasive species
8	Nonfunctional	Instream energy dissipation, riparian plantings
9	Proper Functioning Condition	No restoration needed

Ella Stream Reach 1: Wetland at outlet to Juan de Fuca Strait

Rating: Proper Functioning Condition

Reach 1 is a large wetland located at the downstream-most portion of Ella Stream. It is approximately 60m by 45m and has an outlet channel directly into a man-made saltwater lagoon. This lagoon was excavated from an area that was historically (50+ years ago) an extension to the wetland.

The wetland is marine-influenced as a result of its proximity to the saltwater lagoon, salt water periodically enters the wetland through the outlet culvert at high tides. No signs of erosion are evident from wave or tidal action.

The vegetation present in this reach is diverse and vigorous. Species observed include: Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), willow sp. (*Salix* ssp.), Indian plum (*Oemleria cerasiformis*), oceanspray (*Holodiscus discolor*), salmonberry (*Rubus spectabilis*), twinberry (*Lonicera involucrata*), Himalayan blackberry (*Rubus armeniacus*), salal (*Gaultheria shallon*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), silverweed (*Potentilla anserina* ssp. *pacifica*), stink currant (*Ribes bracteosum*), marsh skullcap (*Scutellaria galericulata*), skunk cabbage (*Lysichiton americanum*), cattail (*Typha latifolia*), seashore saltgrass (*Distichilis spicata* var. *spicata*), slough sedge (*Carex obnupta*), sedges (*Carex* ssp.), and various grasses.

Rating: This reach is currently in Proper Functioning Condition.

Recommendations: In order to maintain this functioning section, invasive species management is recommended, primarily for Himalayan blackberry. Additionally, if large wood falls into the wetland it should be left to create microsite habitats. Large wood may also be added to improve habitat diversity immediately.

Lentic Checklist

Name of Riparian-Wetland Area:	**Ella Creek**		
Date:	**09-07-24**	Segment/Reach ID:	**Reach 1: Wetland at outlet to Juan de Fuca Strait**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Yes	No	N/A	HYDROLOGICAL
√			1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events
√			2) Fluctuation of water levels is not excessive
√			3) Riparian-wetland area is widening or has achieved potential extent
√			4) Upland watershed is not contributing to riparian-wetland degradation
√			5) Water quality is sufficient to support riparian-wetland plants.
√			6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e. hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities)
√			7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)

Yes	No	N/A	VEGETATION
√			8) There is a diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			9) There is a diverse composition of riparian-wetland vegetation (for maintenance/recovery)
√			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g. storm events, snowmelt)
√			12) Riparian-wetland plants exhibit high vigor
√			13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows
√			14) Frost or abnormal hydrologic heaving is not present
√			15) Favorable microsite condition (i.e. woody material, water temperature, etc.) is maintained by adjacent site characteristics

Yes	No	N/A	EROSION DEPOSITION
√			16) Accumulation of chemicals affecting plant productivity/composition is not apparent
√			17) Saturation of soils (i.e. ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils
√			18) underlying geologic structure/soil material/permafrost is capable of restricting water percolation
√			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)
√			20) Islands and shoreline characteristics (i.e. rocks, coarse and/or coarse woody material) are adequate to dissipate wind and wave event energies

Remarks

GPS: UTM 0443681 5357697 to 0443812 5357720

Constraints:
This wetland was historically much larger prior to logging activities that resulted in the creation of a lagoon for transportation of logs. Presently, the extent of the wetland is controlled by the outlet and residential areas on the southern side.

Potential Restoration:
Invasive species removal and management will protect the native riparian species and the functioning of the wetland. If trees fall into the wetland they should be allowed to remain to create habitat.

Notes:
2. This reach is tidally influenced as a result of its proximity to the salt-water lagoon.

Vegetation:

Common Name	Scientific Name
Black twinberry	*Lonicera involucrata*
Cattail	*Typha latifolia*
Common horsetail	*Equisetum arvense*
Douglas fir	*Pseudotsuga menziesii*
False Lily of the Valley	*Maianthemum dilatum*
Grasses	Various
Himalayan blackberry	*Rubus armeniacus*
Indian plum	*Oemleria cerasiformis*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Oceanspray	*Holodiscus discolor*
Red alder	*Alnus rubra*
Salal	*Gaultheria shallon*
Salmonberry	*Rubus spectabilis*
Seashore saltgrass	*Distichlis spicata* var. *spicata*
Sedges	*Carex* ssp.
Silverweed	*Potentilla anserina* ssp. *pacifica*
Sitka spruce	*Picea sitchensis*
Skunk cabbage	*Lysichiton americanum*
Slough sedge	*Carex obnupta*
Stink currant	*Ribes bracteosum*
Sword fern	*Polystichum munitum*
Western hemlock	*Tsuga heterophylla*
Western red cedar	*Thuja plicata*
Willow sp.	*Salix* ssp.

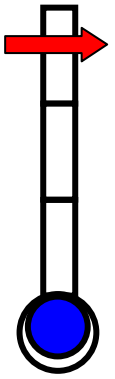
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



PFC

FAR

NF

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Ella Stream Reach 2: Lowest wetland to sediment deposition/wetland area

Rating: Functional-at-Risk (Downward Trend)

Reach 2 is approximately 250m long extending from the large wetland to another small section of wetland pockets. At the upstream reach break there is a large section of deposited sediment which contrasts sharply with the lack of sediment deposition in the downstream portion of the reach.

The Rosgen channel type for this reach is a "B5/6", an entrenched channel with silt/clay substrate, with some sands and gravels.. The potential Rosgen channel type is also a "B6" but this reach is not at its full potential due to excessive erosion occurring in the downstream portion of the reach and the excessive of the deposition occurring in the upstream portion of the reach. Additionally, the width and depth ratio are not consistent for a "B" channel and the channel is vertically unstable (downcutting), especially in the lower section. The upper section is in better condition due in part to the deposition of sediment which maintains the channel bottom. Numerous juveline salmonids were observed in the upstream section indicating good water quality, appropriate temperature, and fish accessibility.

The riparian area for this reach is expansive, extending for more than 30m from the stream banks for the majority of the reach. However, in some sections the riparian vegetation is not capable of stabilizing the banks and preventing erosion. This is likely due to historical logging and the young vegetation now present does not have a strong enough root structure to withstand the energy of the amount of water that is being carried through this system. The vegetation species are diverse and include the following: Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa* ssp.

pubens), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), common horsetail (*Equisetum arvense*), stinging nettle (*Urtica dioica*), small-flowered bulrush (*Scirpus microcarpus*).

Rating: This reach is Functional-at-Risk with a downward trend due to the excessive erosion that is occurring in the lower portion of the reach.

Recommendations: This reach needs management to control the erosion and sediment deposition. As it is near the bottom of the Ella Stream watershed, upstream management of peak flows and sediment inputs is important for the healing of this reach. To combat the erosion occurring in the lower portion of this reach, weirs could be installed but should be spaced widely (100m apart) to help build up the bottom of the channel.

Lotic Checklist

Name of Riparian-Wetland Area:		**Ella Creek**	
Date:	**09-07-24**	Segment/Reach ID:	**Reach 2: Wetland to sediment deposition wetland area**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous
Potential Channel Characteristics: Rosgen "B5/6"

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
	√		16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0443812 5357720 to 0443923 5357781

Potential channel type:
The potential Rosgen channel type is Rosgen "B5/6" to match the landscape setting.

Present channel type:
The present Rosgen channel type is a "B5/6" channel however, while the channel morphology matches the potential, its functional condition does not.

Constraints:
This channel has a sediment deficit as is evidenced by the concentration of sediment deposition at the top of this reach and the downcutting that is occurring at the downstream end of this reach. Additionally, historical logging activity damage is still slowly being corrected.

Potential Restoration:
This channel needs time to move sediment from the upstream portion of the reach to the downstream portion of the reach. Weirs may help manage erosion in the downstream portion but these should not be placed close together. If installed, weirs should be approximately 100m apart.

Notes:
1. The channel is downcut and erosion is occurring in the downstream portion of this reach.
3. The width-depth ratio is not suitable for a "B" channel as it is currently too wide and too deep. The channel shows evidence of being vertically unstable as downcutting is occurring in the downstream section of this reach.
4. The riparian area is not widening inwards and has not reached potential extent.
5. Upper watershed is contributing to degradation as a result of high peak flows.
11. Erosion is occurring, large trees are minimal suggesting they may have been removed historically.
13. Erosion is occurring in the downstream portion of the channel.
17. Erosion is occurring in the downstream portion while deposition is occurring in the upstream portion. Evidence of high peak flows is present.

Vegetation:

Common Name	**Scientific Name**
Bigleaf maple	*Acer macrophyllum*
Common horsetail	*Equisetum arvense*
Douglas fir	*Pseudotsuga menziesii*
Lady fern	*Athyrium filix-femina*
Red Alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*

Sedges	*Carex* sp.
Sitka spruce	*Picea sitchensis*
Skunk Cabbage	*Lysichiton americanum*
Small-flowered bulrush	*Scirpus microcarpus*
Stinging nettle	*Urtica dioica*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*

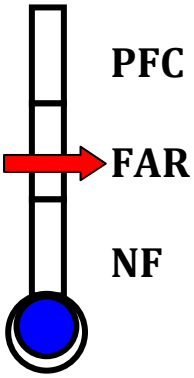
SUMMARY DETERMINATION

___Proper Functioning Condition

_√_ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward

_√_ Downward

___ Not Apparent

(Revised 1998) (7/12/04)

Ella Stream Reach 3: Sediment deposition wetland area to West Coast Road

Rating: Functional-at-Risk (Downward Trend)

Reach 3 is approximately 430m long and includes the area between the deposition section at the downstream end of the reach and West Coast Road. Bounded by Ella Road to the south and West Coast Road to the north, the creek meanders in the wide riparian/forest area in between. A tributary runs along the north edge of the forested area and meets Reach 3 near its midpoint (see next summary for description of the tributary).

The lower section of Reach 3 is in good condition showing typical Rosgen "B3" channel characteristics such as pools and riffles, with cobble as the channel material. The width-depth ratio and sinuosity correspond with the landscape setting. In at least three areas of this lower portion, juvenile salmonids were observed indicating appropriate habitat characteristics for their survival.

The upper half of Reach 3 is in poor condition. The channel has downcut for the majority of the length and has exposed clay layers which are slowly being eroded. In one section, one bank of the channel is an almost vertical clay wall with the channel bottom well below the top of bank giving it gully-like character. Damage to this portion of the reach was initially likely the result of historic logging. However, continued erosion is occurring as a result of high peak flows and the inability of the channel to manage these flows as a result of the historical degradation (young riparian vegetation is incapable of withstanding high streamflow events, therefore cannot establish bank stability). At the uppermost section of the reach, an elevated culvert acts as a fish barrier likely preventing fish from accessing the upper reaches of Ella Stream.

Vegetation plays an important role in reaches such as this as large trees and riparian root systems stabilize the banks and help dissipate the energy being received by the system. While there is a variety and abundance of vegetation in this reach, the downcut channels are preventing growth in the areas that need stabilization the most. Additionally, there is less large wood in the system than would be expected in an undisturbed condition, which also plays a role in mitigating energy effects such as erosion and downcutting. Currently, the vegetation species present include the following: Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), Indian plum (*Oemleria cerasiformis*), salmonberry (*Rubus spectabilis*), trailing blackberry (*Rubus ursinus*), red elderberry (*Sambucus racemosa* ssp. *pubens*), red huckleberry (*Vaccinium parvifolium*), English holly (*Ilex aquifolium*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), foam flower (*Tiarella trifoliata*), marsh skullcap (*Scutellaria galericulata*), stink currant (*Ribes bracteosum*), English ivy (*Hedera helix*), common horsetail (*Equisetum arvense*), false lily-of-the-valley (*Maianthemum dilatatum*), small-flowered bulrush (*Scirpus microcarpus*), skunk cabbage (*Lysichiton americanum*), and sedges (*Carex* sp.).

Rating: The lower portion of this reach is in much better condition than the upper section where most of the heavy downcutting and erosion has occurred. However, overall the reach is Functional-at-Risk with a downward trend as a result of the erosion damage. Additionally, invasive species (English holly and English ivy) are present that can negatively influence the riparian area by outcompeting native vegetation which has root systems more appropriate for bank stabilization.

Recommendations: Possible restoration options for this reach include the management of invasive species, especially English holly and English ivy, upstream management of water flows to ensure peak flows are not increasing, installing sediment ponds at the culverts to mitigate some of the energy coming out of them as well as creating a fish ladder to allow fish to migrate upstream. Log weirs installed in the channel will also help to capture sediment and help mitigate erosion, bioengineering should also be explored for bank stabilization.

Lotic Checklist

Name of Riparian-Wetland Area:	**Ella Creek**		
Date:	**09-07-24**	Segment/Reach ID:	**Reach 3: Sediment deposition wetland area to West Coast Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous
Potential Channel Characteristics: Rosgen “B3”

Yes	No	N/A	HYDROLOGICAL
		√	1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
	√		16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0443923 5357769 to 0444388 5357956

Potential channel type:
The potential Rosgen channel type is Rosgen "B3" to match the landscape setting.

Present channel type:
The present Rosgen channel type is a "B3" channel however, while the overall channel morphology matches the potential it is heavily downcut and its functional condition is not at potential.

Constraints:
This channel is constrained by heavy downcutting, historical logging activities, and the presence of invasive species. Residential housing is located in the vicinity but does not constrain the channel as it is found in a raving and the homes are on the ridge. The culverts under West Coast Road are a fish barrier as they are above the elevation of the channel. The lower half of the channel is in better condition that the upper half.

Potential Restoration:
Invasive species removal of the English holly and English ivy should happen immediately before they become fully established. Upstream water management will aid in erosion management especially in terms of high peak flows. Sediment ponds in front of the culverts will help dissipate energy of the water being concentrated through them. A fish ladder can be created near the culverts by putting in some weirs so fish can migrate upstream.

Notes:
3. The channel is wider and deeper than what would be expected for a "B" channel.
4. The riparian area is not widening inwards as the channel is eroding. Steep slopes prevent vegetation from growing down the banks.
5. Upper watershed is contributing to degradation as a result of high peak flows.
11. Erosion is occurring. Historical removal of large trees has lead to destabilization of the banks.
13. Erosion is occurring and more wood would be beneficial to aid in energy dissipation.
17. Excessive erosion has occurred but has slowed presently as the clay layer has been exposed which is difficult material to erode.

Vegetation:

Common Name	**Scientific Name**
Bigleaf maple	*Acer macrophyllum*
Common horsetail	*Equisetum arvense*
Douglas fir	*Pseudotsuga menziesii*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix*
False Lily of the Valley	*Maianthemum dilatatum*
Foamflower	*Tiarella trifoliata*
Indian plum	*Oemleria cerasiformis*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Red alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Red huckleberry	*Vaccinium parvifolium*
Salmonberry	*Rubus spectabilis*
Sedges	*Carex* sp.
Skunk cabbage	*Lysichiton americanum*
Small-flowered bulrush	*Scirpus microcarpus*
Stink currant	*Ribes bracteosum*
Sword fern	*Polystichum munitum*
Trailing blackberry	*Rubus ursinus*
Western hemlock	*Tsuga heterophylla*
Western red cedar	*Thuja plicata*

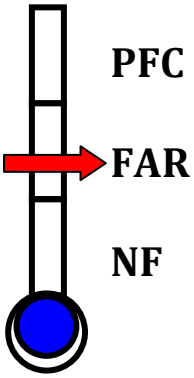
SUMMARY DETERMINATION

___Proper Functioning Condition

_√_ Functional - At Risk

___ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward

_√_ Downward

___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

(Revised 1998) (7/12/04)

Ella Stream Reach 3a: Tributary to Reach 3 – check map for tributary

Rating: Proper Functioning Condition

This tributary runs from West Coast Road and meets the main Ella Stream Reach 3 near its mid-point. This channel is representative of a Rosgen "B3" channel, similar to the main channel (entrenched channel with cobble substrate) but with less erosion and downcutting in the channel. At the time of assessment, the channel was dry.

The vegetation in this reach is composed of the same species structure as the main Reach 3 channel. These species include the following: Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), Indian plum (*Oemleria cerasiformis*), salmonberry (*Rubus spectabilis*), trailing blackberry (*Rubus ursinus*), red elderberry (*Sambucus racemosa* ssp. *pubens*), red huckleberry (*Vaccinium parvifolium*), English holly (*Ilex aquifolium*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), foam flower (*Tiarella trifoliata*), marsh skullcap (*Scutellaria galericulata*), stink currant (*Ribes bracteosum*), English ivy (*Hedera helix*), common horsetail (*Equisetum arvense*), false lily-of-the-valley (*Maianthemum dilatatum*), small-flowered bulrush (*Scirpus microcarpus*), skunk cabbage (*Lysichiton americanum*), and sedges (*Carex* sp.).

Rating: This reach is in Proper Functioning Condition.

Recommendations: Upstream water management, especially along West Coast Road will be important in order to manage runoff to prevent excessive peak flows which could degrade this tributary. Large trees are intact in the riparian zone, which is likely providing the stability to this reach. The riparian vegetation

should be protected to continue providing this function and to maintain the health of the channel. The majority of the vegetation is native, however, some invasives (English Ivy) do exist which should controlled early so as to protect the integrity of the native vegetative structure.

Lotic Checklist

Name of Riparian-Wetland Area:	**Ella Creek**
Date: **09-07-24**	Segment/Reach ID: **Reach 3a: Tributary to Reach 3**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen "B3"

Yes	No	N/A	HYDROLOGICAL
		√	1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444049 5357800 to West Coast Road

Potential channel type:
The potential Rosgen channel type is Rosgen "B3" to match the landscape setting.

Present channel type:
The present Rosgen channel type is a "B3" channel and is in good condition.

Constraints:
This reach had no obvious constraints.

Potential Restoration:
To maintain the current condition of this tributary, caution should be taken with respect to the addition of more water/higher peak flows to this area. The large trees in the area are what maintain the structure of the channel; therefore, if clearing is to happen in the area it should only occur well back from the edge of the ravine bank.

Vegetation:

Common Name	**Scientific Name**
Bigleaf maple	*Acer macrophyllum*
Common horsetail	*Equisetum arvense*
Douglas fir	*Pseudotsuga menziesii*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix*
False Lily of the Valley	*Maianthemum dilatatum*
Foamflower	*Tiarella trifoliata*
Indian plum	*Oemleria cerasiformis*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Red alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Red huckleberry	*Vaccinium parvifolium*
Salmonberry	*Rubus spectabilis*
Sedges	*Carex* sp.
Skunk cabbage	*Lysichiton americanum*
Small-flowered bulrush	*Scirpus microcarpus*
Stink currant	*Ribes bracteosum*
Sword fern	*Polystichum munitum*
Trailing blackberry	*Rubus ursinus*

Common Name	Scientific Name
Western hemlock	*Tsuga heterophylla*
Western red cedar	*Thuja plicata*

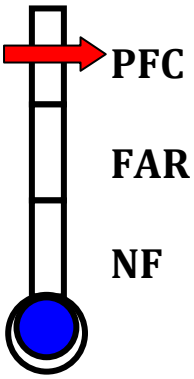
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Ella Stream Reach 4: West Coast Road to Cedar Brook Place

Rating: Nonfunctional

Reach 4 of Ella Stream is approximately 120m long and extends from West Coast Road upstream to the culverts under Cedar Brook Place. The reach flows between residential properties and is, constrained (no floodplain access) along both banks. The Rosgen channel classification for this reach is a "B3/4" channel with more cobble than gravel and evidence of pool sections.

The banks in this reach are heavily eroded and the channel bottom is downcut. Culverts both at the upstream and downstream reach breaks concentrate flows within the reach with few opportunites to dissipate energy from stream flows. Water is also injected into the channel along its banks by drainage pipes from the adjacent residential properties. The channel is overly wide and deep as a result of the erosion and riparian vegetation is not well established along the banks. Consequently, while it has the character of a Rosgen "B3/4" channel it is not at its potential.

The vegetation in this reach is diverse, however, there is not enough vegetative cover present to protect the banks and dissipate energy during high flows. The vegetation includes the following species composition: Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), salmonberry (*Rubus spectabilis*), Himalayan blackberry

(*Rubus armeniacus*), English holly (*Ilex aquifolium*), English ivy (*Hedera helix*), sword fern (*Polystichum munitum*), Lady fern (*Athyrium filix-femina*), common burdock (*Arctium minus*), marsh skullcap (*Scutellaria galericulata*), orchard morning glory (*Convolvulus arvensis*), and ornamentals. With the close proximity of residential properties, additional pressure is placed on this reach 4 as a result of the encroachment of yards, ornamental vegetation, invasive species, and yard waste.

Rating: This reach is classified as Nonfunctional due to the excessive erosion and downcutting occurring in this reach. The channel is constrained and there is inadquate vegetation to stabilize the channel against the flows it is receiving.

Recommendations: Opportunities for restoration include the installation of log and/or rock weirs to allow sediment deposition and rebuild the channel bottom. Channel bank stability may be improved through removing invasive species, planting native riparian species and bioengineering. Additionally, homeowner education may be useful in mitigating some of the riparian area encroachment and altering the amount of water moving off the properties into the creek via the drainage pipes.

Lotic Checklist

Name of Riparian-Wetland Area:	**Ella Creek**		
Date:	**09-07-24**	Segment/Reach ID:	**Reach 4: West Coast Road to Cedar Wood Place**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous
Potential Channel Characteristics: Rosgen “Bc 3/4”

Yes	No	N/A	HYDROLOGICAL
	√		1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
	√		16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444388 5357956 to 0444421 5358108

Potential channel type:
The potential Rosgen channel type is Rosgen “B 3/4” to match the landscape setting.

Present channel type:
The present Rosgen channel type is a “Bc 3/4” channel and is, therefore, not at its potential channel morphology. This channel is too wide and too deep for a “B” channel which would be expected in this landscape setting.

Constraints:
Residential properties are found on both sides of this channel and culverts are present at either end. The channel is heavily downcut, banks are steep, and roof leaders/drainage from residential areas drain directly to the creek.

Potential Restoration:
Log and/or rock weirs should be installed to reduce erosion and build up the channel bottom. A pond could be constructed at the downstream end to slow and dissipate energy prior to it being further

concentrated in the culverts. A rain barrel program or other form of roof leader disconnection program should be examined so drainage no longer goes directly to the creek from pipes.

Notes:
1. Channel is eroded and downcut so does not access floodplain areas above bankfull.
3. The channel is too deep and too wide for the landscape setting.
5. There is evidence of high peak flows and erosion, and invasive species are present.
11. Lots of erosion is occurring indicating that there is not enough riparian vegetative cover to manage flows.
12. Plant communities are an adequate source of wood, however, the wood is not currently in the channel.
13. Erosion is occurring. The channel would benefit from having wood within the channel to dissipate energy and stabilize banks.
16. The channel is downcut and eroding.
17. Excessive erosion is occurring. Culverts are present upstream and downstream which help to concentrate the energy of the water.

Vegetation:

Common Name	Scientific Name
Bigleaf maple	*Acer macrophyllum*
Common burdock	*Arctium minus*
Douglas fir	*Pseudotsuga menziesii*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix*
Himalayan blackberry	*Rubus armeniacus*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Orchard Morning glory	*Convolvulus arvensis*
Ornamentals	various
Red alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Sword fern	*Polystichum munitum*
Western red cedar	*Thuja plicata*

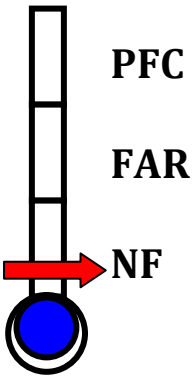
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

_√_ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?
___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Ella Stream Reach 5: Cedar Brook Place to Henlyn Road

Rating: Nonfunctional

Reach 5 of Ella Stream is located between Cedar Brook Place and Henlyn Road and is approximately 72m long. At the downstream end of the reach, the right bank is adjacent to Cedar Brook Park while the left bank borders a residential property. At the upstream end, the creek runs alongside residential properties on both banks.

Historically, this reach likely would have been a Rosgen "C" channel based on landscape character. However, it is currently functioning as a ditch, it is straightened, channelized, and armoured with large boulders. Similar to Reach 4, this reach has culverts at both ends and therefore, water is concentrated through the reach. There is little opportunity for energy to be dissipated as a result of the straightness of the channel and the lack of channel complexity, this is likely why armoured banks have been constructed, to prevent erosion. The constraining factors mean that the potential for this reach is either a ditch (as is, with poor ecological value) or as a lentic waterbody such as a pond or wetland (which would provide energy dissipation and additional ecological value).

The vegetation in this reach is diverse, and the park area on the right bank allows for a wide riparian zone on this side. However, on the left bank in the lower section of the reach, the riparian zone has been entirely cut back to the edge of the bank. As such, overall, there is not enough riparian vegetation present to protect banks and dissipate energy flow without aid (as observed by the presence of a rock wall along the left bank). The vegetation that is present consists of the following: western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), oceanspray (*Holodiscus discolor*), salmonberry (*Rubus spectabilis*), Himalayan blackberry (*Rubus armeniacus*), trailing blackberry (*Rubus ursinus*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), marsh skullcap (*Scutellaria galericulata*), and false lily-of-the-valley (*Maianthemum dilatatum*).

Rating: Overall, due to the constrained nature of the channel, its straightened and ditched character, and the encroachment of the riparian zone, this reach is Nonfunctional.

Recommendations: In order to improve its functional capacity, invasive species control (Himalayan blackberry) should be conducted in conjunction with re-planting with native riparian vegetation especially along the left bank near Cedar Brook Place. Additionally, a pond or wetland could be created with a terraced riparian zone to provide an area where the energy dissipation can occur and to provide habitat for birds and small wildlife. This pond/wetland should be created at the downstream end, near the lower culvert to help reduce the energy of the water being transported through the culvert into Reach 4.

Lotic Checklist

Name of Riparian-Wetland Area:		**Ella Creek**	
Date:	**09-07-24**	Segment/Reach ID:	**Reach 5: Cedar Wood Place to Henlyn Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous
Potential Channel Characteristics: Rosgen "N/A" – pond or ditch.

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
	√		5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444447 5358132 to 0444496 5358176

Potential channel type:
A potential Rosgen channel type could not be assigned to this reach as a result of its constrained nature. However, the possible morphology of the channel is either to remain as a ditch or become a pond.

Present channel type:
The present Rosgen channel type is a ditch.

Constraints:
Residential properties surround this reach except for the one section of Cedar Brook Park at the downstream portion of this reach. Culverts are located at the upstream and downstream ends of the reach and concentrate water flows. Riparian clearing, especially in the downstream section has removed all riparian vegetation on the left bank.

Potential Restoration:
Himalayan blackberry removal should be conducted and native riparian vegetation planted in its place. A pond just upstream of the Cedar Brook Place culvert, within park boundaries, would be beneficial to dissipate energy and provide habitat. If constructed, the pond should have terraces to accommodate a variety of riparian/aquatic species. Exclusionary fencing along the park boundary could also aid in protecting the stream from encroachment.

Notes:
3. This reach has been channelized and culverts define the upstream and downstream ends of the reach.
4. The left bank has been stripped of riparian vegetation.
5. Vegetation cutting has occurred and the culverts accelerate the flow through this reach.
10. Invasive species are present.
11. Culverts concentrate the flows resulting in a need for more vegetative cover. If banks were not rip-rapped more erosion would be evident as riparian vegetation has been removed in places.
13. The channel is rip-rapped and sediment is accumulating.
17. Deposition is occurring, the channel is silting up, and culverts are concentrating the flow of water through this reach.

Vegetation:

Common Name	Scientific Name
False Lily of the Valley	*Maianthemum dilatatum*
Himalayan blackberry	*Rubus armeniacus*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Oceanspray	*Holodiscus discolor*
Red alder	*Alnus rubra*
Salmonberry	*Rubus spectabilis*
Sword fern	*Polystichum munitum*
Trailing blackberry	*Rubus ursinus*
Western red cedar	*Thuja plicata*

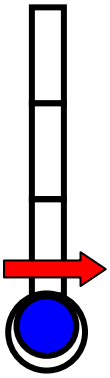
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

_√_ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Ella Stream Reach 6: Henlyn Road to 7142 Grant Road

Rating: Functional-at-Risk (Downward Trend)

Reach 6 of Ella Stream extends for approximately 85m from Henlyn Road to 7142 Grant Road. The Rosgen channel character is a "B3" due to the gradient and presence of pools with a cobble channel bottom.

As with the two reaches discussed above, Ella Stream is constrained in this location by residential properties on either side. However, in this case, there is more room between the residences in which the creek can meander. This reach also has culverts at both the upstream and downstream reach breaks. As a result, water is concentrated through the channel with little chance for energy dissipation especially in the vicinity of the culverts. This problem is represented by the overwidening of the channel in both these locations with the middle section of Reach 6 being much narrower than either of the two ends. The culvert at the upstream end travel underneath the entire 7142 Grant Road Rustic Cooperative leaving a portion of the channel enclosed for approximately 150 metres.

The vegetation in this reach is primarily native with a few invasive species. The vegetative community consists of: western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), Indian plum (*Oemleria cerasiformis*), weeping willow (*Salix babylonica*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa* ssp. *pubens*), thimbleberry (*Rubus parviflorus*), Himalayan blackberry (*Rubus armeniacus*), trailing blackberry (*Rubus ursinus*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), deer fern (*Blechnum spicant*), Gunnera (*Gunnera* ssp.), Lamium (*Lamium* ssp.), marsh skullcap (*Scutellaria galericulata*), stinging nettle (*Urtica dioica*), false lily-of-the-valley (*Maianthemum dilatatum*), Pacific water parsley (*Oenanthe sarmentosa*), and a trailing ornamental.

Rating: Reach 6 has been characterized as Functional-at-Risk with a downward trend as a result of the erosion at the upstream and downstream sections. The culverts are playing a large role in concentrating the energy of the water causing damage in this reach.

Recommendations: An invasive species removal (primarily garden ornamentals)and native planting program will benefit the reach by allowing native riparian vegetation to re-colonize the area and improve bank stability with the appropriate root systems. The creation of a pond upstream of the Henlyn Road culvert will help dissipate energy and reduce erosion. Fencing across the channel at the downstream end of the reach should be removed and rock/log weirs should be installed in the upstream portion of the channel where concentrated flows from the upstream culverts have caused erosion.

Lotic Checklist

Name of Riparian-Wetland Area:	**Ella Creek**		
Date:	**09-07-24**	Segment/Reach ID:	**Reach 6: Henlyn Road to 7142 Grant Road**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous
Potential Channel Characteristics: Rosgen "B3"

Yes	No	N/A	HYDROLOGICAL
		√	1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444496 5358176 to 0444525 5358318

Potential channel type:
The potential Rosgen channel type is a Rosgen "B3" to match the landscape setting.

Present channel type:
The present Rosgen channel type is a "B3"; however, it is not at its full potential as a result of invasive species and erosion in the upper section.

Constraints:
This reach is also bound by culverts at the upstream and downstream ends. This reach is bound on both sides by residential properties and the upstream end is found entirely within a culvert underneath the 7142 Grant Road Rustic Cooperative. Invasive species are also present in this reach especially in the downstream section near Henlyn Road.

Potential Restoration:
An invasive species removal program will benefit the reach by allowing native riparian vegetation to recolonize the area and improve banks stability with the appropriate root systems. The creation of a pond just upstream of the Henlyn Road culvert will help dissipate energy. The fencing across the channel at the downstream end should be removed and rock/log weirs should be installed in the upstream portion of the channel where concentrated flows from the upstream culverts have caused erosion.

Notes:
3. The majority of this reach has an overwidened channel except for a small portion in the middle of the reach which has a balanced width/depth ratio.
4. Invasive species are prevalent especially in the downstream section of the reach.
5. Evidence of high peak flows is present and water is being concentrated in the culverts.
11. The majority of the reach has enough vegetative covert to protect the banks, however, the very bottom portion and a section of the upstream area are showing evidence of erosion. Invasive species are concentrated on the right bank.
13. The majority of the reach has channel characteristics that dissipate energy. Evidence of erosion is primarily at the very bottom of the reach and in the upstream portion.
17. There is evidence of high flows, erosion and overwidening. It is difficult to determine if it is historically man-made or a current issue.

Vegetation:

Common Name	Scientific Name
Deer fern	*Blechnum spicant*
False Lily of the Valley	*Maianthemum dilatatum*
Gunnera	*Gunnera* ssp.
Himalayan blackberry	*Rubus armeniacus*
Indian plum	*Oemleria cerasiformis*
Lady fern	*Athyrium filix-femina*
Lamium	*Lamium* ssp.
Marsh skullcap	*Scutellaria galericulata*
Pacific water parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa* ssp. *pubens*
Salmonberry	*Rubus spectabilis*
Stinging nettle	*Urtica dioica*
Sword fern	*Polystichum munitum*
Thimbleberry	*Rubus parviflorus*
Trailing blackberry	*Rubus ursinus*
Trailing ornamental	
Weeping willow	*Salix babylonica*
Western red cedar	*Thuja plicata*

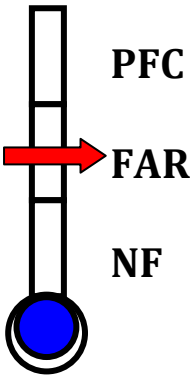
SUMMARY DETERMINATION

___Proper Functioning Condition

_√_ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___

No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward

_√_ Downward

___ Not Apparent

(Revised 1998) (7/12/04)

Ella Stream Reach 7: 7142 Grant Road to the upstream property boundary 2233 Firwood Place

Rating: Proper Functioning Condition

Reach 7 extends from 7142 Grant Road upstream for 425m to the property boundary of 2233 Firwood Place. The reach is located in a large forested area between the Grant Road Rustic Cooperative and Firwood Place; a section of this is within the boundaries of Firwood Park.

This reach cannot be defined using Rosgen terminology as it does not fit within common classification. The reach has a mixture of multiples channels and sections of ponding that span the majority of the forested area. At the time of assessment, this reach was mostly dry with some moist pockets and minimal flow where water was noted in channels.

The riparian area is wide, greater that 30m in this location and has a variety of species inhabiting the area. The vegetative community is composed of the following: Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), oceanspray (*Holodiscus discolor*), English holly (*Ilex aquifolium*), salmonberry (*Rubus spectabilis*), red huckleberry (*Vaccinium parvifolium*), thimbleberry (*Rubus parviflorus*), common snowberry (*Symphoricarpos albus*), trailing blackberry (*Rubus ursinus*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), bracken fern (*Pteridium aquilinum*), deer fern (*Blechnum spicant*), salal (*Gaultheria shallon*), false lily-of-the-valley (*Maianthemum dilatatum*), foamflower (*Tiarella trifoliata*), marsh skullcap (*Scutellaria galericulata*), Pacific bleeding heart (*Dicentra formosa*), skunk cabbage (*Lysichiton americanum*), Pacific water parsley (*Oenanthe sarmentosa*), and sedges (*Carex* ssp.).

Rating: Overall, the reach is in good condition and is in Proper Functioning Condition.

Recommendations: This reach should be protected as it is as it currently functions to capture and store water and helps to provide summer base flows and buffer peak flows. Of note, at the upstream end of the reach an old skid road is present that runs over the channel. In this area, restoration activities should include the installation of weirs to recreate pools and manage erosion. This skid road is discussed in more detail in the Reach 8 summary. Invasive species should be managed within this reach to prevent future problems with a degraded riparian vegetation community.

Lotic Checklist

Name of Riparian-Wetland Area:	**Ella Creek**		
Date:	**09-07-24**	Segment/Reach ID:	**Reach 7: 7142 Grant Road to upstream property boundary 2233 Firwood Pl**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen “N/A” forested multi-channel with wetland pockets

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444525 5358318 to 0444610 5358834

Potential channel type:
The channel character of this reach cannot be assigned a Rosgen classification due to its mixed morphology.

Present channel type:
The present channel consists of multiple channels with areas of ponding. Although it cannot be assigned Rosgen classification, it is at its potential.

Constraints:
This reach is constrained on its left bank by Firwood Place and at its downstream end by culverts. However, there is lots of room for the channels to move around within the area it is presently confined too. Additionally, at the upstream reach break a small portion of the channel has a skid road historically built over top of it.

Potential Restoration:
Restoration opportunities for this reach consist of installing log weirs at the upstream portion of the reach to narrow up the portion of the channel that is currently skid road. The rest of the reach should be protected as is as it provides storage and detention of water and aids in energy dissipation prior to water flowing through the culvert under 7142 Grant Road.

Notes:
3. Sinuosity was altered historically by logging and skidding in the upstream area.
5. A small portion of the upstream has a skid road running over it that has altered the morphology of the channel (flattened and widened it).

Vegetation:

Common Name	Scientific Name
Bracken fern	*Pteridium aquilinum*
Common snowberry	*Symphoricarpos albus*
Deer fern	*Blechnum spicant*
English holly	*Ilex aquifolium*
False Lily of the Valley	*Maianthemum dilatatum*
Foamflower	*Tiarella trifoliata*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Oceanspray	*Holodiscus discolor*
Pacific bleeding heart	*Dicentra formosa*
Pacific water parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Red huckleberry	*Vaccinium parvifolium*
Salal	*Gaultheria shallon*
Salmonberry	*Rubus spectabilis*
Skunk cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Thimbleberry	*Rubus parviflorus*
Trailing blackberry	*Rubus ursinus*
Western hemlock	*Tsuga heterophylla*
Western red cedar	*Thuja plicata*

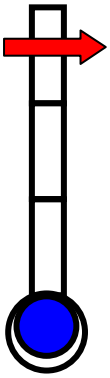
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No _√_

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Ella Stream Reach 8: Upstream property boundary 2233 Firwood Place to the upstream end of the single defined channel

Rating: Nonfunctional

Reach 8 of Ella Stream starts at the upstream property boundary of 2233 Firwood Place and continues upstream along an old skid road for approximately 50m before another forested wet area opens up. The channel is a Rosgen “B3/4”, which is the same character as its potential; however, its condition is not at potential.

This channel follows along an old skid road suggesting that when the site was logged historically, the skid road access was installed over top of the channel in the valley bottom.

The upstream section of the reach runs parallel adjacent to the skid road and provides a reference example of what the reach should look like. The channel is narrow (0.8m) and the depth is approx. 0.3m. The lower part of the reach, where the skid road was built over the channel it is wider (3m) and shallower (0.15m). There is essentially very little vegetation within the channel on the skid road, the riparian vegetation is dense in the small upstream section.

This channel experiences high velocity flows as there are no materials, wood/vegetation etc., dissipate the energy of the water. As such, bigger rocks are moving downstream and erosion is occurring along the channel and especially at the downstream reach break where a headcut is occurring. Along the skid road, there is evidence of erosion within the tire tracks.

While there is vegetation present in this reach, it is concentrated in the area outside of the skid road and active channel and is therefore, not providing the function a riparian zone should. The small section upstream shows that the vegetation should create a dense riparian zone adjacent to a narrow channel. The vegetation species present include the following: Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), oceanspray (*Holodiscus discolor*), English holly (*Ilex aquifolium*), salmonberry (*Rubus spectabilis*), red huckleberry (*Vaccinium parvifolium*), thimbleberry (*Rubus parviflorus*), common snowberry (*Symphoricarpos albus*), trailing blackberry (*Rubus ursinus*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), bracken fern (*Pteridium aquilinum*), deer fern (*Blechnum spicant*), salal (*Gaultheria shallon*), false lily-of-the-valley (*Maianthemum dilatatum*), foamflower (*Tiarella trifoliata*), marsh skullcap (*Scutellaria galericulata*), Pacific bleeding heart (*Dicentra formosa*), skunk cabbage (*Lysichiton americanum*), and Pacific water parsley (*Oenanthe sarmentosa*).

Rating: Due to the damaged created by the skid road and the erosion and lack of riparian zone function associated with this, this reach is determined to be Nonfunctional. Overall, the reach is receiving more energy than it is capable of managing as the degraded channel morphology has impeded the ability of the channel to dissipate energy, resulting in erosion within the channel.

Recommendations: This can be improved by installing rock/wood weirs to dissipate some of the energy and to re-create step-pool morphology that would be expected in this reach to manage water within the gradient, as well as to loosen compacted soil in the skid road area and replant with native riparian species. This work requires caution to prevent additional downstream sedimentation from erosion during high flows.

Lotic Checklist

Name of Riparian-Wetland Area:	**Ella Creek**		
Date:	**09-07-24**	Segment/Reach ID:	**Reach 8: Upstream property boundary 2233 Firwood Pl to the end of the single defined channel**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous Potential Channel Characteristics: Rosgen “Ba3”

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
	√		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	√		4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
	√		11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
	√		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
	√		15) Lateral stream movement is associated with natural sinuosity s
	√		16) System is vertically stable (*not downcutting*)
	√		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444610 5358834 to 0444614 5358946

Potential channel type:
The potential Rosgen channel type for this reach is a “Ba3.” While primarily showing “B” character, the slope is characteristic of an “A” in places.

Present channel type:
The present channel type is a “Ba3” however, the channel is not at its potential as it is too wide as a result of a skid road being built over top of it historically.

Constraints:
This reach is constrained as a result of a skid road having been built over top of it historically. The change in morphology has resulted in a headcut and downcutting in the lower portion of the reach as the energy of the water is not dissipated as it travels along the skid road. Additionally, survey pins for a road alignment along the creek were noted, as such, this reach is at risk from development.

Potential Restoration:
Restoration opportunities include installing a series of log weirs down the length of the channel to create step-pool morphology characteristic of “B” channels. This will narrow the currently overwidened channel.

Notes:

1. The channel is overwidened and shallow with areas of headcuts and scour. The channel is flattened by a skid road.
3. Channel is overwide and too shallow as a result of the skid road.
4. Riparian vegetation is not widening inwards and the width of the road has encroached into the riparian area.
5. The skid road has changed the morphology of the channel historically. Although not a “No” presently it is at risk as a result of the potential development.
11. Vegetation is not growing inward and narrowing the channel, the creek was historically flattened and is therefore overwide and does not have a bank per se for the majority of the reach.
13. Too much energy is not being dissipated as a result of the overwidening and isolated headcuts and erosion are occurring.
15. The water has escaped its banks as the are no defined banks due to the skid road activity.
16. Downcutting and headcuts are occurring in isolated areas. There is the potential for these to get much worse if the upper watershed is developed.
17. The channel is being exposed to too much energy which it is unable to manage as a result of it being over wide. Development, including any form of clearing, could exacerbate this issue as the vegetation will no longer be present to store and evapotranspirate water increasing flows downstream.

Vegetation:

Common Name	**Scientific Name**
Bracken fern	*Pteridium aquilinum*
Common snowberry	*Symphoricarpos albus*
Deer fern	*Blechnum spicant*
English holly	*Ilex aquifolium*
False Lily of the Valley	*Maianthemum dilatatum*
Foamflower	*Tiarella trifoliata*
Fringecup	*Tellima grandiflora*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Oceanspray	*Holodiscus discolor*
Pacific bleeding heart	*Dicentra formosa*
Pacific water parsley	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*
Red huckleberry	*Vaccinium parvifolium*
Salal	*Gaultheria shallon*
Salmonberry	*Rubus spectabilis*
Skunk cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Thimbleberry	*Rubus parviflorus*
Trailing blackberry	*Rubus ursinus*
Western hemlock	*Tsuga heterophylla*
Western red cedar	*Thuja plicata*

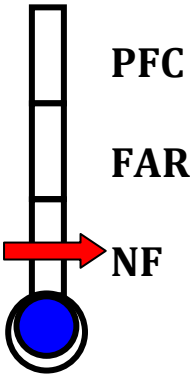
SUMMARY DETERMINATION

___Proper Functioning Condition

___ Functional - At Risk

_√_ Nonfunctional

___ Unknown



Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _√_
No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
_√_ Other (property not owned by Sooke)

Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

(Revised 1998) (7/12/04)

Ella Stream Reach 9: The upstream end of the single defined channel to the bedrock outcrops (top of watershed)

Rating: Proper Functioning Condition

Reach 9 is the top of the Ella Stream Watershed and extends for approximately 295m from the end of the single defined channel to the bedrock outcrops. As with Reach 7, Reach 9 cannot be defined using Rosgen terminology as it is composed of multiple channels and intermittent moist, ponding areas. At the time of assessment, no flows were observed but the soils were moist.

The vegetation is well developed in this reach and consists of the following species: Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), oceanspray (*Holodiscus discolor*), English holly (*Ilex aquifolium*), salmonberry (*Rubus spectabilis*), red huckleberry (*Vaccinium parvifolium*), thimbleberry (*Rubus parviflorus*), common snowberry (*Symphoricarpos albus*), trailing blackberry (*Rubus ursinus*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), bracken fern (*Pteridium aquilinum*), deer fern (*Blechnum spicant*), salal (*Gaultheria shallon*), false lily-of-the-valley (*Maianthemum dilatatum*), foamflower (*Tiarella trifoliata*), marsh skullcap (*Scutellaria galericulata*), Pacific bleeding heart (*Dicentra formosa*), skunk cabbage (*Lysichiton americanum*), and Pacific water parsley (*Oenanthe sarmentosa*).

This reach presents a good example of how important vegetation is to the management of water. The soils here are shallow and the bedrock is close to the surface meaning there is not much opportunity for soils to absorb and store water. The vegetation is involved in interception and evaporation so has the

ability to capture, store, and move water. Without the vegetation, there would be very little ability for this landscape to absorb water and, therefore, flows in downstream reaches would be increased.

Rating: this reach is in Proper Functioning Condition. As it is the top of the Ella Stream watershsed, it should be maintained as is in order to provide and store water for the downstream reaches

Recommendations: Vegetation in this reach is essential to the management of the surface water in this area and should be maintained to retain rainfall and provide buffering for downstream areas.

Lotic Checklist

Name of Riparian-Wetland Area:	**Ella Creek**		
Date:	**09-07-24**	Segment/Reach ID:	**Reach 9: The end of the single defined channel to the bedrock outcrops (top of watershed)**
ID Team Observers:	**Cori Barraclough, Sarah Buchanan, Brian LaCas, and Lehna Malmkvist**		

Potential Riparian-Wetland Vegetation: coniferous/deciduous
Potential Channel Characteristics: Rosgen "N/A"- forest floor channel with areas of ponding, headwaters

Yes	No	N/A	HYDROLOGICAL
√			1) Floodplain above bankfull is inundated in "relatively frequent" events
		√	2) Where beaver dams are present are they active and stable
√			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
√			4) Riparian-wetland area is widening or has achieved potential extent
√			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
√			6) Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
√			7) Diverse composition of riparian-wetland vegetation (for maintenance/recovery) (*species present*)
√			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
√			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events (*community types present*)
√			10) Riparian-wetland plants exhibit high vigor
√			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows (*enough*)
√			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION DEPOSITION
√			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy
		√	14) Point bars are revegetating with riparian-wetland vegetation
√			15) Lateral stream movement is associated with natural sinuosity s
√			16) System is vertically stable (*not downcutting*)
√			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

***GPS*:** UTM 0444614 5358946 to 0444575 5358569

Potential channel type:
A potential Rosgen channel type cannot be assigned as the morphology does not fit Rosgen classification.

Present channel type:
The present channel is a forest floor channel with areas of ponding. This reach consists of the headwaters for Ella Creek.

Constraints:
Some garbage, namely used automobile tires, have been dumped, likely from the top of the adjacent bedrock outcrops, into this reach. Additionally, this reach is at risk from potential development. The soils are shallow and bedrock outcrops are close to the surface indicating that most of the water storage and interception is conducted by the vegetation. Removal of the vegetation would decrease the storage capacity significantly exposing this reach, and those reaches downstream, to increased water flows and energy.

Potential Restoration:
Restoration opportunities include removal of the tires and maintenance of this reach as a water storage area.

Notes:
5. There is evidence of planned development in the form

Vegetation:

Common Name	**Scientific Name**
Bracken fern	*Pteridium aquilinum*
Common snowberry	*Symphoricarpos albus*
Deer fern	*Blechnum spicant*
English holly	*Ilex aquifolium*
False Lily of the Valley	*Maianthemum dilatatum*
Fringecup	*Tellima grandiflora*
Lady fern	*Athyrium filix-femina*
Marsh skullcap	*Scutellaria galericulata*
Oceanspray	*Holodiscus discolor*
Pacific bleeding heart	*Dicentra formosa*
Red alder	*Alnus rubra*
Red huckleberry	*Vaccinium parvifolium*
Salal	*Gaultheria shallon*

Common Name	Scientific Name
Salmonberry	*Rubus spectabilis*
Skunk cabbage	*Lysichiton americanum*
Sword fern	*Polystichum munitum*
Thimbleberry	*Rubus parviflorus*
Trailing blackberry	*Rubus ursinus*
Western hemlock	*Tsuga heterophylla*
Western red cedar	*Thuja plicata*

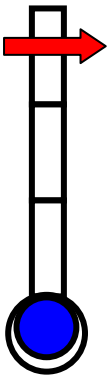
SUMMARY DETERMINATION

_√_Proper Functioning Condition

___ Functional - At Risk

___ Nonfunctional

___ Unknown



Trend for Functional - At Risk:

___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes _√_
No ___

If yes, what are those factors?

___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
_√_ Other (property not owned by Sooke)

(Revised 1998) (7/12/04)

KERR WOOD LEIDAL
consulting engineers

Appendix C

Hydrogeology Inventory and Assessment

LOWEN HYDROGEOLOGY CONSULTING LTD.
4030 Zinnia Road, Victoria, B.C., Canada V8Z-4W3 Phone: 250 595-0624, Fax: 250 595-0634

May 20, 2010
LHC Project File: 09-01

Re: Sooke Rainwater Management Plan, Soil Assessment for infiltration Potential

SUMMARY

A soil assessment of the District of Sooke Core area was carried out by Lowen Hydrogeology Consulting Ltd. in 2009 to determine rainwater infiltration characteristics. The assessment involved a desk-top study and literature review therefore it is assumed that the local soil assemblages are comparable to those in the reference material. It was also assumed that most of the soils in the study area are un-disturbed. Additionally reliance has been placed on the latest soil mapping available from the Province. As the local soils units are mixtures of several different soil types it has been assumed that the weighted average hydraulic conductivity of the individual soils is equal to the hydraulic conductivity of the soil unit. Estimated infiltration rates were found to range from 1.0 to 20.0 cm/hour.

The site soils are highly variable with diverse origins including; glacial, marine, fluvial and weathering products. Most of the soils are well drained but depth of soil is limited. A small portion (<15%) of the study area has soil and groundwater conditions suitable for rainwater infiltration facilities according to this preliminary assessment. This area has been mapped.

The desk-top study carried out has relied on existing information sources and the results with respect to hydraulic conductivity estimates are deemed to have an accuracy of plus-minus one order of magnitude. Some soils in the study area have been disturbed and the natural hydraulic conductivity will have been impacted. This also contributes to uncertainty for the soil assessment. There are no reliable hydraulic conductivity measurements available for the subject soils. We recommended conducting field hydraulic conductivity testing to refine this preliminary analysis.

LOWEN HYDROGEOLOGY CONSULTING LTD.
4030 Zinnia Road, Victoria, B.C., Canada V8Z-4W3 Phone: 250 595-0624, Fax: 250 595-0634

May 20, 2010
LHC Project File: 09-01

Kerr Wood Leidal Associates Ltd.
201 - 3045 Douglas Street
Victoria, BC
V8T 4N2

Attention : Craig Sutherland, M.Sc., P.Eng.
Water Resources Engineer

Dear Sir:

Re: **Sooke Rainwater Management Plan, Soil Assessment for Infiltration Potential**

Scope

The soil Assessment was carried out by Lowen Hydrogeology Consulting Ltd. Between January and April 2009. The objective of the assessment was to provide an overview of soil types and characteristics for use in estimating rainwater infiltration potential. Infiltration facilities are being considered for reduction of peak rainwater run-off flows. Also infiltration rates are required for run-off modeling.

The soil assessment was accomplished with a desk-top study utilizing existing information sources including; soils and surficial geology mapping and reports, water well records, geotechnical and hydrogeology reports, aquifer mapping and Ministry of Health soil percolation testing data. A literature search was also undertaken with respect to soil types and related hydraulic conductivities. The following watersheds; Ella Stream, Nott Brook, Throup Stream, Wright Road Creek and adjacent shoreline between Ella Stream and Sooke River. The study area comprised a total of 586 Ha.

Methodology

The soils of the study area where categorized and mapped as presented in Table 1 and Figure 1. Hydraulic conductivities (K) for each soil unit were estimated by comparing the soil descriptions to average values provided in five main references, publications and text books. The geomean of the reference K values was determined and then weighted average K values calculated for each soil unit mixture. Each soil unit contains 3-5 distinct soil types (eg. Unit 3 - clay, silty loam, sand & gravel). The results of this analysis are presented in Table 2.

Table 1 - Sooke Soil Descriptions

Soil Unit No. on Map	Soils Descriptions (within polygons)	Mode(s) of Deposition	Texture	Drainage	Slope (%)	Surface Expression	Comments
1	$\frac{F_1 / S_1\ D_2}{bc}$	F - Marine S - Moraine D - Marine	sicl gsl vgls / gsl	i w w	0.5 - 5	gently undulating to undulating	F - stonefree fine textured soils S- mod. to strongly cemented pans D- includes shallow fluvial soils
2	$\frac{D_2 / F_1}{b}$	D - Marine F - Marine	vgls / gsl sicl	w i	0.5 - 2	gently undulating	D- includes shallow fluvial soils F - stonefree fine textured soils
3	$\frac{D_2 / S_1\ F_1}{bc}$	D - Marine S - Moraine F - Marine	vgls / gsl gsl sicl	w w i	0.5 - 5	gently undulating to undulating	D- includes shallow fluvial soils S- mod. to strongly cemented pans F- stonefree fine textured soils
4	$\frac{SL_6 \,//\, RO}{eg}$	SL- Colluvium RO- Rock outcrop	gls -	r -	9 - 60	mod. rolling to hilly	SL- soils of the Island Intrusions RO- bedrock within 10 cm.
5	$\frac{QN_2 \,//\, RB_2}{cd}$	QN - Moraine RB - Colluvium	gsl gsl	w w	2 - 9	undulating to gently rolling	QN- strongly cemented RB- Stony soil on steep slopes
6	$\frac{Q_1}{cd}$	Q - fluvial	vgsl	r	2 - 9	undulating to gently rolling	includes marine / fluvioglacial deposits
7	TF	TF - Marine	-	-	-	-	saline fluvial and marine estuary

Symbols

Soils
D -Dashwood
F -Fairbridge
Q -Qualicum
QN -Quinsam
RB -Robertson
RO -Rock Outcrop
S -Shawnigan
SL -Squally
TF -Tidal Flat

Textures
sicl - silty clay loam
gsl - gravelly sandy loam
vgls- very gravelly loamy sand
gls - gravelly loamy sand
vgsl- very gravelly sandy loam

Drainage
i - imperfect
r - rapid
w - well

Subscripts
D_1 - most common soil
D_2 - less common soil
SL_6 - shallower soil most common, with modal soil less common (for SL soil unit)

Composite soils
SD - equal proportions of S & D
S / D - S greater than D
S // D - S much greater than D

Notes:
- Symbol arrangement: $\frac{D2/\ F1}{bc} \rightarrow \frac{\text{soil description(s)}}{\text{slope class(es)}}$
- Slope classes (eg. bc) b to g all complex topography or irregular surfaces.

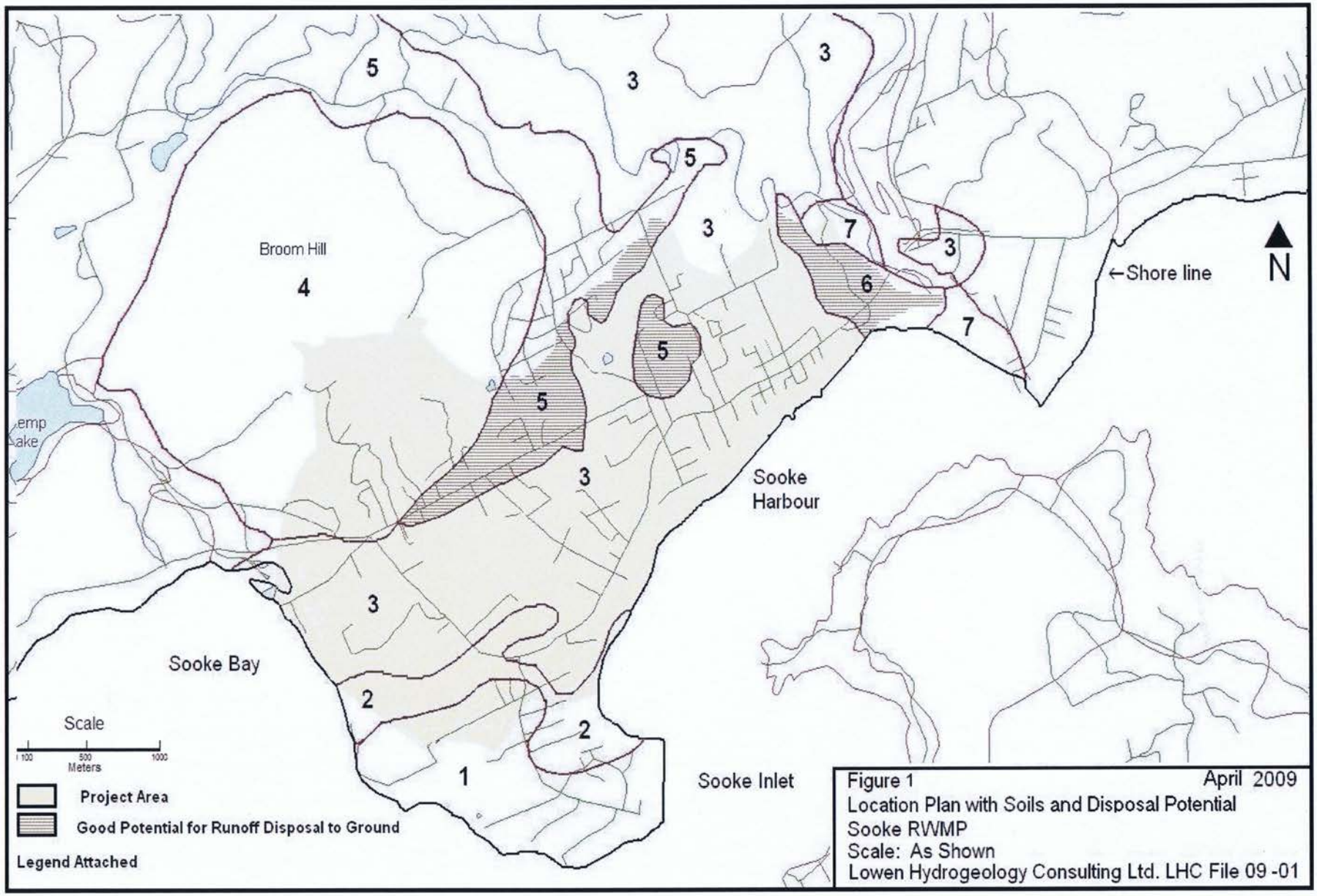


Figure 1 April 2009
Location Plan with Soils and Disposal Potential
Sooke RWMP
Scale: As Shown
Lowen Hydrogeology Consulting Ltd. LHC File 09 -01

Table 2 - Estimated Soil Hydraulic Conductivities and Infiltration Rates - Sooke Soils

Soil Unit No. on Map	Soil Description	Soil types in Unit	Saturated Hydraulic Conductivity (m/d)					Geoman of K Values (1-5)	Relative Weighting	Weighted K values	Weighted Average for Soil Unit	K	K	Adjusted* Range Infiltration Rate
			K1	K2	K3	K4	K5	(m/d)		(m/d)	(m/d)	(m/sec.)	(cm/sec.)	($cm.h^{-1}$)
1	F	sicl	0	0.001	0.000001	0.0003	0.00001	1.04E-04	6	6.22E-04				
	S	gsl	400	86	10	30	25	4.81E+01	2	9.62E+01				
	D	vgls	1000	520	10	42	100	1.17E+02	1	1.17E+02				
	D	gsl	400	86	10	30	25	4.81E+01	1	4.81E+01	7	7.56E-05	7.56E-03	**1 - 4**
2	D	vgls	1000	520	10	42	100	1.17E+02	3	3.51E+02				
	D	gsl	400	86	10	30	25	4.81E+01	3	1.44E+02				
	F	sicl	0	0.001	0.000001	0.0003	0.00001	1.04E-04	4	4.15E-04	17	1.91E-04	1.91E-02	**2.3 - 9.4**
3	D	vgls	1000	520	10	42	100	1.17E+02	3	3.51E+02				
	D	gsl	400	86	10	30	25	4.81E+01	3	1.44E+02				
	S	gsl	400	86	10	30	25	4.81E+01	2	9.62E+01				
	F	sicl	0	0.001	0.000001	0.0003	0.00001	1.04E-04	2	2.07E-04	15	1.71E-04	1.71E-02	**2.0 - 8.0**
4	SL	gls	900	400	70	40	50	1.38E+02	10	1.38E+03	138	1.60E-03	1.60E-01	**9 - 19**
5	QN	gsl	400	86	10	30	25	4.81E+01	8	3.85E+02				
	RB	gsl	400	86	10	30	25	4.81E+01	2	9.62E+01	48	5.57E-04	5.57E-02	**6.6 - 15**
6	Q	vgsl	860	440	60	38	75	1.45E+02	10	1.45E+03	145	1.68E-03	1.68E-01	**10 - 20**

References for K values:

K_1 - Freeze, R. Allen / Cherry, John, Prentice - Hall Inc.; *Groundwater*, Englewood Cliffs, NJ, 1979.

K_2 - Domenico, P. A., & Swartz F. W., J. Wiley and Sons, *Physical and Chemical Hydrogeology*, NY, 1990

K_3 - BC Ministry of Environment, *Aquifer Vulnerability Mapping, K values for soils.*

K_4 - USEPA, *K Values for Soil Types*, 1986

K_5 - Van Stempvoort, D., PhD. Et.al., *Aquifer Vulnerability Index, Prairie Provinces Water Board*, Regina, Sask., 1992

* According to Site Percolation Testing (MOH records) and Literature Search

Soil hydraulic conductivity is just one component used for assessing suitability for Rainwater runoff disposal to ground. The thickness or depth of the soil layer (s) and topographic slope must also be considered. Considering all three relevant factors the whole of the study area was rated; good, fair or unsuitable for runoff disposal facility siting. The results of this analysis is shown in Table 3 and areas with good potential for runoff disposal to ground are shown in Figure 1.

Assumptions and Limitations

1. Natural soils have hydraulic conductivities that can range from $K = 5 \times 10^{-11}$ cm/sec. (marine clay) to $K = 1 \times 10^{2}$ (clean gravel). Considering this thirteen orders of magnitude variation and the fact a single soil type has a range of hydraulic conductivities of four orders magnitude (eg. Sand - 10^{-4} - 1 cm/sec.). A desk-top study of soils as presented herein has an accuracy of +/- one order of magnitude.

2. Natural soils that have been disturbed (compacted, excavated, filled or moved) will display markedly different hydraulic conductivity than un-disturbed soil. There has been significant human activity in the study area and a significant proportion of the local soils may have been disturbed. It is beyond the scope of this study to quantify the effects of soil disruption and the soils have been considered to be un-disturbed. This also affects the accuracy of the analysis.

3. No field measurements of hydraulic conductivity are available to refine the analysis.

Recommendations

1. Areas that have been identified as Fair or Good for runoff disposal should be studied further with test pitting and soils logging, field hydraulic conductivity testing and water level monitoring.

2. As a next step (following recommendation #1) in site selection for run-off disposal a water injection test should be carried out for a minimum of 1 week in the wet season.

Table 3 - Sooke Rainwater Management Plan

Date: 14/04/2009

Runoff Disposal Potential Assessment*

LHC File 09-01

Soil Unit No. on Map	Average Drainage or Infiltration Rate	Depth of Soils (m.)	Topographic Slope	Disposal Potential**	Notes
1	Fair - Poor	>1.0	0.5 - 5	Marginal to Unsuitable	60% of soils have poor drainage
2	Fair	<1.0 to >1.0	0.5 - 2	Fair to Unsuitable	40% of area with shallow poor draining soil
3	Fair	<1.0 to >1.0	0.5 - 5	Fair to Unsuitable	20% of area with shallow poor draining soil
4	Good	<1.0	9 - 60	Unsuitable	Shallow soil on steep slopes
5	Good	>1.0	2 - 9	Good	Well drained thicker soils
6	Good	>1.0	2 - 9	Good	Rapidly drained thicker soils
7	N/A	>1.0	N/A	Unsuitable	Tidal flat subject to flooding.

* *Preliminary assessment only, test pit work and winter water level monitoring needed for confirmation*

** *Based on Soils Type, drainage rates, soil thickness, ground slope and previous sewage disposal studies (Thurber Engineering, 2002; Associated Engineering, 2004)*

Rating System: Good - Potential for High Volume Runoff Disposal to Ground
Fair - Potential for Moderate Volume of Runoff Disposal to Ground
Marginal - Limited Potential for Small Volume only of Runoff Disposal to Ground
Unsuitable - No Potential for Runoff Disposal to Ground

If you have any questions or require further information please contact the undersigned.

Yours very truly,

LOWEN HYDROGEOLOGY CONSULTING LTD.

Dennis Lowen

Dennis A. Lowen, P. Eng. P. Geo.
DAL/hmr

File: NewOffice\Projects\2009\SookeRainWater\LetterMay2010

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Author(s)/Company/Institution	Date	Title or Subject	Publication/Client/Project	Notes/Pages
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Freeze, R. Allen & Cherry, John	1979	*Groundwater*	Prentice Hall Inc., Englewood Cliffs, N.J.	
Hazelton, P.A.; Murphy, B.W.	2007	*Interpreting Soil Test Results*	NSW Department of Natural Resources, CSIRO Collingwood VIC, Australia	
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National Soil Survey Handbook National Cooperative Soil Survey	2003	*Evolution of Permeability and Saturated Hydraulic Conductivity (Ks) Classes: 1951 - 2003*	NSSH NCSS	Table 2
Thurber Engineering Ltd.	2002	*District of Sooke Core Area - Suitability of Soils for On-Site Septic Systems*	District of Sooke	
USEPA	1986	*Estimated Saturated Hydraulic Conductivities for Fine Grained Materials*		Table 5 - 3
Van Stempvoort, D.	1992	*Aquifer Vulnerability Index*	Prairie Provinces Water Board, Regina, Saskatoon	Soil K values

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Appendix D

Watershed Health Tracking System

1. Watershed Health Tracking System

The Watershed Health Tracking System (WHTS) was developed by the Metro Vancouver for use in Integrated Stormwater Management Plans. Two ecological health indicators, imperviousness and riparian forest integrity, form the basis of the WHTS. It is a simple method of showing the relative impacts of unmitigated development on stream health.

Using the WHTS to Quantify Ecological Health

To protect the ecological health of urban creeks, emphasis must be placed on four primary factors. These factors, in order of importance, are:

- changes in hydrology;
- disturbance to the riparian corridor;
- disturbances to fish habitat; and
- deterioration in water quality.

Although there is not a complete understanding of the physical processes that link these factors to environmental health, empirical evidence strongly suggests that addressing the above four factors is a critical first step in watershed development planning.

The WHTS condenses the four ecological factors into two measurable watershed-scale indicators, total impervious area and riparian forest integrity, as follows:

Table D-1: Watershed Health Indicators and Factors

Primary Factor	Measurable Watershed Indicator
Changes in Hydrology	% Impervious Area
Disturbance to the Riparian corridor	% Riparian Forest Integrity
Disturbance to fish habitat	% Impervious Area and % Riparian Forest Integrity
Water quality	% Impervious Area

The WHTS combines the two indicators (imperviousness and riparian forest integrity) graphically to rate ecological health into four classifications: poor, fair, good and excellent. This provides an indication of a watershed's current capacity to support fish and by association, its environmental health.

From leading research in the Pacific Northwest, three measures of watershed health have been proposed:

- impervious area assessment (Indicator #1);
- riparian forest integrity (Indicator #2); and
- B-IBI scoring system (Indicator #3).

Importance of Imperviousness (Indicator #1)

Research shows a strong relationship between the impervious area of a watershed and a stream's health as outlined in the following table:

Table D-2: Stream Health Relative to Impervious Area

Health	Total Impervious Area
Stressed	1-10 %
Impacted	11-25 %
Degraded	26-100%
Reference: *The Importance of Imperviousness*, 1994 by T.R. Schueler.	

A very broad description of the health categories shown might say that a stressed stream (≤10% impervious) is starting to receive the pressure of development in the form of hydrologic changes that don't yet have significant impact on the hydrology of the stream itself. An impacted stream (11-25% impervious) would be one where the hydrologic response of the stream itself is changing as a result of the development impacts. A degraded stream (> 25% impervious) is not only exhibiting altered hydrology but impacted, or degraded, fish habitat and fish-bearing capacity as a result of development impacts.

In natural forest conditions, minor rainfall events do not yield surface runoff. Rainfall is captured in the vegetation canopy, evaporates, or infiltrates through the forest floor. It then either transpirates, is conveyed by interflow (subsurface flow) to creek systems, or infiltrates to deep groundwater.

With development, impervious areas cause rainfall to run off directly to the creek system. Efficient drainage systems such as storm sewers exacerbate the problem by further speeding up the runoff process and increasing peak flow response. Furthermore, rainfall that does manage to infiltrate through pervious areas is typically intercepted by basement drains and quickly directed to a creek system, further increasing the peak flow contribution. Increases in flows and volumes and the frequency of their occurrence accelerate the natural rate of erosion and sedimentation in the stream, degrades or flushes out aquatic and riparian habitat, and deteriorates water quality. This trend is more dramatic with frequently occurring events (less than the 2-year return period) than with extreme events. Reductions in groundwater infiltration and recharge also result in lower creek base flows.

The increased frequency of runoff events, which results from an increase in impervious areas associated with development, causes wear and tear on creeks. Urban watersheds in the Pacific Northwest eco-region may be unable to sustain abundant self-supporting populations of cold water fish once the total impervious area exceeds 30%.

Importance of Riparian Forest Integrity (Indicator #2)

Riparian areas are areas adjacent to watercourses that may be subject to temporary, frequent or seasonal inundation, and support plant life typical to the wetter soil conditions. These riparian areas provide natural features, functions and conditions that support fish life processes, such as:

- multi-canopied forest and ground cover that:
  - moderates water temperature,
  - provides a source of food, nutrients, and organic matter,
  - stabilizes the soil with root systems, thereby minimizing erosion,

  - filters sedimentation and pollution;
- provides a source of large woody debris;
- is part of active floodplain areas;
- provides areas for side channels, intermittent streams; and
- provides areas for infiltration that can aid in sustaining base flows.

The riparian forest integrity (RFI) of the WHTS is an indicator that measures the integrity of a 30-metre setback on both sides of a watercourse over its entire length.

Comparison with B-IBI Scores (Indicator #3)

The Benthic Index of Biotic Integrity (B-IBI) is a biologically based measure of the underlying macro-invertebrate communities, or streambed insects, that occupy all watercourses. Unlike fish counts, the B-IBI is a stable measure of stream and watershed health as the presence of the benthic invertebrates is independent of fish barriers and blockages, commercial and sport fishing quotas, and ocean survival rates. The B-IBI, developed by Karr (1196-1999), is a multimetric rating system that can be used to measure benthic communities. The 10-metric index version of the system reflects Pacific Northwest conditions and has proven to be surprisingly reproducible across most creek systems.

The index ranges from a score from 10 indicating “poor” watershed health to 50 indicating “excellent” health. Wild salmon are expected in watersheds with high scores while fewer fish species and lower salmon densities are expected in watersheds with scores below 25.

The measured B-IBI scores, if available, are superimposed on the graph and can be compared to predicted B-IBI scores (based on a linear regression using the RFI and TIA values) as a separate indicator of watershed health. The B-IBI score can also be tracked over time to evaluate development impacts on watershed health.

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Appendix E

Mitigative Measures for Environmental Protection

Contents

1. Low Impact Development Practices

Low Impact Development (LID) is a design with nature approach that reduces a development's ecological footprint. LID concepts embodied at the planning stage, often affords more opportunities to reduce the overall negative effects of development and reduce costs. Requirements for expensive traditional stormwater infrastructure may also be reduced as less runoff will be generated.

There are many best management practices (BMPs) commonly used in LID, however it is not always possible to incorporate all of them into a development, and even with adoption of all available LID options, there will still be changes to the hydrologic regime relative to the pre-development conditions and some additional measures or facilities will often be required. LID practices are most effective in mitigating adverse stormwater effects when used in combination with other BMPs, such as constructed source controls and detention. The *Puget Sound Action Team's LID Technical Guidance Manual*[1] is an excellent resource for LID planning and design.

Reduced Road Widths

Traditional road pavement widths may be larger than they need to be, particularly for streets that are residential access only, and not thoroughfares. Road widths can be narrowed to a minimum that allows necessary traffic flow, but that discourages excess traffic and excess speed, both of which are beneficial in a family- and pedestrian-oriented neighbourhood. Road widths do, however, need to meet the community's needs for utility and emergency vehicle access and these requirements will often determine acceptable minimum road widths.

Reduced Building Footprints

Building footprints, and impervious roof area, may be reduced without compromising floor area by increasing building height. This also allows greater flexibility to develop layouts that preserve naturally vegetated areas and provide space for infiltration facilities. Some relaxation of building height restrictions may be necessary to allow this type of design.

Reduced Parking Standards

Reducing the required number of parking spaces for a development reduces the impervious area and encourages pedestrian and public transit-friendly communities. Reducing the required parking spaces also reduces development costs.

Limiting Surface Parking

Limiting surface parking and restricting parking to below building roof areas, also directly reduces the impervious area in a development.

Pervious Parking Surfaces

Use of pervious paving materials rather than impervious concrete or asphalt can reduce the runoff generated from parking areas. Pervious materials may include gravel, reinforced turf, or engineered permeable pavements.

1 Low Impact Development Technical Guidance Manual for Puget Sound, 2005 http://www.psparchives.com/our_work/stormwater/lid.htm

Building Compact Communities

A complete and compact development plan preserves more natural watershed features and significantly reduces imperviousness. In some cases, compact communities have up to 75% less roadway pavement per dwelling unit, and parking needs are reduced because local services are more accessible by pedestrians and via public transit.

Preserving Naturally Significant Features

Preservation of natural areas in a watershed is always an important consideration, which can provide recreational as well as environmental benefits but some natural areas perform special aquatic ecosystem functions and as such are vital to maintaining watershed health. These areas, which include riparian forests, wetlands, floodplains and natural infiltration depressions with highly permeable soils, are particularly important to inventory and protect from alteration.

2. Stormwater Source Control Technologies

Stormwater source controls reduce the runoff that is discharged to the stream network by managing the water balance at the site level. Source controls play a key role in achieving Rainwater Management Criteria for volume reduction, water quality treatment, and runoff control and can be very effective at reducing runoff volumes and peak runoff rates from events smaller than the 50% of 2-year storm. Though they do provide some flow-detention benefits for the 2-year storms, source controls have limited ability to reduce peak runoff rates from large storms and must be designed with adequate overflow capacity. Additional stormwater infrastructure must be provided to safely convey stormwater offsite for the larger events.

Several standard source control technologies are described below. *The Metro Vancouver Stormwater Source Control Design Guidelines*[2] is an excellent reference for source control BMP design advice.

Absorbent Landscaping

Natural topsoil is generally permeable. The vegetation on topsoil provides a layer of organic matter which is mixed into the soil by worms and micro-organisms, creating voids, which allow rain water to percolate through, and making the soil more structurally capable of providing storage in the void spaces when saturated.

Standard construction practice is often to strip the existing topsoil, compact or excavate a site surface to the desired grade, and then cover it with a thin layer of imported topsoil. Although lawns and other ornamental landscaping will establish a vegetated surface, both the original surface and subsurface flows and storage capacities have been altered and surface runoff will be increased. Instead of stripping and removing, original topsoil it should be replaced on the site and augmented with organic matter and sand to improve soil structure and increase macropore development.

To increase absorbency, surface soils should have a minimum organic content to facilitate plant growth and a soil depth sufficient to meet the 50% of 2-year rainfall capture target. Increased soil depths also provide retention for runoff from adjacent hard surfaces. Surface vegetation should include herbaceous groundcovers with a thickly matted rooting zone, deciduous trees, or evergreens.

2 Metro Vancouver, Stormwater Source Control Design Guidelines, 2005 http://www.gvrd.bc.ca/sewerage/stormwater_reports.htm

Some maintenance over the long term is required for the absorbent landscape to continue to provide stormwater benefits. Maintenance activities may include replacing soils that have eroded and replanting dead or dying vegetation.

Surface Infiltration Facilities

Rainfall runoff is stored at or near the surface in a layer of absorbent soil, sand, gravel, or rock, and/or on the ground surface in a ponding area. The stored runoff that infiltrates into the soil becomes interflow and augments groundwater in the sub-surface.

Surface infiltration facilities can look like normal vegetated swales or ponds, and can be aesthetically landscaped and integrated into the design of open spaces. They include bioretention facilities and rain gardens. Both surface and sub-surface infiltration facilities can be effective at the lot level, as well as at the neighbourhood level, where individual lot sizes or layouts don't support on-lot facilities or where more permeable soils or groundwater recharge areas are located off-site. Surface infiltration facilities can, depending on their design, provide some level of water quality treatment as well.

Surface infiltration can be combined with detention, where the detention release rate allows sufficient time for infiltration through the pond. Infiltration facilities are highly dependent on the hydrologic properties of the sub-surface soils.

Surface infiltration can also be promoted by the used of permeable pavers or other pervious surfacing materials.

Bio-Retention Facilities

If infiltration rates are low, such as is likely in clay and till soils, bio-retention facilities can be designed to store the volume reduction target in soil and rock trench voids and infiltrate it slowly over time.

Where applicable, a retention facility may also be designed as a baseflow augmentation facility that retains the design capture volume in a tank or pond and releases it at baseflow rates. These rates are very low, and are based on measured summer baseflows in a watercourse divided by the contributing watershed area, and then applied to the area of the site contributing runoff. Baseflow augmentation facilities discharge the capture volume to the downstream stormwater system or watercourse at a maximum of the determined baseflow rates. Any volumes above the capture volume must be allowed to bypass the baseflow augmentation facility.

Sub-surface Infiltration Facilities

A similar design process is used for sub-surface infiltration as for surface infiltration facilities. The main advantage of sub-surface facilities is that they often have vertical walls and do not require as much dedicated ground area, allowing them to be located beneath paved impervious areas.

Sub-surface facilities must be located at least 0.5 m above the level of the water table so that they can discharge through the sides and bottom of the structure and will not merely store infiltrated groundwater. Generally, the deeper an infiltration facility is located, the less-effective it will be. Subsurface infiltration facilities can be as simple as a trench filled with clean, free-draining rock that is protected from soil by a permeable membrane. There are numerous products available commercially for subsurface infiltration as well.

Green Roofs

Installing a green roof rather than a conventional impervious roof can significantly reduce the volume and rate of runoff from a building lot particularly for the smaller, more frequent storm events.

A green roof is essentially a roof with a layer of absorbent soil and vegetation on top of a drainage collection layer or system. Rainfall is absorbed or stored by the soil and vegetation for later evapotranspiration. The green roof has a limited storage capacity, so any excess rainfall percolates through and is collected by a drainage system. The excess rainfall is then routed to the ground for detention and conveyance.

Green roofs are more expensive to build as they have structural costs as well as landscaping costs and do require maintenance to ensure their ongoing functionality. However, when compared with land costs for alternate facilities in high density urban areas, the costs for a green roof may be favourable. Green roofs also have other benefits, in addition to stormwater benefits, that can include heating or cooling cost savings by insulating the building, aesthetic benefits, air quality benefits, and reduced solar gain that decreases the urban heat island effect. Green roofs should only be designed and constructed by qualified professionals as structural engineering, building envelope and landscape design as well as stormwater engineering are all critical components. Green roofs are the preferable source control in areas where ground surface controls are not possible. For more information on green roofs readers are referred to the *Green Roofs for Healthy Cities* website.

Rainwater Re-use

Rainwater re-use is commonly afforded by residential rain barrels which are effectively retention facilities for roof runoff. Limitations of rain barrels are that rainfall is seldom a reliable source for water during the dryer seasons and rain barrels are often not large enough to store the 50% of 2-year capture target. The most significant reductions in runoff volume from re-use are achieved by capturing and re-using rainwater for indoor grey-water uses, or for commercial and industrial applications with high water consumption rates or where water supplies are limited. Recycling rainwater reduces demands from surface waters and reservoirs and can reduce supply infrastructure costs. Rainwater re-use can also be combined with infiltration facilities.

3. Water Quality Best Management Practices

Changes in land use, loss of natural biofiltration capacity, increases in impervious area, and pollutant laden runoff associated with urban development can contribute to reduced water quality which impacts fish and fish habitat. BMPs designed to capture and treat runoff need to be incorporated into RWMPs.

Water Quality BMPs are physical, structural or management practices that reduce or prevent water quality degradation. Many of these are the same as, or similar to those used for runoff volume reduction and rate control and but have ancillary benefits for water quality. Source control remains the key means of reducing introduction of toxic and hazardous materials or organic and inorganic contaminants, originating from land and water use or as a result of commercial or industrial spills. Without source control, runoff water quality is limited by the effectiveness of treatment technology.

Treatment controls are point-source water quality management measures. They are generally constructed facilities and are often individual installations incorporated into the stormwater management infrastructure. They should be designed on a site-specific basis, after examining all alternative treatment technologies, and selecting the best available options based on cost and effectiveness.

These controls should be designed and constructed by appropriately qualified environmental professionals.

Water Quality Best Practical Technologies

Several technologies have the ability to provide both water quality benefits and runoff control. Water quality benefits are derived from contaminant removal mechanisms that use biological and physical processes. Runoff control is accomplished by improving stormwater detention and retention which reduces peak runoff discharge rates and volumes.

Biofilters

Biofilters are vegetated filter strips, swales and rain gardens that remove deleterious substances, notably particulate contaminants, though some combination of physical (e.g.: adsorption) and biological (biodegradation) removal mechanisms. Biofilter technology is suitable for sheet flow runoff, typical of large linear impervious developments like roadways and parking lots.

Urban Forests and Leave Strips

Depending on the extent of tree canopy and ground cover retained, runoff reduction and pollutant removal can be achieved by maintaining natural well functioning urban forested areas. The contaminant removal processes forests and natural vegetation provide include: filtration, adsorption, absorption, and biological uptake and conversion by plant life. Urban forests also provide habitat refuges for many species whose habitats have been fragmented while riparian leave strips along watercourses, provide critical fish and wildlife habitat.

Infiltration Systems

Infiltration systems generally require pre-treatment for water quality to prevent clogging and binding-off of the permeable materials and contamination of underlying aquifers. Physical removal of deleterious substances by filtration and adsorption, as well as conversion of soluble pollutants by bacteria, also occurs within the infiltrating soils.

Constructed Wetlands

Physical, biological and chemical processes combine in wetlands to remove contaminants and either surface or subsurface flow wetlands can be constructed specifically to treat stormwater runoff. Constructed wetlands also offer retention benefits and can create preferred habitats for aquatic and terrestrial wildlife species. **The use of existing natural wetlands to treat stormwater however is not an acceptable practice**.

Wet Detention Ponds

Permanent wet ponds remove pollutants and other deleterious substances through physical processes such as sedimentation, filtration, absorption and adsorption and through biological mechanisms such as: uptake and conversion by plants, and microbial degradation. Wet ponds can also detain flows thereby contributing to rate control and volume reduction objectives. General design parameters need to include: vegetation types (floating, emergent and submergent vegetation), water depth and ponding area, and will often require consideration of detailed pond specific operational parameters.

Oil and Grit Separators

Oil and grit separators are suitable for spill control and removal of floatable petroleum-based contaminants as well as coarse grit and sediment from small areas, such as gas stations, automotive service areas and parking lots. Oil and grit separators have limited application in large-scale stormwater runoff applications, and should be limited to small area generation sites.

Construction Best Practices

Construction Best Practices for instream stormwater management works include timing of the works to minimize impacts. Timing windows should be adhered to in order to minimize impacts to fish and wildlife and specifically to avoid sensitive periods for certain life history stages of fish (e.g.; adult spawning, egg and alevin intergravel incubation). Where information is available on critical life history stages and timing for any identified Species at Risk, these times should also be avoided. Clearing should only be undertaken immediately in advance of work, and only during vegetation clearing timing windows, where these have been identified for protection of nesting birds. To the extent possible, work should be restricted to cells and undertaken in a systematic manner to limit the area disturbed at any given time. Works should only be undertaken during favourable weather conditions and low water conditions.

Measures must be taken to prevent the release, from any work site, of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other *deleterious substance* into any ditch, watercourse, stream, or storm sewer system. The work area should be isolated from flowing water as much as possible and diversions around the site should be provided for overland flow paths. Ensuring that all equipment used on-site is in good working order, and having a ready spill containment kit and staff trained in its use, are also critical measures.

For further information on managing erosion and sediment discharges during construction, see the Erosion and Sediment Control section of the *Land Development Guidelines and the* *Standards and Best Practices for Instream Works*.[3]

4. Stormwater Detention Systems

The rainwater detention objective is to limit the post-development runoff to the pre-development rate, volume, and approximate shape of the hydrograph for the 50% MAR, and 2-year/24-hour storm events and to maintain, as closely as possible, the natural pre-development flow pattern in the receiving watercourse.

These detention levels have been adopted to address increases in impervious areas in developments and the environmental impacts (e.g. stream erosion, sedimentation; loss of riparian habitat, changes in stream morphology, etc.) that are occurring due to the more frequent, smaller storm events being rapidly conveyed off hard surfaces into fish bearing waters.

[3] BC Ministry of Water, Land and Air Protection's *Standards and Best Practices for Instream Works* (draft March 2004) http://wlapwww.gov.bc.ca/sry/iswstdsbpsmarch2004.pdf.

5. Infiltration Systems

Stormwater infiltration systems can provide many benefits to urban streams. Infiltration systems can retain runoff, recharge groundwater and control peak flows. The soil, through which the stormwater runoff passes, also acts as a filter removing a large percentage of the common pollutants normally discharged to the stream or creek. Infiltration can recharge local groundwater which in turn feeds smaller streams and creeks through seepage. Groundwater which is slowly discharged back into streams and can constitute all or part of a stream's baseflow. This baseflow can be critical for fish and fish habitat during extended periods of little or no precipitation and runoff. It maintains preferred spawning conditions for several salmon species which key on groundwater seepage areas for spawning and egg incubation.

In areas with well-draining soils, stormwater runoff from a site can be collected and discharged into an infiltration system where there are no conventional stormwater removal systems, or infrastructure, which reduces the costs of providing offsite conveyance.