BIOLOGICAL ASSESSMENT

(continued)

APPENDIX X

ODFW Aquatic Inventories Project Reach Data Used to Evaluate Benchmark Levels for Aquatic Habitat Conditions in Watersheds Crossed by the Pacific Connector Pipeline Project

Subbasin Fifth Field Watershed Stream Name	Reach					Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
		PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Coos Sub-basin (HUC 17100304), Coos Bay Frontal Pacific Ocean (HUC 1710030403) Fifth field Watershed																					
Big Creek	1	1009	0	4.2	0.3	71.0	16.7	0.7	3.0	7.0	10.0	69.0	72.0	3.0	1.7	0.1	0.0	0.0	84.0	5.0	0.0
Cox Canyon Creek	1	144	1078	2.3	0.5	30.4	305.5	0.4	0.0	36.0	40.0	15.0	70.0	43.8	84.3	1.4	0.0	0.0	33.0	7.0	0.0
Cox Canyon Creek	2	1744	596	2.4	1.1	78.5	37.8	0.3	0.0	23.0	14.0	31.0	85.0	5.4	14.3	0.4	54.3	24.1	38.0	3.0	0.0
Cox Canyon Creek	3	759	0	0.5	5.9								93.0	9.6	30.8	0.7	60.3	0.0	38.0	2.0	0.0
Fourth Creek	1	247	30	1.5	2.6	5.7	153.9	0.3	0.0	17.0	0.0	100.0	58.0	5.3	8.3	0.4	0.0	0.0	70.0	18.0	0.0
Fourth Creek	3	1157	133	5.7	2.2	2.7	307.1	0.2	0.0	8.3	1.0	99.0	40.0	9.1	3.1	0.0	0.0	0.0	88.0	2.0	0.0
Joe Ney Slough (North Fork)	1	179	0	2.5	0.1	100.0	6.0	0.0	0.0				22.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Joe Ney Slough (North Fork)	2	1046	0	4.4	0.1	68.5	2.5	0.7	0.0				69.0	2.8	1.3	0.0	0.0	0.0	100.0	0.0	0.0
Joe Ney Slough (North Fork)	3	329	0	3.3	0.5	92.7	5.8	1.0	0.0				63.0	12.8	6.1	0.0	0.0	0.0	100.0	0.0	0.0
Palouse Creek	1	4185	0	4.5	0.1	16.5	298.9	0.6	0.0				32.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
Palouse Creek	2	1091	1389	2.8	0.4	21.4	73.8	0.6	0.0				38.0	1.7	2.7	0.4	0.0	0.0	35.0	9.0	0.0
Palouse Creek	3	3487	36	3.3	0.5	47.1	27.9	0.8	0.0	17.7	46.0	14.0	62.0	2.6	5.2	0.4	0.0	0.0	22.0	32.0	0.0
Palouse Creek	4	1456	305	4.4	0.5	65.4	15.5	0.6	0.0	32.4	66.0	6.0	66.0	48.0	86.3	1.7	0.0	0.0	19.0	46.0	0.0
Palouse Creek	5	969	19	3.6	1.7	24.0	17.5	0.7	0.0	56.9	55.0	5.0	84.0	17.1	56.5	2.4	0.0	0.0	7.0	36.0	0.0
Palouse Creek	6	4226	383	2.7	2.4	28.1	17.0	0.4	0.0	32.9	53.0	5.0	92.0	20.3	59.5	3.0	0.0	0.0	7.0	25.0	0.0
Joe Ney Slough (South Fork)	1	204	0	3.0	0.5	93.4	10.2	0.0	0.0				48.0	5.9	1.1	0.0	0.0	0.0	100.0	0.0	0.0
Joe Ney Slough (South Fork)	2	347	9	1.6	0.2	1.8	38.6	0.5	0.0				67.0	0.6	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Sullivan Creek	1	219	6	5.6	6.8					14.5	43.0	4.0	59.0	10.0	11.8	0.0	0.0	0.0	18.0	28.0	38.0
Sullivan Creek	2	697	33	2.7	3.7	13.8	20.4	0.4	0.0	9.4	31.0	42.0	86.0	13.8	11.0	0.1	0.0	0.0	42.0	21.0	19.0
Sullivan Creek	3	836	205	3.8	3.5	56.1	24.0	0.5	6.0	7.0	36.0	25.0	79.0	26.4	19.5	0.1	0.0	0.0	53.0	19.0	11.0
Tarheel Creek	1	264	0	3.3	1.3	0.4	17.6	1.3	0.0	28.2	0.0	100.0	67.0	3.4	1.2	0.0	0.0	0.0	71.0	0.0	0.0
Tarheel Creek	2	772	0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tarheel Creek	3	231	0	2.7	0.0	23.5	6.8	0.0	0.0	5.6			81.0	18.2	23.8	0.0	0.0	0.0	100.0	0.0	0.0
Tarheel Creek	4	125	5	0.3	3.2					1.3	0.0	100.0	83.0	15.9	4.2	0.0	0.0	0.0	91.0	1.0	0.0
Palouse Creek - Trib F	1	1958	259	2.7	6.6	5.4	33.8	0.5	0.0	49.0	36.0	5.0	93.0	14.2	59.7	3.7	41.0	20.0	6.0	17.0	0.0
Palouse Creek - Trib A	1	580	147	1.8	6.2	2.9	110.0	0.3	0.0	26.4	86.0	5.0	86.0	46.9	97.7	4.7	122.0	0.0	13.0	54.0	0.0
Palouse Creek - Trib A	2	1051	0	1.5	11.6	2.6	146.0	0.4	0.0	44.3	53.0	18.0	94.0	67.9	150.2	6.2	30.2	0.0	11.0	26.0	0.0

						Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Winchester Creek	1	3047	227	3.0	1.0	5.9	45.0	0.5	0.0	10.1	2.0	97.0	56.0	62.0	2.0	0.1	0.0	0.0	98.0	1.0	0.0
Winchester Creek	2	1647	42	2.6	1.0	6.9	37.3	0.4	0.0	17.3	3.0	97.0	97.0	6.2	8.3	0.4	0.0	0.0	98.0	2.0	0.0
Winchester Creek	3	994	0	2.8	0.9	72.6	20.5	0.4	0.0	17.0	0.0	100.0	94.0	4.9	17.1	1.4	60.3	0.0	99.0	1.0	0.0
Winchester Creek	4	752	15	5.2	0.7	85.2	13.5	0.8	0.0	16.0	30.0	70.0	83.0	2.3	8.3	0.7	0.0	0.0	95.0	5.0	0.0
Winchester Creek	5	1332	10	1.5	1.2	3.6	223.6	0.5	0.0	34.0	20.0	60.0	94.0	7.7	8.1	0.4	337.9	0.0	91.0	8.0	0.0
Coquille Sub-basin (HUC 17100305), North Fork Coquille River (HUC 1710030504) Fifth field Watershed																					
Honcho Creek	1	558	0.0	3.0	4.2	19.9	12.1	0.4	0.0	20.9	18.0	11.0	97.0	6.6	6.8	0.2	0.0	0.0	11.0	15.0	0.0
Honcho Creek	2	1339	11.0	3.6	10.8	1.0	170.5	0.8	0.0	21.3	17.0	10.0	98.0	10.2	18.7	0.7	20.0	0.0	8.0	16.0	0.0
Vaughns Creek Tributary 1	1	154	38.0	2.3	3.8	36.8	10.0	0.4	10.4	19.0	36.0	21.0	98.0	27.3	43.1	1.3	0.0	0.0	27.0	32.0	0.0
Vaughns Creek	1	543	25.0	3.0	5.5	20.1	10.6	0.7	0.0	18.1	36.0	27.0	92.0	23.2	37.5	1.1	0.0	0.0	24.0	23.0	0.0
Vaughns Creek	2	1413	0.0	3.0	2.4	51.3	10.6	0.6	2.1	24.3	51.0	11.0	90.0	17.4	26.2	0.6	30.0	0.0	18.0	37.0	0.0
Vaughns Creek	3	1697	10.0	1.7	7.2	23.2	41.4	0.4	1.2	19.4	38.0	11.0	72.0	8.3	14.3	0.5	0.0	0.0	8.0	29.0	0.0
Alder Creek	1	2528	118.0	4.0	1.9	18.0	11.0	0.5	0.0	25.6	65.0	2.0	89.0	11.0	10.4	0.5	33.1	18.1	10.0	41.0	0.0
Alder Creek	2	578	18.0	3.1	7.6	13.6	14.4	0.5	0.0	23.5	48.0	0.0	93.0	5.7	17.3	0.5	120.6	60.3	4.0	23.0	0.0
Alder Creek	3	498	27.0	3.2	1.3	8.1	20.7	0.6	0.0	30.6	55.0	1.0	91.0	3.8	4.1	0.0	0.0	0.0	11.0	48.0	0.0
Alder Creek	4	761	57.0	1.8	6.9	2.3	89.4	0.3	0.0	19.0	35.0	15.0	91.0	14.1	15.0	0.4	0.0	0.0	10.0	32.0	0.0
Alder Creek	5	767	31.0	1.7	14.5								87.0	15.4	19.9	0.7	121.3	60.3	14.0	26.0	0.0
North Fork Cherry Creek	1	413	46.0	2.7	2.9	4.5	25.6	0.4	0.0	17.4	21.0	16.0	86.0	44.8	140.6	10.4	364.0	181.0	20.0	17.0	0.0
North Fork Cherry Creek	2	1839	100.0	1.8	3.1	4.6	115.2	0.5	0.0	15.7	34.0	10.0	89.0	9.8	41.4	2.2	0.0	0.0	12.0	27.0	0.0
North Fork Cherry Creek	3	527	0.0	1.0	18.7								95.0	11.6	24.8	0.6	121.3	60.3	11.0	17.0	0.0
South Fork Cherry Creek	1	878	10.0	2.4	8.0	13.3	18.1	0.6	0.0	22.6	38.0	4.0	92.0	11.4	18.6	0.8	0.0	0.0	9.0	18.0	0.0
South Fork Cherry Creek	2	1172	39.0	2.4	2.5	7.9	17.4	0.3	0.0	24.3	37.0	8.0	94.0	10.0	23.5	1.5	60.2	30.2	17.0	31.0	0.0
South Fork Cherry Creek	3	1465	27.0	0.9	9.8								96.0	25.5	80.4	4.6	60.3	0.0	3.0	29.0	0.0
Little North Fork Coquille River	1	1451	205.0	3.1	2.0	51.1	4.7	0.5	10.9	15.5	36.0	17.0	78.0	26.7	26.7	0.9	0.0	0.0	24.0	31.0	3.0
Little North Fork Coquille River	2	2710	199.0	2.0	4.3	40.4	8.6	0.4	8.6	10.6	36.0	13.0	88.0	13.8	19.4	1.1	7.0	0.0	24.0	30.0	3.0
Moon Creek Tributary 1	1	122	13.0	2.1	2.8	25.8	3.1	0.3	0.0	10.6	35.0	17.0	99.0	65.0	135.5	14.0	0.0	0.0	23.0	37.0	0.0
Moon Creek Tributary 1	2	996	290.0	1.7	4.6	19.1	8.2	0.4	2.3	13.2	35.0	26.0	99.0	40.8	32.7	1.3	12.1	0.0	24.0	32.0	0.0
Little Cherry Creek	1	738	0.0	0.0	4.0								100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach					Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
		PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Little Cherry Creek	2	984	55.0	3.3	7.2	16.1	25.7	0.5	0.0	23.5	25.0	5.0	99.0	11.0	17.5	0.8	0.0	0.0	13.0	20.0	0.0
Little Cherry Creek	3	2058	59.0	2.8	9.7	6.1	40.3	0.6	0.5	23.8	32.0	9.0	96.0	14.8	32.9	1.7	0.0	0.0	9.0	22.0	0.0
Moon Creek	1	1499	63.0	4.5	1.1	19.2	5.2	0.3	0.0	31.1	11.0	13.0	94.0	7.2	3.1	0.0	0.0	0.0	22.0	11.0	0.0
Moon Creek	2	2600	40.0	3.7	1.5	42.4	4.5	0.4	1.1	25.5	28.0	19.0	94.0	15.1	11.2	0.4	0.0	0.0	27.0	24.0	0.0
Moon Creek	3	1504	113.0	1.9	3.0	31.3	10.2	0.4	1.9	11.9	31.0	30.0	99.0	39.4	37.9	1.1	0.0	0.0	35.0	28.0	0.0
Moon Creek	4	290	0.0	0.8	1.9					0.0	40.0	58.0	80.0	6.2	16.5	1.4	60.3	0.0	64.0	34.0	0.0
Mast Creek	1	375	0.0	1.6	1.7	54.6	1.1	0.4	8.0	5.4	37.0	37.0	96.0	13.9	10.9	0.0	61.0	30.0	52.0	16.0	0.0
Mast Creek	2	545	21.0	1.4	1.7	68.0	9.0	0.4	14.1	9.5	37.0	58.0	83.0	16.0	16.4	0.4	0.0	0.0	73.0	19.0	0.0
Mast Creek	3	641	34.0	1.3	3.3	77.4	11.5	0.5	16.3	8.5	21.0	80.0	88.0	34.3	80.7	1.9	0.0	0.0	81.0	10.0	0.0
Mast Creek	4	910	36.0	0.7	3.4	25.8	33.5	0.4	4.2	8.7	20.0	79.0	100.0	17.1	24.3	0.9	81.0	0.0	83.0	13.0	0.0
Cherry Creek	1	454	73.0	5.0	0.7	19.6	1.8	0.7	0.0	33.4	38.0	3.0	86.0	8.8	10.7	0.0	0.0	0.0	22.0	26.0	0.0
Cherry Creek	2	455	20.0	4.7	3.4	24.1	8.6	1.6	0.0	26.1	37.0	3.0	83.0	8.8	13.2	0.7	0.0	0.0	17.0	17.0	0.0
Cherry Creek	3	954	130.0	4.8	1.1	5.7	27.6	0.6	0.0	31.3	41.0	5.0	89.0	4.4	6.5	0.5	0.0	0.0	14.0	32.0	0.0
Cherry Creek	4	580	57.0	4.2	4.1	2.5	38.6	0.7	0.0	26.6	25.0	11.0	92.0	11.5	10.9	0.3	0.0	0.0	9.0	31.0	0.0
Cherry Creek	5	2382	182.0	3.5	2.7	15.3	18.5	0.6	0.0	19.1	30.0	10.0	82.0	6.0	9.5	0.2	0.0	0.0	16.0	18.0	0.0
Coak Creek	1	1086	28.0	1.9	1.1	75.1	7.2	0.4	15.3	9.0	43.0	53.0	82.0	18.1	13.0	0.1	0.0	0.0	58.0	23.0	0.0
Coak Creek	2	996	78.0	1.3	1.8	52.1	7.0	0.4	24.2	9.6	40.0	55.0	87.0	47.3	70.1	1.3	0.0	0.0	69.0	27.0	0.0
Coak Creek	3	252	26.0	1.0	8.0	31.7	77.3	0.7	0.0	6.0	35.0	25.0	94.0	36.1	63.1	2.0	0.0	0.0	12.0	13.0	0.0
Bay Creek	1	1087	44.0	1.7	0.6	62.7	7.6	0.4	10.6	8.4	14.0	81.0	94.0	20.8	8.7	0.0	122.0	15.0	85.0	9.0	0.0
Bay Creek	2	1224	86.0	2.3	1.7	83.8	12.3	0.5	11.5	7.8	33.0	54.0	90.0	23.9	17.9	0.5	0.0	0.0	65.0	17.0	0.0
Bay Creek	3	793	48.0	1.2	1.7	38.0	15.2	0.5	4.8	8.6	16.0	84.0	95.0	26.9	21.7	0.3	0.0	0.0	83.0	13.0	0.0
Giles Creek	1	1382	186.0	3.6	3.4	34.8	2.2	0.5	3.8	20.1	47.0	23.0	85.0	17.9	30.7	1.2	0.0	0.0	29.0	34.0	0.0
Giles Creek	2	404	75.0	2.8	2.8	49.0	3.7	0.3	0.0	14.2	46.0	41.0	90.0	10.1	26.1	0.7	0.0	0.0	43.0	42.0	0.0
Giles Creek	3	907	54.0	1.7	6.4					6.1			94.0	8.9	38.5	3.2	30.0	30.0	19.0	20.0	0.0
Giles Creek Trib B	1	704	0.0	1.5	7.1					6.5			78.0	17.3	91.1	6.0	0.0	0.0	19.0	29.0	0.0
Giles Creek Trib A	1	518	0.0	1.8	11.5					6.4			95.0	9.1	24.4	1.0	0.0	0.0	31.0	34.0	0.0
Hudson Creek	1	5510	514.0	3.3	1.6	54.4	5.2	0.5	11.3	14.8	35.0	26.0	85.0	16.9	14.5	0.5	0.0	0.0	35.0	19.0	20.0
Wimer Creek	1	976	37.0	2.5	0.8	88.5	22.1	0.5	2.0	7.6	29.0	70.0	57.0	7.7	6.7	0.0	0.0	0.0	82.0	17.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Wimer Creek	2	1753	49.0	1.0	5.6	59.9	10.5	0.3	14.4	10.6	71.0	14.0	99.0	18.4	22.0	0.3	30.0	15.0	28.0	58.0	5.0
Steele Creek	1	1458	26.0	3.0	0.6	73.1	5.1	0.6	14.2	12.1	25.0	45.0	96.0	16.5	9.7	0.1	37.0	0.0	59.0	16.0	0.0
Steele Creek	2	666	14.0	1.9	0.7	88.1	5.4	0.5	20.6	19.1	0.0	100.0	85.0	16.8	13.4	0.3	41.0	0.0	98.0	2.0	0.0
Steele Creek	3	479	0.0	1.3	1.6	83.2	12.7	0.6	10.4	8.0	20.0	80.0	76.0	7.9	10.7	0.2	0.0	0.0	94.0	4.0	0.0
Steele Creek	4	868	73.0	1.8	0.8	87.0	14.8	0.6	9.6	7.6	0.0	100.0	90.0	9.8	9.8	0.3	0.0	0.0	99.0	1.0	0.0
Steele Creek	5	1145	80.0	2.4	2.0	88.9	26.8	0.4	5.7	5.3	10.0	90.0	89.0	12.3	5.3	0.2	30.0	0.0	92.0	8.0	0.0
Woodward Creek	1	859	0.0	4.3	0.4	88.5	3.8	0.7	0.0	26.3	38.0	9.0	88.0	6.8	4.8	0.1	0.0	0.0	25.0	32.0	0.0
Woodward Creek	2	5267	167.0	4.0	0.5	91.7	3.7	0.7	1.7	25.6	56.0	10.0	95.0	22.6	24.9	0.5	0.0	0.0	39.0	41.0	0.0
Woodward Creek	3	2619	0.0	2.5	2.1	65.7	12.5	0.5	0.4	20.5	71.0	10.0	82.0	22.9	27.3	0.9	0.0	0.0	33.0	49.0	0.0
Blair Creek	1	314	0.0	1.5	1.2	33.6	48.3	0.2	0.0	26.4	66.0	29.0	96.0	2.5	1.4	0.0	0.0	0.0	45.0	43.0	0.0
Blair Creek	2	308	0.0	0.4	1.2					0.0	48.0	53.0	85.0	0.0	0.0	0.0	0.0	0.0	43.0	40.0	0.0
Blair Creek	3	827	0.0	2.5	1.2	80.9	206.8	0.0	0.0	12.0	51.0	43.0	98.0	7.5	1.8	0.0	0.0	0.0	56.0	39.0	0.0
Steele Creek Tributary A	1	555	12.0	2.2	0.8	85.2	7.4	0.6	14.1	6.7	12.0	86.0	94.0	15.5	9.2	0.0	122.0	0.0	93.0	6.0	0.0
North Fork Coquille River	3	1668	95.0	4.0	5.9	36.7	7.2	0.5	4.0	28.6	23.0	10.0	94.0	29.9	121.3	8.3	30.0	0.0	16.0	21.0	0.0
Middle Creek (X)	1	9430	327.0	8.3	0.2	56.9	8.2	0.9	0.0	41.5	48.0	11.0	0.0	7.6	6.9	0.3	24.1	12.1	38.0	22.0	0.0
Middle Creek (X)	2	10550	1035.0	8.5	0.4	68.4	5.9	0.6	0.1	68.4	51.0	3.0	0.0	4.1	2.4	0.1	24.1	18.1	16.0	30.0	0.0
Middle Creek (X)	3	2176	372.0	7.6	1.0	63.1	4.5	0.7	5.5	19.4	22.0	11.0	85.0	16.5	21.7	0.7	0.0	0.0	18.0	21.0	10.0
Middle Creek (X)	4	4830	534.0	8.0	0.6	48.5	6.9	0.6	3.7	24.2	37.0	15.0	84.0	7.1	10.6	0.3	0.0	0.0	21.0	22.0	26.0
Middle Creek (X)	5	4126	184.0	6.7	0.9	64.3	4.7	0.7	6.7	19.6	33.0	14.0	90.0	13.0	18.9	0.6	0.0	0.0	20.0	18.0	30.0
Middle Creek (Z)	7	1797	198.0	1.6	7.8	47.2	13.2	0.3	6.0	11.0	75.0	7.0	93.0	13.4	38.5	1.2	9.0	0.0	8.0	55.0	9.0
Middle Creek (Y)	6	2054	137.0	4.2	1.2	73.3	4.6	0.5	11.9	18.1	34.0	16.0	92.0	16.8	31.2	1.2	20.0	0.0	24.0	28.0	15.0
Johns Creek	1	306	0.0	1.6	2.0	58.6	7.5	0.4	3.3	10.5	65.0	16.0	79.0	6.2	2.9	0.0	0.0	0.0	29.0	54.0	4.0
Johns Creek	2	1533	74.0	1.7	3.9	24.6	13.9	0.4	6.2	13.6	53.0	22.0	90.0	9.9	7.1	0.4	41.0	0.0	22.0	38.0	2.0
Johns Creek	3	1196	96.0	1.4	6.2	12.0	30.5	0.4	1.5	9.1	45.0	10.0	92.0	13.6	12.7	0.5	20.0	0.0	13.0	29.0	1.0
Coquille Sub-basin (HUC 17100305), East Fork Coquille River (HUC 1710030503) Fifth field Watershed																					
Knapper Creek	1	591	115.0	2.3	3.4	55.7	6.0	0.6	4.3	5.3	23.0	77.0	88.0	29.6	72.7	1.2	0.0	0.0	71.0	18.0	0.0
Knapper Creek	2	1103	27.0	3.1	15.2	36.0	26.4	1.0	0.9	7.3	43.0	48.0	100.0	10.2	19.3	0.3	0.0	0.0	35.0	14.0	0.0
Lost Creek	1	4031	28.0	6.3	3.5	37.1	7.5	1.0	0.0	25.0	48.0	10.0	92.0	65.1	247.4	0.0	0.0	0.0	23.0	18.0	0.0

						Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Lost Creek	2	547	0.0	6.8	1.3	43.4	7.6	0.4	0.0	29.0	21.0	17.0	100.0	14.4	16.1	0.0	0.0	0.0	18.0	15.0	0.0
Dead Horse Creek	1	2742	348.0	2.2	6.3	26.1	8.5	0.6	1.9	13.2	34.0	41.0	98.0	18.6	31.9	1.5	24.0	0.0	37.0	25.0	0.0
Dead Horse Creek	2	477	16.0	1.5	22.6	2.6	88.1	0.4	0.0	10.7	33.0	21.0	96.0	17.8	20.3	0.6	0.0	0.0	18.0	21.0	0.0
Dead Horse Creek	3	1020	110.0	1.4	4.7	22.7	25.0	0.5	0.9	5.7	60.0	30.0	100.0	33.2	79.6	2.6	0.0	0.0	50.0	37.0	0.0
Sf Camas Creek, Tributary A	1	950	21.0	2.9	5.6	6.0	48.6	0.5	0.0	15.8	48.0	2.0	92.0	53.0	223.3	12.7	0.0	0.0	5.0	18.0	0.0
South Fork Camas Creek	1	3026	47.0	2.9	6.9	15.5	30.1	0.7	0.0	26.0	10.0	60.0	94.0	32.8	157.4	10.1	0.0	0.0	10.0	15.0	0.0
Camas Creek	1	2789	28.0	6.2	1.7	24.0	9.0	1.0	3.2	22.7	16.0	6.0	93.0	9.2	5.2	0.0	0.0	0.0	8.0	14.0	5.0
Camas Creek	2	3355	50.0	7.5	3.1	8.7	22.4	1.2	0.9	20.8	12.0	8.0	98.0	7.8	5.9	0.0	41.0	20.0	5.0	10.0	23.0
Camas Creek	3	3629	247.0	6.4	1.9	39.7	5.3	0.9	5.9	19.7	40.0	2.0	96.0	9.5	15.3	0.4	0.0	0.0	4.0	22.0	42.0
Camas Creek	4	1574	132.0	3.0	4.5	33.3	9.7	0.4	10.0	10.9	80.0	20.0	99.0	20.8	46.2	2.5	122.0	61.0	6.0	52.0	9.0
Middle Fork Brummit Creek	1	1110	399.0	3.1	7.0	32.6	9.2	0.6	0.0	16.9	8.0	3.0	77.0	39.9	174.2	2.5	61.0	41.0	4.0	13.0	0.0
Middle Fork Brummit Creek	2	509	148.0	3.3	9.1	48.0	7.7	0.4	1.5	7.3	70.0	0.0	87.0	34.2	425.0	6.3	183.0	61.0	8.0	24.0	0.0
Middle Fork Brummit Creek	3	1539	334.0	2.5	5.1	36.7	10.9	0.6	0.5	15.3	63.0	24.0	84.0	43.9	258.4	4.0	0.0	0.0	8.0	27.0	0.0
Middle Fork Brummit Creek	4	798	59.0	1.7	12.8	26.9	16.6	0.4	0.0	8.2	40.0	42.0	88.0	27.3	320.6	9.3	122.0	61.0	35.0	26.0	0.0
Camas Creek Sec13 Tributary	1	2140	110.0	2.7	12.1	33.3	8.0	0.6	5.8	13.4	61.0	27.0	88.0	57.7	60.8	1.3	0.0	0.0	30.0	26.0	30.0
East Fork Brummit Creek	1	1608	155.0	6.7	4.1	26.7	4.4	0.9	5.1	30.1	15.0	11.0	84.0	14.6	38.0	1.9	0.0	0.0	16.0	15.0	0.0
East Fork Brummit Creek	2	1403	182.0	5.8	4.8	31.0	4.8	1.0	3.2	25.2	26.0	12.0	83.0	16.5	30.8	1.2	0.0	0.0	14.0	17.0	0.0
East Fork Brummit Creek	3	1402	11.0	4.7	3.5	37.8	8.2	0.8	8.5	16.3	54.0	25.0	88.0	44.7	132.8	6.6	61.0	30.0	25.0	19.0	0.0
East Fork Brummit Creek	4	993	27.0	3.9	2.4	61.2	4.1	0.7	16.7	26.2	43.0	16.0	83.0	24.3	35.7	0.5	152.0	61.0	20.0	40.0	0.0
East Fork Brummit Creek	5	650	27.0	3.1	1.9	16.2	9.3	0.4	3.0	15.9	17.0	13.0	96.0	8.0	12.2	0.0	0.0	0.0	16.0	14.0	0.0
East Fork Brummit Creek	6	2297	124.0	1.2	5.0	32.4	4.6	0.4	15.3	17.5	31.0	37.0	99.0	27.2	47.4	1.3	0.0	0.0	47.0	25.0	0.0
West Fork Brummit Creek	1	2711	235.0	6.2	0.7	62.3	3.1	0.9	20.4	12.1	32.0	67.0	77.0	24.2	20.4	0.9	0.0	0.0	82.0	15.0	0.0
West Fork Brummit Creek	2	726	140.0	5.1	3.2	34.3	7.4	1.0	5.8	12.7	20.0	25.0	97.0	15.7	26.8	1.4	0.0	0.0	28.0	16.0	0.0
West Fork Brummit Creek	3	1361	423.0	5.1	5.3	27.1	4.6	0.8	5.6	19.8	20.0	40.0	98.0	11.6	30.3	0.5	0.0	0.0	31.0	18.0	0.0
West Fork Brummit Creek	4	594	169.0	5.0	5.9	30.2	3.7	1.0	6.6	22.2	20.0	41.0	99.0	33.8	76.6	1.5	0.0	0.0	29.0	14.0	0.0
West Fork Brummit Creek	5	1217	132.0	5.3	4.8	46.6	3.7	1.0	8.9	22.2	51.0	36.0	94.0	24.2	46.5	0.7	0.0	0.0	29.0	29.0	0.0
West Fork Brummit Creek	6	872	79.0	5.4	2.3	56.5	3.4	0.8	10.5	15.3	59.0	33.0	96.0	15.5	27.8	0.2	0.0	0.0	32.0	43.0	0.0
West Fork Brummit Creek	7	1249	78.0	2.8	3.4	41.4	6.7	0.6	9.8	10.2	74.0	17.0	100.0	14.7	27.9	0.6	0.0	0.0	31.0	45.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
West Fork Brummit Creek	8	955	55.0	2.6	16.3	57.3	11.5	0.6	8.9	13.5	50.0	50.0	95.0	48.7	173.4	5.0	61.0	61.0	52.0	28.0	0.0
West Fork Brummit Creek	9	888	63.0	1.1	3.3	27.7	33.7	0.6	6.3	10.7	27.0	73.0	48.0	39.8	75.5	0.5	0.0	0.0	69.0	23.0	0.0
Karl Creek	2	656	62.0	3.0	2.1	36.8	6.4	0.6	8.4	17.8	55.0	13.0	79.0	68.1	194.0	6.7	183.0	122.0	18.0	20.0	0.0
Karl Creek	3	894	126.0	3.1	4.9	68.2	5.9	0.6	11.8	18.7	30.0	38.0	88.0	35.7	138.8	4.5	274.0	122.0	44.0	31.0	0.0
Karl Creek	4	224	95.0	2.5	0.7	69.5	2.8	0.7	3.1	22.7	73.0	27.0	85.0	20.6	120.7	5.8	0.0	0.0	55.0	39.0	0.0
Karl Creek	5	730	81.0	2.1	9.5	29.2	12.7	0.4	4.9	13.0	60.0	20.0	89.0	41.8	58.5	2.7	0.0	0.0	17.0	20.0	0.0
Karl Creek	1	722	50.0	3.8	3.2	42.5	3.8	0.7	14.2	17.7	42.0	12.0	94.0	31.9	99.4	1.0	30.0	0.0	20.0	25.0	0.0
China Creek Tributary A	1	1182	41.0	1.2	12.2	15.1	21.5	0.5	0.0	27.5	20.0	9.0	93.0	15.6	37.3	1.5	20.0	0.0	6.0	13.0	0.0
China Creek	1	754	14.0	2.8	6.5	31.5	6.4	0.5	0.0	7.2	12.0	3.0	93.0	15.4	37.9	0.9	0.0	0.0	7.0	16.0	0.0
China Creek	2	1709	442.0	1.9	7.3	17.4	22.7	0.8	0.0	17.1	12.0	2.0	95.0	21.3	91.1	3.9	20.0	20.0	6.0	11.0	0.0
Bills Creek	1	2561	76.0	1.3	14.2	3.9	47.6	0.4	0.0	7.0	23.0	10.0	99.0	10.7	27.5	1.3	61.0	0.0	15.0	15.0	0.0
Steel Creek	1	1216	40.0	4.6	1.6	47.6	4.3	0.4	0.8	20.1	56.0	12.0	89.0	13.2	18.3	0.2	91.0	0.0	9.0	25.0	0.0
Steel Creek	2	2170	328.0	3.8	2.1	44.6	9.1	0.5	1.6	41.9	22.0	6.0	88.0	11.1	21.5	1.2	61.0	20.0	13.0	23.0	0.0
Steel Creek	3	3175	566.0	2.7	8.3	19.2	13.8	0.7	0.5	6.0	85.0	10.0	91.0	15.6	68.8	2.1	52.0	9.0	6.0	16.0	0.0
South Fk Elk Creek Tributary #2	1	634	13.0	2.2	2.7	31.8	6.8	0.3	7.7	11.1	56.0	2.0	99.0	14.7	22.1	0.9	61.0	0.0	7.0	54.0	4.0
South Fk Elk Creek Tributary #2	2	1967	44.0	1.7	7.4	35.1	23.9	0.4	7.0	5.3	82.0	13.0	81.0	15.9	26.6	2.2	0.0	0.0	16.0	69.0	0.0
South Fork Elk Creek	1	3848	375.0	4.6	1.2	62.8	3.4	0.6	2.1	24.3	47.0	16.0	86.0	13.4	13.6	0.3	10.0	10.0	26.0	34.0	0.0
South Fork Elk Creek	2	1395	26.0	3.3	1.8	46.4	5.6	0.6	2.1	14.9	39.0	15.0	85.0	15.4	51.0	2.3	20.0	20.0	14.0	37.0	0.0
South Fork Elk Creek	3	845	97.0	2.9	1.7	57.0	4.5	0.7	0.0	13.4	27.0	16.0	73.0	7.8	10.8	0.4	0.0	0.0	24.0	27.0	0.0
South Fork Elk Creek	4	1515	114.0	1.8	10.2	13.7	16.6	0.5	0.0	9.5	26.0	11.0	91.0	20.0	63.9	2.0	152.0	91.0	9.0	17.0	0.0
Elk Creek Sec33 Tributary	1	2044	195.0	1.2	11.5	36.2	8.6	0.4	6.7	9.3	87.0	0.0	98.0	21.5	75.9	4.5	30.0	10.0	8.0	41.0	24.0
Elk Creek	1	1453	156.0	3.7	0.5	74.3	3.4	0.6	1.2	9.6	65.0	23.0	70.0	8.5	5.1	0.1	0.0	0.0	34.0	52.0	0.0
Elk Creek	2	3080	55.0	6.3	0.9	66.3	5.4	0.7	0.3	32.7	29.0	19.0	97.0	3.5	2.1	0.0	30.0	0.0	16.0	21.0	0.0
Elk Creek	3	1860	57.0	3.0	2.0	59.1	4.0	0.4	0.5	19.9	24.0	14.0	96.0	16.7	29.8	1.0	49.0	0.0	26.0	17.0	0.0
Elk Creek	4	834	34.0	1.7	2.4	61.2	4.3	0.4	6.9	13.4	39.0	19.0	94.0	27.3	48.9	2.4	0.0	0.0	41.0	27.0	0.0
Elk Creek	5	1721	117.0	1.3	13.1	24.1	18.8	0.4	0.5	10.6	15.0	4.0	99.0	13.5	25.9	1.2	15.0	0.0	15.0	14.0	0.0
Yankee Run	1	730	11.0	3.5	1.6	42.9	4.3	0.5	6.7	21.0	63.0	28.0	80.0	8.4	14.6	0.5	0.0	0.0	37.0	42.0	0.0
Yankee Run	2	536	0.0	3.4	1.4	37.4	4.0	0.5	5.6	22.2	68.0	21.0	79.0	7.3	5.3	0.0	0.0	0.0	41.0	51.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach					Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
		PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Yankee Run	3	2348	66.0	1.6	1.7	36.3	6.5	0.3	3.3	24.5	71.0	17.0	86.0	9.5	13.2	0.6	34.0	20.0	43.0	45.0	0.0
Yankee Run, Tributary 1	1	2144	33.0	2.0	1.3	53.5	4.4	0.3	3.2	37.1	70.0	12.0	91.0	10.0	11.9	0.3	880.0	0.0	37.0	46.0	0.0
Weekly Creek Tributary B	1	811	25.0	1.2	6.9	17.8	19.2	0.4	1.2	25.0	5.0	95.0	100.0	10.4	14.4	0.4	0.0	0.0	32.0	13.0	0.0
Weekly Creek	1	1207	0.0	2.5	1.0	71.7	8.6	0.7	0.8	9.9	57.0	43.0	82.0	6.1	1.7	0.0	0.0	0.0	65.0	31.0	0.0
Weekly Creek	2	842	35.0	3.2	2.8	60.1	5.5	0.8	10.3	11.6	50.0	22.0	98.0	21.2	17.0	0.5	244.0	0.0	34.0	33.0	0.0
Weekly Creek	3	684	25.0	2.5	2.5	62.1	5.8	0.5	9.9	15.6	27.0	22.0	94.0	28.7	31.0	1.0	122.0	0.0	32.0	26.0	0.0
Weekly Creek	4	493	19.0	1.9	2.1	50.6	6.0	0.5	2.0	12.5	11.0	8.0	95.0	17.9	14.8	0.0	61.0	0.0	28.0	17.0	0.0
Weekly Creek	5	1153	44.0	1.5	7.0	28.8	15.0	0.7	0.0	5.0	20.0	15.0	99.0	14.0	16.8	0.8	30.0	0.0	23.0	16.0	0.0
Weekly Creek	6	745	6.0	1.0	9.2	8.6	39.5	0.6	0.0	5.0	50.0	10.0	96.0	18.3	20.5	0.9	0.0	0.0	21.0	20.0	0.0
Hantz Creek	1	505	23.0	1.5	2.4	87.8	17.4	0.5	0.0	17.0	70.0	30.0	90.0	5.9	1.9	0.0	0.0	0.0	17.0	30.0	0.0
Hantz Creek	2	2184	34.0	1.4	3.1	21.9	15.7	0.5	5.0	12.5	72.0	20.0	99.0	30.3	14.1	0.1	49.0	0.0	28.0	59.0	0.0
Hantz Creek	3	393	11.0	0.7	11.7	5.7	46.5	0.5	0.0	6.0	30.0	0.0	100.0	18.6	8.8	0.0	0.0	0.0	15.0	20.0	0.0
Weekly Creek Sec31 Tributary	1	200	1.0	1.0	3.9	22.5	7.6	0.3	24.9	6.6	68.0	12.0	99.0	24.0	21.6	1.0	0.0	0.0	17.0	56.0	0.0
Weekly Creek Sec31 Tributary	2	885	23.0	0.8	2.0	44.9	7.0	0.3	12.1	9.1	68.0	10.0	100.0	14.0	30.8	2.3	30.0	15.0	15.0	54.0	1.0
Weekly Creek Sec31 Tributary	3	665	14.0	0.8	7.6	36.0	14.7	0.2	4.4	7.4	32.0	4.0	98.0	17.7	72.9	4.4	61.0	0.0	9.0	50.0	1.0
Coquille Sub-basin (HUC 17100305), Middle Fork Coquille River (HUC 1710030501) Fifth field Watershed																					
Upper Rock Creek Sec18 Trib	1	372	41.0	2.0	6.6	49.7	4.1	0.5	14.5	16.7	40.0	35.0	98.0	23.4	58.3	1.9	0.0	0.0	18.0	43.0	0.0
Upper Rock Creek Sec18 Trib	2	1336	93.0	2.4	3.5	44.4	6.7	0.7	10.5	13.9	69.0	8.0	97.0	32.8	167.9	4.6	152.0	61.0	19.0	45.0	7.0
Upper Rock Creek Sec18 Trib	3	1897	316.0	1.4	9.0	45.3	24.9	0.6	5.9	8.6	62.0	34.0	99.0	23.5	91.9	2.3	0.0	0.0	25.0	48.0	3.0
Slater Creek	1	1283	129.0	3.5	2.8	47.7	7.1	0.7	0.0	29.7	50.0	4.0	96.0	6.2	6.2	0.1	0.0	0.0	9.0	30.0	0.0
Slater Creek	2	746	0.0	3.9	0.2	90.2	6.1	0.8	2.7	23.6	96.0	4.0	83.0	27.9	47.4	1.7	0.0	0.0	36.0	60.0	0.0
Slater Creek	3	1521	53.0	3.1	3.1	47.9	5.9	0.7	1.9	32.0	38.0	2.0	96.0	7.3	31.9	1.1	0.0	0.0	7.0	25.0	0.0
Slater Creek	4	773	10.0	3.1	5.5	16.0	9.3	0.7	1.3	110.8	25.0	0.0	100.0	13.8	47.6	1.7	0.0	0.0	5.0	18.0	0.0
Slater Creek	5	1575	69.0	2.3	10.1	20.8	16.3	0.6	0.6	29.3	45.0	4.0	99.0	19.8	76.9	3.3	0.0	0.0	6.0	29.0	0.0
Upper Rock Creek Tributary 1	1	772	21.0	3.5	3.9	13.6	22.7	0.4	0.0	42.5	40.0	16.0	98.0	13.9	3.5	0.0	0.0	0.0	18.0	28.0	0.0
Lake Creek	1	680	0.0	6.7	14.9	8.3	8.0	0.6	0.0	0.0	10.0	6.0	97.0	37.1	50.9	0.0	0.0	0.0	5.0	7.0	0.0
Lake Creek	2	934	1.0	12.7	4.0	88.5	8.3	0.5	0.0	43.9	90.0	11.0	97.0	23.6	32.2	0.0	0.0	0.0	22.0	45.0	0.0
Little Rock Creek	1	3082	238.0	3.0	12.5	11.2	25.0	0.4	0.0	24.0	34.0	16.0	96.0	11.5	8.3	0.2	0.0	0.0	14.0	21.0	0.0

						Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Sandy Creek Tributary B	1	2727	103.0	2.7	10.2	8.1	26.6	0.5	0.0	28.1	28.0	0.0	89.0	5.0	5.2	0.1	54.3	18.1	6.0	19.0	0.0
Sandy (R5) Creek	1	1627	53.0	3.1	26.3	3.9	29.7	0.5	0.0	43.0	35.0	0.0	96.0	6.9	7.7	0.4	0.0	0.0	9.0	16.0	0.0
Sandy Creek Tributary F	1	930	0.0	0.5	10.0								89.0	4.3	4.1	0.1	0.0	0.0	0.0	0.0	0.0
Sandy Creek Tributary G	1	1097	0.0	0.8	7.1								87.0	14.1	9.3	0.1	120.7	0.0	0.0	0.0	0.0
Sandy Creek Tributary H	1	1538	0.0	1.8	7.2	9.1	56.9	0.5	0.0	24.9	60.0	0.0	93.0	12.4	8.3	0.0	60.3	0.0	10.0	32.0	0.0
Big Creek Tributary A	1	498	296.0	1.6	7.4	1.5	227.0	0.3	0.0	23.0	40.0	0.0	93.0	20.1	38.6	1.0	150.9	30.2	1.0	24.0	0.0
Fetter Creek	1	230	0.0	0.7	8.4								97.0	5.2	3.9	0.0	0.0	0.0	0.0	0.0	0.0
Slide Creek	1	715	71.0	4.0	2.8	43.1	3.1	0.4	0.0	21.8	37.0	34.0	89.0	7.4	10.5	0.3	0.0	0.0	43.0	36.0	0.0
Slide Creek	2	2354	265.0	3.3	3.1	42.0	3.2	0.4	0.0	27.6	27.0	23.0	99.0	6.7	9.0	0.3	28.0	0.0	33.0	16.0	0.0
Slide Creek	3	633	50.0	2.2	8.6	24.3	9.6	0.3	0.0	19.5	42.0	13.0	97.0	20.7	48.5	3.2	142.0	41.0	19.0	28.0	0.0
Swamp Creek Tributary A	1	342	0.0	2.4	4.3	3.7	114.0	0.3	0.0	16.9	28.0	45.0	69.0	42.7	77.7	2.3	0.0	0.0	40.0	17.0	0.0
Swamp Creek Tributary B	1	697	0.0	1.6	1.9								54.0	10.0	17.8	0.6	0.0	0.0	58.0	32.0	0.0
Swamp Creek Tributary C	1	989	0.0	0.6	6.7								84.0	21.8	16.2	0.0	0.0	0.0	56.0	16.0	0.0
Slide Creek, Tributary A	1	1371	20.0	1.6	13.3	14.6	9.0	0.2	0.0	17.0	40.0	13.0	100.0	7.4	8.4	0.1	37.0	0.0	15.0	23.0	0.0
Slide Creek, Tributary D	1	325	63.0	2.3	8.3	9.0	21.8	0.4	0.0	17.9	40.0	13.0	99.0	24.2	16.7	0.4	102.0	61.0	14.0	31.0	0.0
Slide Creek, Tributary E	2	552	0.0	1.4	10.9	3.5	51.1	0.3	0.0	11.3	48.0	25.0	100.0	17.9	22.6	0.9	0.0	0.0	24.0	29.0	0.0
Frenchie Creek	1	1410	91.0	1.6	6.6	41.1	7.3	0.4	9.3	11.7	58.0	5.0	99.0	22.8	50.8	2.4	15.0	0.0	12.0	37.0	9.0
Frenchie Creek	2	1450	149.0	1.1	11.3	27.8	17.0	0.4	5.6	6.6	50.0	40.0	99.0	27.4	66.4	1.8	46.0	0.0	10.0	36.0	5.0
Belieu Creek	1	2815	58.0	1.6	4.7	46.2	6.5	0.4	6.6	11.5	78.0	13.0	97.0	10.4	18.3	0.5	0.0	0.0	22.0	55.0	2.0
Belieu Creek	2	508	20.0	1.1	7.3	28.8	11.7	0.4	7.6	10.6	90.0	11.0	100.0	26.2	64.8	2.8	0.0	0.0	17.0	60.0	3.0
Belieu Creek	3	1070	27.0	1.0	5.7	62.8	11.8	0.4	23.7	7.9	100.0	0.0	98.0	37.9	92.8	3.1	0.0	0.0	22.0	66.0	0.0
Brownson Creek Tributary A	1	1237	0.0	2.9	2.0	42.5	23.0	0.4	0.0	27.1	73.0	2.0	74.0	4.3	8.2	0.2	0.0	0.0	45.0	26.0	0.0
Rasler Creek	1	1281	16.0	2.8	4.5	12.3	14.5	0.5	0.0	42.5	24.0	29.0	93.0	4.0	3.3	0.2	0.0	0.0	40.0	21.0	0.0
Rasler Creek	2	11980	0.0	1.9	10.6	3.0	713.1	0.5	0.0	18.5	13.0	13.0	100.0	10.7	17.0	0.8	0.0	0.0	13.0	12.0	0.0
Myrtle Creek	1	7850	144.0	14.1	0.5	33.0	13.2	1.6	0.0	83.9	32.0	4.0	57.0	1.7	1.4	0.1	20.0	0.0	22.0	36.0	0.0
Myrtle Creek	2	6546	276.0	8.8	0.8	35.0	14.1	1.2	0.0	89.3	43.0	5.0	51.0	5.2	4.1	0.0	0.0	0.0	38.0	38.0	0.0
Myrtle Creek	3	4361	229.0	7.1	0.7	24.2	15.4	0.9	0.0	65.8	53.0	5.0	68.0	6.3	5.6	0.1	20.0	0.0	20.0	41.0	0.0
Myrtle Creek	4	3901	105.0	5.9	8.5	13.2	19.4	0.8	0.5	34.2	47.0	10.0	91.0	13.5	34.2	1.6	61.0	0.0	19.0	22.0	0.0

						Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Myrtle Creek	5	978	131.0	4.8	0.4	46.2	12.9	0.8	0.9	16.3	76.0	20.0	79.0	22.4	49.4	0.0	0.0	0.0	55.0	40.0	0.0
Myrtle Creek	6	4759	46.0	3.4	6.7	19.6	44.1	0.7	0.2	25.7	57.0	15.0	88.0	37.2	89.0	3.3	0.0	0.0	33.0	30.0	0.0
Cole Creek	1	2471	0.0	3.3	1.3	23.1	25.7	0.7	0.0	20.8	52.0	8.0	62.0	6.3	3.4	0.0	0.0	0.0	30.0	50.0	0.0
Cole Creek	2	4456	82.0	1.7	6.7	6.1	179.7	0.6	0.0	15.7	63.0	11.0	84.0	15.2	19.6	0.7	0.0	0.0	15.0	39.0	0.0
Snow Creek	1	3727	46.0	1.7	4.6	12.0	56.6	1.1	0.3	17.5	50.0	9.0	72.0	22.1	25.0	0.6	0.0	0.0	10.0	30.0	0.0
Lower Rock Creek	1	1762	0.0	11.5	0.5	32.4	10.0	0.8	0.0	53.3	27.0	24.0	46.0	0.2	0.2	0.0	0.0	0.0	29.0	20.0	0.0
Lower Rock Creek	2	1571	0.0	9.5	0.8	55.1	7.4	1.0	0.0	36.6	25.0	23.0	70.0	0.8	1.6	0.1	0.0	0.0	28.0	15.0	0.0
Lower Rock Creek	3	1583	22.0	9.0	0.4	49.5	8.4	0.7	0.0	58.6	62.0	20.0	54.0	0.6	0.6	0.0	0.0	0.0	36.0	47.0	0.0
Lower Rock Creek	4	1734	112.0	8.4	1.4	40.5	5.3	0.8	0.0	37.9	28.0	21.0	89.0	0.6	2.2	0.1	30.0	30.0	28.0	21.0	0.0
Lower Rock Creek	5	2048	74.0	8.3	1.0	35.4	6.7	0.8	0.0	56.9	34.0	22.0	62.0	0.5	0.1	0.0	0.0	0.0	28.0	23.0	0.0
Lower Rock Creek	6	4349	403.0	7.6	1.7	47.2	4.9	0.8	0.0	40.6	26.0	22.0	92.0	1.9	6.9	0.2	0.0	0.0	31.0	16.0	0.0
Lower Rock Creek	7	4903	248.0	5.9	6.0	18.5	7.9	0.8	0.0	39.4	27.0	27.0	99.0	13.6	42.9	1.1	24.0	0.0	29.0	17.0	0.0
Lower Rock Creek	8	2576	130.0	5.2	2.8	17.1	11.8	0.7	0.0	37.2	34.0	21.0	97.0	19.1	67.6	1.4	0.0	0.0	31.0	23.0	0.0
Salmon Creek	1	548	2.0	1.4	1.2	38.9	9.2	0.3	5.5	10.2	60.0	25.0	96.0	5.8	1.4	0.0	0.0	0.0	21.0	49.0	19.0
Salmon Creek	2	1943	54.0	1.5	4.0	39.1	10.0	0.4	1.5	11.7	62.0	10.0	97.0	4.9	7.8	0.3	41.0	0.0	18.0	44.0	9.0
Salmon Creek	3	1175	132.0	1.0	12.6	26.0	45.7	0.3	0.8	10.4	75.0	16.0	96.0	15.2	26.1	1.4	41.0	20.0	15.0	41.0	7.0
Smith Creek	1	1275	16.0	1.8	3.8	15.0	55.9	0.5	0.0	10.6	66.0	6.0	98.0	9.3	10.4	0.4	0.0	0.0	30.0	49.0	0.0
Smith Creek	2	704	37.0	1.3	8.7	2.4	234.7	0.4	0.0	11.0	45.0	13.0	100.0	17.8	30.1	2.1	244.0	183.0	11.0	33.0	0.0
King Creek	1	4779	77.0	2.3	3.1	34.0	21.0	0.5	0.0	13.9	63.0	8.0	91.0	8.7	11.3	0.6	30.0	0.0	27.0	48.0	0.0
Mcmullen Creek	1	1341	8.0	1.4	3.6	17.8	33.8	0.1	0.0	26.6	70.0	19.0	94.0	1.9	0.5	0.0	0.0	0.0	21.0	58.0	0.0
Indian Creek	1	444	20.0	2.8	1.9	35.8	7.9	0.5	10.8	12.3	45.0	21.0	89.0	17.6	12.7	0.5	0.0	0.0	26.0	39.0	5.0
Indian Creek	2	395	21.0	3.0	1.7	60.4	6.0	0.4	9.6	12.1	38.0	20.0	84.0	9.1	5.8	0.3	0.0	0.0	28.0	34.0	9.0
Indian Creek	3	400	17.0	2.8	3.0	48.9	3.9	0.4	16.8	14.3	42.0	17.0	86.0	36.2	36.8	1.2	30.0	0.0	28.0	41.0	4.0
Indian Creek	4	538	31.0	2.4	3.2	24.7	0.0	0.5	0.0	12.9	55.0	29.0	94.0	2.0	10.0	0.4	183.0	122.0	35.0	22.0	27.0
Shields Creek	1	388	0.0	2.3	4.8	23.7	9.5	0.9	0.0	9.7	20.0	3.0	100.0	0.8	4.9	0.0	0.0	0.0	6.0	22.0	5.0
Shields Creek	2	680	151.0	2.2	13.3	38.8	7.5	1.0	0.0	9.0	40.0	8.0	99.0	1.6	6.7	0.1	0.0	0.0	9.0	22.0	16.0
Fall Creek	1	630	35.0	1.7	2.2	32.8	9.0	0.4	3.0	11.2	26.0	6.0	87.0	4.3	2.3	0.0	91.0	0.0	21.0	22.0	31.0
Fall Creek	2	908	58.0	2.2	8.8	21.6	17.6	0.4	3.1	14.1	30.0	5.0	88.0	6.3	4.2	0.0	0.0	0.0	22.0	33.0	2.0

Subbasin Fifth Field Watershed Stream Name	Reach					Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
		PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Fall Creek	3	360	0.0	2.3	1.9	10.5	40.0	0.5	0.0	19.0	12.0	59.0	0.0	8.6	10.0	0.0	0.0	0.0	51.0	20.0	0.0
Brownson Creek	1	286	17.0	1.9	0.6	57.0	4.8	0.4	3.3	16.7	86.0	11.0	76.0	4.9	4.0	0.0	0.0	0.0	12.0	77.0	4.0
Brownson Creek	2	316	7.0	1.5	1.6	66.0	5.2	0.5	15.5	9.1	76.0	16.0	67.0	16.5	11.6	0.0	0.0	0.0	21.0	68.0	6.0
Brownson Creek	3	1220	51.0	2.1	0.9	70.0	4.3	0.5	17.3	12.2	80.0	8.0	89.0	16.6	17.2	0.5	46.0	15.0	23.0	66.0	5.0
Brownson Creek	4	1206	0.0	1.5	2.4	2.2	172.3	0.6	0.0				0.0	3.6	2.5	0.1	0.0	0.0	4.0	55.0	0.0
Axe Creek	1	1312	16.0	1.9	3.7	23.1	10.5	0.4	7.5	11.2	76.0	4.0	93.0	15.5	17.3	0.4	30.0	0.0	12.0	62.0	5.0
Bear Pen Creek	1	1136	82.0	1.7	3.5	40.7	7.2	0.4	12.3	12.5	57.0	7.0	89.0	15.3	24.2	1.8	30.0	0.0	16.0	47.0	0.0
Big Creek	1	858	67.0	4.2	0.5	47.2	5.2	0.4	2.2	17.5	64.0	18.0	69.0	5.6	2.1	0.0	0.0	0.0	22.0	48.0	13.0
Big Creek	2	561	0.0	6.4	1.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Big Creek	3	2375	59.0	6.2	0.4	73.5	4.3	0.6	4.1	21.4	57.0	10.0	84.0	5.2	4.3	0.1	0.0	0.0	21.0	40.0	14.0
Big Creek	4	1353	134.0	5.3	0.4	63.5	3.7	0.5	8.1	21.8	49.0	15.0	85.0	12.0	8.2	0.1	30.0	0.0	21.0	43.0	19.0
Big Creek	5	2154	0.0	0.0	0.1								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Big Creek	6	2006	221.0	5.8	0.4	72.1	3.0	0.7	4.9	22.7	65.0	8.0	81.0	6.1	3.1	0.0	0.0	0.0	25.0	46.0	12.0
Big Creek	7	2001	116.0	5.7	0.6	60.6	3.6	0.5	7.1	19.8	66.0	6.0	75.0	5.8	3.4	0.0	0.0	0.0	14.0	51.0	10.0
Big Creek	8	1204	180.0	4.4	1.0	48.2	3.9	0.4	5.1	19.9	43.0	4.0	84.0	6.6	5.4	0.1	0.0	0.0	11.0	41.0	17.0
Big Creek	9	5953	797.0	4.2	2.5	38.6	4.3	0.4	4.0	18.5	44.0	8.0	89.0	7.7	9.1	0.4	17.0	0.0	10.0	24.0	12.0
Big Creek	10	1917	260.0	2.5	2.6	37.7	6.6	0.4	4.6	13.4	60.0	9.0	90.0	10.0	13.4	0.6	110.0	24.0	16.0	38.0	12.0
Big Creek	11	564	17.0	2.5	6.2	1.5	145.4	0.3	0.0	27.2	38.0	0.0	0.0	1.9	3.3	0.0	0.0	0.0	2.0	28.0	0.0
Swamp Creek	1	580	110.0	2.6	1.6	35.8	5.7	0.5	10.1	18.6	23.0	19.0	87.0	24.1	25.0	0.9	0.0	0.0	28.0	20.0	1.0
Swamp Creek	2	1280	53.0	3.0	0.8	83.4	3.7	0.7	18.8	11.5	48.0	46.0	83.0	14.8	11.9	0.3	0.0	0.0	74.0	22.0	0.0
Swamp Creek	3	400	23.0	2.2	2.7	42.6	5.7	0.5	11.8	11.7	41.0	44.0	91.0	19.8	9.1	0.0	0.0	0.0	56.0	21.0	0.0
Swamp Creek	4	568	0.0	1.5	9.9					0.0	33.0	58.0	92.0	25.0	24.1	0.5	0.0	0.0	48.0	29.0	5.0
Sandy Creek Tributary A	1	2402	155.0	3.6	7.6	22.9	8.6	0.5	0.4	11.6	71.0	19.0	88.0	3.9	3.5	0.0	61.0	30.0	23.0	19.0	22.0
Sandy Creek Tributary E	1	284	0.0	1.7	5.0	33.8	11.2	0.4	0.0	6.8	92.0	8.0	81.0	3.2	2.4	0.0	61.0	0.0	16.0	69.0	12.0
Sandy Creek Tributary E	2	655	3.0	1.4	9.3	24.7	15.1	0.4	4.6	6.5	66.0	26.0	92.0	23.8	22.1	0.3	163.0	61.0	27.0	43.0	25.0
Sandy Creek	1	1721	74.0	5.1	0.4	74.7	6.4	1.0	4.5	11.9	73.0	18.0	46.0	11.2	13.2	0.4	0.0	0.0	26.0	69.0	3.0
Sandy Creek	2	380	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Creek	3	5940	278.0	6.3	0.7	51.3	7.8	0.7	1.8	16.5	77.0	4.0	73.0	2.8	1.8	0.0	10.0	0.0	12.0	43.0	32.0

Subbasin Fifth Field Watershed Stream Name	Reach					Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
		PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Sandy Creek	4	1724	110.0	6.3	1.5	41.1	4.0	0.7	4.4	16.9	74.0	2.0	85.0	15.5	39.0	3.6	30.0	30.0	12.0	34.0	37.0
Sandy Creek	5	1089	88.0	5.0	2.0	41.3	6.7	0.7	0.8	13.1	56.0	4.0	90.0	2.1	1.2	0.0	41.0	20.0	8.0	45.0	19.0
Sandy Creek	6	1379	65.0	4.2	7.3	18.0	8.1	0.8	0.0	12.7	86.0	2.0	92.0	10.7	11.5	0.2	0.0	0.0	8.0	33.0	28.0
Sandy Creek	7	632	23.0	3.5	3.4	47.7	7.3	0.7	10.7	8.6	52.0	2.0	69.0	12.2	12.1	0.3	0.0	0.0	9.0	53.0	2.0
Sandy Creek	8	1449	0.0	2.5	8.7	14.9	9.0	0.5	3.5	10.7	87.0	3.0	84.0	19.5	15.8	0.1	15.0	0.0	6.0	66.0	2.0
Upper Rock Creek	1	1607	276.0	7.8	0.7	35.2	3.6	0.8	1.6	27.5	4.0	16.0	74.0	3.7	2.7	0.1	30.0	0.0	28.0	3.0	38.0
Upper Rock Creek	2	871	0.0	9.9	3.5	25.6	5.0	0.9	2.3	22.7	3.0	20.0	67.0	5.9	9.7	0.3	0.0	0.0	32.0	5.0	6.0
Upper Rock Creek	3	2398	732.0	9.1	8.0	12.1	8.0	1.1	1.6	25.8	25.0	15.0	76.0	19.2	27.0	1.0	102.0	0.0	27.0	7.0	1.0
Upper Rock Creek	4	1939	98.0	8.6	1.3	39.1	6.8	0.9	4.9	19.5	21.0	40.0	72.0	13.3	21.5	0.7	152.0	0.0	45.0	13.0	14.0
Upper Rock Creek	5	5804	1194.0	6.9	5.3	42.4	5.6	0.8	0.7	26.6	27.0	19.0	82.0	8.5	15.6	0.6	60.3	24.1	22.0	19.0	0.0
Upper Rock Creek	6	3548	149.0	5.2	1.0	86.6	11.2	0.7	3.0	20.4	74.0	22.0	83.0	21.5	36.6	1.1	48.3	18.1	56.0	42.0	0.0
Upper Rock Creek	7	1586	26.0	2.3	2.2	42.6	48.9	0.5	2.5	19.7	61.0	37.0	97.0	86.0	67.7	0.9	0.0	0.0	47.0	46.0	0.0
South Umpqua (HUC 17100302) Sub-basin, Olalla Creek-Lookingglass Creek (HUC 1710030212) Fifth field Watershed																					
Bear Creek (Berry)	1	558	0.0	2.7	1.3	39.5	4.7	0.2	0.0	32.9	20.0	7.0	78.0	4.8	7.2	0.2	0.0	0.0	14.0	45.0	0.0
Bear Creek (Berry)	2	1050	80.0	2.1	1.3	45.3	5.0	0.5	0.0	20.3	53.0	6.0	77.0	9.3	24.0	0.8	61.0	0.0	12.0	52.0	0.0
Bear Creek (Berry)	3	1988	37.0	1.7	2.0	64.1	6.1	0.4	0.0	17.0	48.0	4.0	70.0	12.9	17.9	0.5	30.0	0.0	9.0	43.0	0.0
Bear Creek (Berry)	4	1262	0.0	1.3	5.2	12.0	16.7	0.3	0.0	16.7	55.0	9.0	46.0	7.1	5.2	0.0	0.0	0.0	10.0	38.0	0.0
Berry Creek	1	1049	121.0	6.3	1.4	49.1	5.3	0.7	0.0	18.5	31.0	5.0	70.0	1.2	0.8	0.0	0.0	0.0	11.0	34.0	0.0
Berry Creek	3	7039	241.0	4.2	1.1	74.6	5.2	0.5	0.5	34.1	52.0	8.0	72.0	16.0	24.3	0.6	0.0	0.0	19.0	42.0	0.0
Berry Creek	4	2783	53.0	2.6	2.3	62.7	5.7	0.5	0.0	27.1	48.0	12.0	75.0	27.6	68.4	2.4	0.0	0.0	23.0	37.0	0.0
Berry Creek	5	3996	57.0	1.9	8.9	59.6	12.1	0.5	0.0	9.9	60.0	33.0	78.0	15.2	31.5	1.1	61.0	8.0	41.0	32.0	0.0
Byron Creek	1	3679	87.0	2.2	3.7	39.0	4.5	0.3	0.0	45.2	29.0	4.0	76.0	2.1	4.7	0.0	0.0	0.0	11.0	21.0	0.0
Byron Creek	2	1825	5.0	1.3	2.8	40.9	4.8	0.3	0.0	31.3	31.0	13.0	86.0	16.0	35.1	1.2	9.0	0.0	23.0	30.0	0.0
Byron Creek	3	1004	8.0	0.9	4.5	9.3	61.4	0.3	0.0	19.2	32.0	36.0	76.0	8.2	20.6	0.7	0.0	0.0	46.0	30.0	0.0
Coarse Gold Creek	1	2189	0.0	2.1	2.3	50.2	12.1	0.4	0.0	31.9	52.0	7.0	51.0	2.9	2.0	0.0	0.0	0.0	20.0	44.0	0.0
Coarse Gold Creek	2	613	19.0	1.5	4.1	2.4	84.2	0.3	0.0	20.0			77.0	5.7	16.7	0.8	0.0	0.0	7.0	20.0	0.0
Olalla Creek	1	3926	365.0	8.1	1.2	30.5	7.4	0.5	0.0	35.6	10.0	1.0	57.0	1.4	1.0	0.0	0.0	0.0	6.0	12.0	0.0
Olalla Creek	2	1950	98.0	7.2	2.2	55.4	3.7	0.5	0.0	27.9	20.0	6.0	78.0	4.1	21.7	1.2	0.0	0.0	6.0	21.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Olalla Creek	3	1591	252.0	4.3	7.9	50.5	2.8	0.5	0.0	11.5	36.0	1.0	55.0	6.0	14.9	0.4	0.0	0.0	5.0	21.0	0.0
Olalla Creek	4	476	35.0	4.7	5.2	56.3	2.4	0.7	2.0	29.5	35.0	0.0	86.0	15.8	62.9	2.1	30.0	0.0	6.0	20.0	0.0
Olalla Creek	5	3113	245.0	3.7	1.6	57.3	3.9	0.3	0.9	21.1	28.0	18.0	86.0	13.1	21.5	0.6	17.0	0.0	22.0	25.0	0.0
Olalla Creek	6	785	28.0	2.3	1.0	82.2	2.8	0.5	6.2	12.5	55.0	21.0	70.0	24.7	40.4	0.4	15.0	0.0	35.0	40.0	0.0
Olalla Creek	7	1246	87.0	2.4	4.0	62.9	4.1	0.3	3.8	14.6	39.0	19.0	89.0	32.7	63.1	1.0	12.0	0.0	22.0	35.0	0.0
Olalla Creek	8	2477	49.0	1.5	13.1	45.8	4.0	0.3	0.4	13.2	44.0	24.0	77.0	33.0	64.9	0.9	11.0	0.0	24.0	37.0	0.0
Shields Creek	1	4369	67.0	4.1	0.3	77.7	4.4	0.7	0.0	0.0	35.0	25.0	72.0	6.6	3.7	0.0	0.0	0.0	44.0	29.0	0.0
Shields Creek	2	3072	48.0	1.8	1.4	70.0	9.0	0.4	0.0	0.0	57.0	28.0	84.0	5.1	4.1	0.0	0.0	0.0	49.0	36.0	0.0
Shields Creek	3	2027	0.0	2.9	8.9	90.5	26.4	0.4	1.0	0.0	34.0	54.0	77.0	24.1	21.7	0.0	0.0	0.0	60.0	22.0	0.0
Thompson Creek	1	1960	158.0	3.1	1.0	53.6	4.9	0.6	0.0	21.7	34.0	7.0	72.0	6.1	7.1	0.2	46.0	0.0	10.0	36.0	0.0
Thompson Creek	2	2856	36.0	2.4	1.4	55.6	5.9	0.5	0.0	20.6	35.0	4.0	74.0	7.0	12.6	0.3	84.0	0.0	9.0	31.0	0.0
Thompson Creek	3	1593	57.0	3.5	9.2	16.8	9.4	0.5	0.0	15.0			78.0	6.2	8.4	0.1	163.0	0.0	11.0	36.0	0.0
Thompson Creek	4	1435	15.0	2.4	1.4	54.1	5.6	0.5	0.0	17.8	43.0	6.0	76.0	5.2	9.9	0.3	203.0	0.0	14.0	50.0	0.0
Thompson Creek	5	1825	18.0	1.7	7.5	39.0	8.4	0.6	0.0	13.3	76.0	5.0	71.0	10.5	25.3	1.0	198.0	15.0	14.0	39.0	0.0
Thompson Creek	6	815	34.0	1.8	1.4	36.8	8.2	0.4	0.0	17.3	65.0	6.0	62.0	14.5	17.0	0.1	0.0	0.0	21.0	59.0	0.0
Thompson Creek	7	643	0.0	0.8	2.0	0.7	321.3	0.2	0.0	12.5			77.0	6.8	12.3	0.2	183.0	0.0	5.0	44.0	0.0
Wildcat Creek	1	932	45.0	2.5	4.5	15.7	10.5	0.3	1.0	21.0	36.0	9.0	82.0	38.3	61.2	1.3	0.0	0.0	20.0	27.0	0.0
Wildcat Creek	2	1406	32.0	1.9	7.9	13.6	21.4	0.3	0.0	13.0	35.0	5.0	90.0	32.3	48.0	1.6	61.0	0.0	17.0	24.0	0.0
Willingham Creek	1	398	15.0	2.4	3.1	48.0	6.2	0.3	0.0	12.0	40.0	7.0	82.0	7.5	9.3	0.5	61.0	0.0	9.0	19.0	0.0
Willingham Creek	2	1111	12.0	2.2	3.8	56.8	6.7	0.2	0.0	14.6	41.0	9.0	71.0	18.0	17.8	0.5	122.0	0.0	24.0	31.0	0.0
Willingham Creek	3	828	4.0	2.6	1.2	92.3	17.0	0.3	0.0	17.0	29.0	10.0	65.0	40.0	47.0	1.4	0.0	0.0	35.0	24.0	0.0
Willingham Creek	4	502	0.0	2.4	1.5	32.2	5.7	0.3	0.0	13.3	20.0	10.0	60.0	19.1	10.5	0.0	30.0	0.0	33.0	40.0	0.0
Willingham Creek	5	1419	19.0	1.7	4.9	11.3	22.9	0.2	0.0	8.0	35.0	15.0	88.0	20.5	25.5	0.5	0.0	0.0	44.0	37.0	0.0
Little Muley Creek	1	874	32.0	1.6	1.4	72.7	4.1	0.3	16.6	10.8	39.7	16.3	94.9	11.9	8.6	0.2	106.7	15.2	21.9	37.4	14.9
Little Muley Creek	2	442	14.0	1.7	2.1	70.7	3.7	0.3	13.2	10.0	37.5	12.5	94.9	15.6	11.0	0.2	203.2	0.0	23.4	38.6	13.9
Little Muley Creek	3	507	80.0	1.6	7.5	48.5	6.0	0.3	8.5	9.6			95.1	24.3	15.9	0.2	304.8	0.0	17.0	31.2	18.6
Little Muley Creek	4	766	34.0	1.6	10.1	45.0	4.7	0.4	6.2	10.6			91.7	21.9	37.4	2.5	304.8	61.0	21.5	30.0	13.2
Little Muley Creek	5	393	50.0	1.4	2.8	68.6	4.0	0.3	20.3	7.0			94.4	22.1	28.1	1.8	243.8	20.3	37.7	33.3	4.7

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Little Muley Creek	6	416	126.0	1.2	1.3	89.8	6.2	0.5	11.1	8.3	35.0	60.0	81.0	15.4	30.6	2.4	182.9	61.0	64.9	20.3	10.9
Muns Creek	1	96	0.0	3.7	1.5	32.9	9.9	0.3	0.0	9.6			91.3	11.5	2.9	0.0	0.0	0.0	17.5	68.3	0.0
Muns Creek	2	634	16.0	2.6	0.9	55.1	4.1	0.5	4.6	16.4	35.0	30.0	69.3	3.3	1.7	0.0	61.0	0.0	24.1	35.5	10.4
Muns Creek	3	2093	270.0	2.7	1.0	66.9	3.6	0.4	5.5	20.2	51.2	10.0	85.7	7.3	3.8	0.2	113.2	0.0	18.9	37.5	13.6
Muns Creek	4	663	26.0	3.0	1.7	48.8	5.0	0.4	5.8	13.7	31.6	20.8	86.7	5.7	5.9	0.0	30.5	0.0	23.7	30.3	11.8
Muns Creek	5	232	50.0	4.8	1.4	75.5	6.9	0.6	3.5	10.6	66.1	22.2	87.2	4.7	3.1	0.0	0.0	0.0	50.9	38.2	0.6
Muns Creek	6	1244	100.0	2.4	1.4	44.5	7.2	0.3	4.5	15.4	30.8	19.5	88.9	7.2	4.8	0.0	61.0	0.0	27.3	26.0	19.4
Muns Creek	7	519	24.0	1.8	3.2	53.6	8.6	0.3	7.4	6.9	39.7	22.6	93.4	11.0	10.0	0.0	121.9	0.0	36.7	32.1	11.5
Muns Creek	8	255	13.0	1.8	5.2	23.2	11.2	0.4	7.5	10.8	70.0	25.0	95.9	20.8	20.3	0.4	0.0	0.0	17.9	23.2	17.8
Muns Creek	9	593	124.0	5.2	2.8	89.3	5.6	0.7	2.8	7.3	44.3	40.4	63.7	7.4	16.0	0.3	30.5	0.0	80.5	16.4	0.5
Muns Creek	10	175	36.0	1.8	1.5	34.6	5.9	0.3	4.7	18.6	40.1	29.4	95.7	18.3	42.6	2.3	121.9	0.0	42.6	35.5	0.0
South Umpqua (HUC 17100302) Sub-basin, Clark Branch-South Umpqua River (HUC 1710030211) Fifth field Watershed																					
Barrett Creek	1	941	0.0	1.6	2.8	7.0	37.9	0.3	0.0	14.6	47.0	4.0	91.0	0.6	0.5	0.0	0.0	0.0	6.0	46.0	0.0
Barrett Creek	2	1084	0.0	1.5	8.4	4.0	44.2	0.3	0.0	16.2	41.0	0.0	96.0	3.0	10.2	0.5	0.0	0.0	3.0	35.0	0.0
Clark Branch Creek	1	766	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clark Branch Creek	2	5677	45.0	3.3	1.6	1.8	36.8	0.3	0.0				65.0	0.8	0.9	0.0	0.0	0.0	39.0	35.0	0.0
Kent Creek	1	1114	17.0	4.2	1.9								89.0	1.2	0.5	0.0	0.0	0.0	14.0	79.0	0.0
Kent Creek	2	3019	7.0	2.8	2.3	1.3	68.9	0.4	0.0	44.5	75.0	5.0	84.0	1.3	1.2	0.0	0.0	0.0	15.0	62.0	0.0
Kent Creek	3	1851	67.0	2.2	2.1	4.3	456.5	0.5	0.0	35.0	75.0	0.0	73.0	1.7	0.7	0.0	0.0	0.0	11.0	68.0	0.0
Kent Creek	4	784	70.0	1.4	2.9	2.8	73.1	0.5	0.0	22.1	75.0	13.0	87.0	2.8	4.4	0.1	0.0	0.0	30.0	54.0	0.0
Kent Creek	5	682	14.0	1.2	7.0	0.7	557.0	0.3	0.0				96.0	2.2	7.0	0.3	0.0	0.0	14.0	56.0	0.0
Myrtle Cr.	1	1066	32.0	8.0	0.4	24.4	3.5	0.6	0.0	38.1	54.0	15.0	146.0	2.2	1.0	0.0	0.0	0.0	31.0	39.0	0.0
Rice Creek	1	2293	34.0	2.0	0.9	22.0	9.1	0.4	0.0	15.6	84.0	1.0	84.0	0.9	0.8	0.0	15.0	0.0	8.0	81.0	0.0
Rice Creek	2	1243	9.0	2.1	1.1	12.0	17.8	0.4	0.0	19.5	65.0	0.0	55.0	0.2	0.0	0.0	0.0	0.0	3.0	71.0	0.0
Rice Creek	3	3736	71.0	2.2	1.3	33.0	7.0	0.4	0.0	19.5	66.0	1.0	85.0	1.3	2.1	0.1	0.0	0.0	14.0	64.0	0.0
Rice Creek	4	2574	19.0	2.0	2.3	5.0	48.0	0.4	0.0	10.0	78.0	0.0	93.0	0.5	1.9	0.1	0.0	0.0	10.0	56.0	0.0
Van Dine Creek	1	3046	54.0	2.9	12.1	3.2	44.5	0.2	0.0	0.0	27.0	16.0	90.0	2.9	4.0	0.2	137.0	15.0	15.0	30.0	0.0
W.Fk. Willis Creek	1	1847	27.0	2.6	0.9	46.9	4.4	0.4	0.0	15.1	60.0	9.0	150.0	2.7	1.5	0.0	0.0	0.0	21.0	57.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach					Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
		PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
W.Fk. Willis Creek	2	654	5.0	2.5	1.6	55.8	4.2	0.5	0.0	26.5	58.0	15.0	152.0	2.6	1.7	0.0	0.0	0.0	22.0	50.0	0.0
W.Fk. Willis Creek	3	1017	9.0	2.8	1.3	49.6	4.4	0.4	1.0	23.6	36.0	13.0	153.0	1.2	0.5	0.0	0.0	0.0	20.0	43.0	0.0
Willis Creek	1	2776	89.0	4.0	1.0	67.7	5.1	0.4	0.0	30.7	53.0	21.0	57.0	2.7	1.5	0.0	0.0	0.0	29.0	51.0	0.0
W.Fk. Willis Creek	5	747	18.0	1.8	6.1	41.2	7.4	0.3	0.0	15.0	20.0	20.0	146.0	7.5	7.4	0.4	0.0	0.0	17.0	27.0	0.0
W.Fk. Willis Creek	4	600	14.0	1.8	1.8	54.1	0.0	0.3	0.0	14.0	41.0	16.0	146.0	2.8	2.1	0.0	0.0	0.0	17.0	36.0	0.0
W.Fk. Willis Creek	6	805	9.0	1.3	18.6	53.4	46.5	0.3	0.0	13.3	82.0	6.0	154.0	26.5	62.3	2.0	20.0	0.0	11.0	27.0	0.0
East Fork Willis Creek	1	451	0.0	2.3	1.6	76.2	4.1	0.4	0.0	17.8	52.0	24.0	69.0	0.2	0.1	0.0	0.0	0.0	41.0	41.0	0.0
East Fork Willis Creek	2	121	0.0	0.0	2.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
East Fork Willis Creek	3	2935	30.0	1.9	1.5	34.7	5.7	0.3	0.0	20.5	63.0	11.0	75.0	1.8	1.3	0.0	14.0	7.0	20.0	59.0	0.0
East Fork Willis Creek	4	1490	0.0	1.1	15.4	8.8	47.3	0.2	0.0	10.0	70.0	10.0	82.0	15.3	19.6	0.3	0.0	0.0	16.0	36.0	0.0
Judd Creek	1	1466	18.0	2.4	2.1	40.1	8.8	0.5	0.0	19.4	41.0	10.0	90.0	1.6	0.9	0.0	0.0	0.0	15.0	32.0	0.0
Judd Creek	2	1514	264.0	2.1	4.1	16.3	12.8	0.3	0.0	20.8	31.0	11.0	96.0	5.4	3.1	0.1	20.0	20.0	11.0	28.0	0.0
Judd Creek	3	815	54.0	1.9	7.2	17.4	13.5	0.3	0.0	29.0	30.0	10.0	92.0	10.1	10.5	0.4	61.0	0.0	12.0	26.0	0.0
Judd Creek	4	901	35.0	2.2	9.5	23.1	8.3	0.4	0.0	15.8	54.0	10.0	87.0	10.8	24.3	1.0	61.0	0.0	11.0	34.0	0.0
Judd Creek	5	1190	46.0	1.0	11.6	6.9	56.1	0.4	0.0	6.7	60.0	11.0	74.0	15.4	23.9	0.8	142.0	41.0	11.0	54.0	0.0
Lane Creek	1	463	0.0	1.6	3.6	7.9	46.1	0.1	0.0	75.0	60.0	10.0	70.0	5.0	1.3	0.0	0.0	0.0	10.0	37.0	0.0
Lane Creek	2	978	0.0	1.3	2.8	5.6	54.3	0.4	0.0	33.1	35.0	8.0	93.0	4.4	2.1	0.0	0.0	0.0	13.0	41.0	0.0
Lane Creek	3	1605	10.0	1.0	5.8	4.5	92.0	0.5	0.0	28.2	46.0	5.0	96.0	2.1	2.7	0.1	0.0	0.0	5.0	35.0	0.0
Lane Creek	4	1521	35.0	0.6	21.0	0.2	897.6	0.0	0.0	15.1	73.0	0.0	94.0	7.2	16.9	0.6	0.0	0.0	4.0	38.0	0.0
South Umpqua (HUC 17100302) Sub-basin, Myrtle Creek (HUC 1710030210) Fifth field Watershed																					
Bilger Creek	1	1575	0.0	3.9	1.5	1.5	21.2	0.2	0.0	30.0			67.0	1.2	0.8	0.0	0.0	0.0	19.0	32.0	0.0
Bilger Creek	2	1600	20.0	2.8	2.2	13.0	9.9	0.4	0.0	36.7	29.0	13.0	73.0	0.6	0.7	0.0	0.0	0.0	22.0	25.0	0.0
Bilger Creek	3	3796	0.0	3.3	1.4	1.7	47.9	0.3	0.0	10.0	33.0	10.0	90.0	0.8	1.6	0.1	20.0	0.0	19.0	23.0	0.0
Buck Fork Creek	1	2953	116.0	2.7	2.5	36.6	10.8	0.4	0.3	19.2	44.0	35.0	87.0	4.0	4.9	0.1	0.0	0.0	48.0	34.0	0.0
Buck Fork Creek	2	1482	164.0	2.1	4.1	19.4	12.4	0.3	0.0	9.0	78.0	17.0	99.0	6.3	8.9	0.2	0.0	0.0	41.0	32.0	0.0
Buck Fork Creek	3	599	0.0	1.7	6.9	35.5	17.8	0.2	0.0	8.6	39.0	49.0	71.0	4.8	4.4	0.2	0.0	0.0	51.0	23.0	0.0
Buck Fork Creek	4	709	7.0	0.5	15.0	1.5	358.0	0.3	0.0	20.0	38.0	62.0	100.0	317.2	38.6	0.4	0.0	0.0	44.0	46.0	0.0
Frozen Creek	1	1168	36.0	2.3	1.4	43.3	11.0	0.5	0.0	36.4	64.0	21.0	62.0	1.4	0.6	0.0	0.0	0.0	37.0	50.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Frozen Creek	2	2279	49.0	2.1	1.8	36.6	34.0	0.4	0.0	20.1	56.0	31.0	39.0	0.5	0.1	0.0	0.0	0.0	58.0	28.0	0.0
Frozen Creek	3	809	20.0	1.4	5.0	2.3	103.6	0.3	0.0	15.0	36.0	50.0	93.0	2.7	2.2	0.0	0.0	0.0	49.0	24.0	0.0
Frozen Creek	4	1684	36.0	0.8	7.1	3.3	301.8	0.4	0.0	23.1	32.0	59.0	100.0	8.3	25.0	1.4	30.0	30.0	58.0	27.0	0.0
Lee Creek	1	3886	197.0	2.4	2.7	38.5	10.4	0.4	0.5	16.4	72.0	24.0	85.0	2.6	1.5	0.0	15.0	0.0	44.0	39.0	0.0
Lee Creek	2	3211	191.0	2.3	5.1	48.7	38.0	0.3	0.0	16.2	32.0	62.0	81.0	7.2	8.9	0.1	61.0	24.1	59.0	23.0	0.0
W. Fk. Frozen Creek	1	2478	27.0	1.4	2.9	16.9	26.9	0.3	0.0	25.5	56.0	12.0	89.0	2.3	1.1	0.0	0.0	0.0	31.0	38.0	0.0
W. Fk. Frozen Creek	2	892	0.0	0.6	7.2	0.9	405.5	0.3	0.0	10.0	57.0	5.0	33.0	2.1	4.8	0.1	0.0	0.0	24.0	38.0	0.0
W. Fk. Frozen Creek	3	820	0.0	0.4	32.1								61.0	2.9	9.3	0.6	183.0	60.3	13.0	19.0	0.0
Letitia Creek	1	1154	37.0	2.1	1.6	71.6	5.6	0.4	4.2	11.0	43.0	16.0	75.0	5.8	6.0	0.1	24.0	0.0	28.0	29.0	11.0
Letitia Creek	2	663	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Letitia Creek	3	592	0.0	2.1	2.2	43.9	7.5	0.3	3.4	9.4	20.0	16.0	94.0	8.9	6.7	0.0	0.0	0.0	28.0	21.0	37.0
Letitia Creek	4	1049	31.0	1.6	2.0	36.7	11.5	0.4	8.3	7.8	44.0	38.0	79.0	9.8	10.3	0.4	0.0	0.0	54.0	32.0	11.0
Letitia Creek	5	798	93.0	1.9	1.8	85.1	2.0	0.5	4.5	61.0	52.0	47.0	60.0	4.5	3.5	0.0	0.0	0.0	70.0	28.0	0.0
Letitia Creek	6	1353	97.0	1.5	1.8	35.0	13.0	0.4	4.1	8.4	65.0	29.0	85.0	9.5	6.5	0.1	41.0	0.0	53.0	41.0	2.0
Letitia Creek	7	1754	115.0	0.8	11.7	6.7	91.4	0.3	1.1	6.8	35.0	62.0	97.0	13.1	25.7	1.2	102.0	20.0	49.0	33.0	13.0
Louis Creek	1	1557	25.0	2.8	2.8	54.9	3.7	0.4	4.4	17.7	73.0	15.0	75.0	4.0	2.3	0.1	0.0	0.0	28.0	56.0	11.0
Louis Creek	2	2682	68.0	2.5	1.4	48.3	4.5	0.4	0.7	16.5	54.0	14.0	80.0	2.5	1.0	0.0	18.0	0.0	27.0	42.0	21.0
Louis Creek	3	153	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louis Creek	4	1167	29.0	2.6	1.3	30.8	6.5	0.4	3.3	14.2	71.0	11.0	79.0	3.4	1.9	0.1	20.0	0.0	26.0	61.0	2.0
Louis Creek	5	498	0.0	2.6	1.3	29.6	6.6	0.3	2.0	14.8	51.0	12.0	90.0	3.8	1.4	0.0	91.0	0.0	30.0	43.0	8.0
Louis Creek	6	300	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louis Creek	7	3920	496.0	2.2	1.7	64.7	4.9	0.4	8.6	12.7	43.0	33.0	89.0	12.1	17.9	0.7	37.0	10.0	54.0	29.0	1.0
Louis Creek	8	446	78.0	2.8	2.4	81.1	6.0	0.7	7.6	29.5	43.0	54.0	53.0	10.5	5.3	0.0	0.0	0.0	72.0	26.0	0.0
Louis Creek	9	2361	95.0	2.0	3.0	32.1	6.9	0.3	4.5	13.9	49.0	27.0	92.0	12.6	47.8	2.7	37.0	12.0	41.0	38.0	1.0
Myrtle Cr.	1	1066	32.0	8.0	0.4	24.4	3.5	0.6	0.0	38.1	54.0	15.0	146.0	2.2	1.0	0.0	0.0	0.0	31.0	39.0	0.0
N. Fk. Myrtle Creek	2	3237	160.0	3.8	0.8	35.0	7.4	0.5	0.0	56.2	42.0	9.0	157.0	0.4	0.2	0.0	10.0	0.0	17.0	38.0	0.0
N. Fk. Myrtle Creek	3	2929	33.0	4.3	0.8	41.9	5.0	0.6	0.0	39.9	53.0	8.0	152.0	1.2	1.0	0.0	41.0	0.0	18.0	47.0	0.0
N. Fk. Myrtle Creek	4	5389	348.0	4.9	1.0	44.1	4.6	0.6	0.7	50.8	54.0	9.0	143.0	2.1	1.0	0.0	7.0	0.0	26.0	45.0	0.0

						Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
N. Fk. Myrtle Creek	5	222	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. Fk. Myrtle Creek	6	4342	207.0	5.0	0.9	58.4	4.8	0.6	0.2	39.4	39.0	10.0	134.0	3.1	1.9	0.0	0.0	0.0	30.0	31.0	0.0
N. Fk. Myrtle Creek	7	6434	156.0	5.0	1.4	42.3	6.1	0.4	0.3	42.5	35.0	9.0	139.0	4.2	5.7	0.1	8.0	0.0	29.0	29.0	0.0
N. Fk. Myrtle Creek	8	3081	67.0	3.0	1.9	31.3	10.1	0.4	1.6	25.9	22.0	24.0	134.0	14.7	19.3	0.2	12.0	0.0	43.0	17.0	0.0
N. Fk. Myrtle Creek	9	3975	113.0	1.7	3.5	14.6	15.6	0.3	0.5	25.1	36.0	29.0	175.0	9.1	18.3	0.6	183.0	18.1	50.0	26.0	0.0
Riser Creek	1	1779	0.0	3.8	1.9	89.8	7.1	0.4	1.1	17.4	65.0	34.0	75.0	10.3	24.0	0.8	46.0	18.1	64.0	35.0	0.0
Riser Creek	2	1129	27.0	5.0	1.6	97.0	8.4	0.2	0.0	16.7	35.0	56.0	39.0	10.6	16.3	0.3	0.0	0.0	93.0	5.0	0.0
Riser Creek	3	3140	118.0	3.3	4.6	84.5	8.6	0.3	0.0	18.3	45.0	43.0	71.0	8.7	26.9	1.0	38.0	18.1	80.0	15.0	0.0
Riser Creek	4	267	0.0	0.2	17.4								100.0	7.9	8.1	0.0	0.0	0.0	49.0	35.0	0.0
Slide Creek	1	1782	0.0	2.4	1.2	55.3	11.2	0.4	0.0	14.7	66.0	25.0	62.0	6.6	3.7	0.1	0.0	0.0	54.0	39.0	0.0
Slide Creek	2	2264	65.0	3.0	1.3	63.9	10.3	0.4	0.9	20.2	63.0	33.0	81.0	6.1	9.3	0.3	30.0	0.0	71.0	25.0	0.0
Slide Creek	3	1819	30.0	5.0	2.3	91.0	10.8	0.3	0.0	20.8	47.0	52.0	73.0	9.0	15.3	0.5	0.0	0.0	83.0	13.0	0.0
Slide Creek	4	1725	17.0	1.8	10.5	25.4	999.9	0.5	0.0	10.0	21.0	79.0	97.0	9.0	28.3	0.8	0.0	0.0	75.0	17.0	0.0
Myrtle Cr.(S.Fk.)	1	2971	168.0	6.1	0.5	13.5	7.5	0.7	0.0	31.1	34.0	26.0	0.0	6.6	2.3	0.0	0.0	0.0	33.0	25.0	0.0
Myrtle Cr.(S.Fk.)	2	5949	606.0	6.6	0.7	19.7	5.9	0.6	0.0	35.9	27.0	45.0	0.0	8.9	2.6	0.0	0.0	0.0	40.0	23.0	0.0
Myrtle Cr.(S.Fk.)	4	8526	283.0	5.9	1.0	29.7	11.2	0.7	0.0	33.9	10.0	26.0	0.0	1.9	0.7	0.0	9.0	0.0	27.0	10.0	0.0
Myrtle Cr.(S.Fk.)	6	4222	77.0	4.6	1.7	32.1	10.0	0.9	0.0	26.4	5.0	19.0	0.0	2.1	2.8	0.1	9.0	0.0	24.0	6.0	0.0
Myrtle Cr.(S.Fk.)	7	2204	144.0	3.5	2.4	5.9	41.9	0.6	0.0	36.5	18.0	30.0	0.0	5.8	5.7	0.0	0.0	0.0	27.0	13.0	0.0
Myrtle Cr.(S.Fk.)	8	758	104.0	3.1	4.4	9.9	19.2	0.6	0.0	40.6	20.0	39.0	0.0	6.6	10.3	0.3	0.0	0.0	36.0	17.0	0.0
Myrtle Cr.(S.Fk.)	9	1488	144.0	2.2	14.9	24.0	9.1	0.4	0.0	17.0	28.0	28.0	0.0	27.8	56.3	3.2	24.0	0.0	30.0	17.0	0.0
Myrtle Cr.(S.Fk.)	10	288	68.0	3.9	1.4	56.2	4.8	0.6	0.0	65.9	44.0	36.0	0.0	12.1	22.8	0.7	366.0	60.0	53.0	34.0	0.0
Myrtle Cr.(S.Fk.)	11	2427	92.0	2.7	8.3	10.6	17.9	0.5	0.0	19.3	32.0	19.0	0.0	8.8	29.1	1.2	122.0	24.1	20.0	21.0	0.0
Myrtle Cr.(S.Fk.)	12	1628	0.0	1.6	5.8	8.7	19.7	0.3	0.0	20.4	43.0	49.0	0.0	32.7	67.9	1.1	15.0	0.0	78.0	15.0	0.0
Myrtle Cr.(S.Fk.)	13	272	0.0	2.9	19.4	49.7	51.3	2.1	0.0	8.0	50.0	50.0	0.0	39.0	185.7	2.2	0.0	0.0	41.0	17.0	0.0
Weaver Creek	1	1230	0.0	3.5	3.0	21.3	12.3	0.4	0.0	29.3	23.0	29.0	77.0	0.9	0.5	0.0	20.0	0.0	35.0	16.0	0.0
Weaver Creek	2	5646	172.0	2.8	2.7	33.9	7.6	0.4	0.0	47.6	33.0	35.0	80.0	5.2	21.2	0.6	20.0	0.0	52.0	25.0	0.0
Weaver Creek	3	1661	24.0	1.7	4.9	25.8	7.5	0.2	0.0	21.4	32.0	31.0	81.0	11.7	52.0	1.5	183.0	12.1	41.0	25.0	0.0
Weaver Creek	4	1574	0.0	0.9	20.0	7.4	56.2	0.2	0.0	14.0	31.0	33.0	85.0	5.0	38.6	2.1	142.0	18.1	40.0	21.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
South Umpqua (HUC 17100302) Sub-Basin, Days Creek-South Umpqua River (HUC 1710030205) Fifth Field Watershed																					
Alder Creek	1	1015	5.0	1.5	3.6					8.4	47.5	10.0	73.1	1.5	0.3	0.0	0.0	0.0	18.8	41.9	3.6
Alder Creek	2	548	18.0	1.5	5.1					7.4			78.5	3.7	2.6	0.0	122.0	0.0	16.3	37.4	5.0
Alder Creek	3	199	10.0	1.3	8.8	0.1	22.7	0.3	0.0	7.7	40.0	10.0	76.2	5.3	2.7	0.0	0.0	0.0	15.3	38.4	0.0
Beals Creek	1	999	0.0	3.4	1.2	19.5	12.4	0.3	0.0	15.5	73.0	23.0	54.0	3.0	2.1	0.0	0.0	0.0	27.0	68.0	0.0
Beals Creek	2	441	25.0	1.9	1.1	45.1	8.0	0.2	0.0	12.0	62.0	16.0	65.0	2.0	2.2	0.0	0.0	0.0	27.0	54.0	0.0
Beals Creek	3	1088	35.0	2.1	1.3	19.6	16.9	0.3	0.0	29.3	48.0	14.0	65.0	3.3	2.4	0.0	0.0	0.0	28.0	45.0	0.0
Beals Creek	4	2462	16.0	2.2	3.0					23.0	43.0	14.0	71.0	3.8	1.2	0.0	0.0	0.0	12.0	40.0	0.0
Canyon Creek	1	2628	249.0	7.0	1.3	56.1	3.2	0.5	0.0	26.9	34.0	0.0	75.0	1.1	0.8	0.0	0.0	0.0	2.0	29.0	0.0
Canyon Creek	2	4275	111.0	6.5	1.1	55.6	4.8	0.4	0.0	21.5	27.0	2.0	86.0	0.8	0.6	0.0	0.0	0.0	3.0	31.0	0.0
Canyon Creek	3	2165	44.0	3.4	1.5	43.4	4.9	0.3	0.0	17.6	33.0	1.0	92.0	0.5	0.1	0.0	0.0	0.0	3.0	39.0	0.0
Canyon Creek	4	1673	120.0	2.8	1.6	37.3	8.1	0.3	0.0	14.5	44.0	0.0	83.0	0.8	0.1	0.0	0.0	0.0	1.0	43.0	0.0
Canyon Creek	5	3357	112.0	1.7	5.2	32.6	13.8	0.3	0.0	10.8	71.0	0.0	80.0	0.6	0.4	0.0	0.0	0.0	3.0	50.0	0.0
Canyon Creek	6	888	0.0	0.4	5.8								89.0	0.6	0.4	0.0	0.0	0.0	32.0	34.0	0.0
Corn Creek	1	1957	54.0	2.1	2.6	46.0	7.8	0.4	0.5	22.7	39.0	22.0	95.0	7.9	11.7	0.3	91.0	15.0	48.0	22.0	0.0
Corn Creek	2	831	10.0	1.4	3.5	35.0	5.8	0.3	2.4	20.3	38.0	26.0	100.0	15.6	37.0	1.6	15.0	0.0	43.0	29.0	0.0
Corn Creek	3	2843	0.0	1.0	9.4	14.0	48.3	0.3	1.8	16.6	26.0	41.0	95.0	11.2	27.1	0.9	46.0	46.0	49.0	17.0	0.0
E.Fk.Poole Creek	1	2858	67.0	1.7	4.6	15.4	21.7	0.3	0.3	11.8	62.0	2.0	93.0	8.0	8.8	0.1	15.0	15.0	17.0	57.0	0.0
East Fork Stouts Creek	1	1911	9.0	2.7	4.3	14.9	23.3	0.3	0.0	15.8	43.0	27.0	95.0	8.3	6.8	0.0	0.0	0.0	20.0	25.0	0.0
East Fork Stouts Creek	2	1699	214.0	2.4	2.8	10.2	32.2	0.2	0.0	63.6	32.0	9.0	86.0	7.9	2.7	0.0	0.0	0.0	26.0	26.0	0.0
East Fork Stouts Creek	3	1407	98.0	2.0	6.5	16.3	31.7	0.3	0.0	13.1	21.0	33.0	98.0	9.2	13.1	0.0	0.0	0.0	33.0	16.0	0.0
Hatchet Creek	1	1017	23.0	3.2	3.7	29.3	6.4	0.4	0.0	0.0	37.0	24.0	85.0	4.2	5.2	0.1	0.0	0.0	21.0	25.0	0.0
Hatchet Creek	2	2523	125.0	2.7	4.1	22.9	9.0	0.3	0.0	0.0	28.0	27.0	83.0	9.8	26.7	1.0	137.0	15.0	26.0	28.0	0.0
Hatchet Creek	3	4412	71.0	2.0	11.4	19.5	29.5	0.4	0.0	0.0	18.0	54.0	80.0	13.1	35.1	1.3	91.0	30.0	29.0	17.0	0.0
Jordan Creek	1	1718	113.0	1.4	1.8	0.1	15.7	0.4	1.1	10.7	57.7	16.3	67.3	2.6	2.4	0.0	0.0	0.0	19.8	50.0	13.1
Jordan Creek	2	1937	50.0	1.2	2.5					7.8	60.0	30.0	71.4	1.0	1.5	0.1	0.0	0.0	16.4	50.3	9.1
Lavadoure Creek	1	3149	38.0	0.7	5.8	10.4	107.1	0.5	0.0	11.8	65.0	11.0	121.0	4.9	17.6	0.5	76.0	30.0	18.0	50.0	7.0
Packard Gulch	1	531	6.0	1.6	0.5	4.1	11.6	0.2	5.6	9.3	41.0	12.0	82.0	9.8	3.2	0.0	0.0	0.0	30.0	28.0	13.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Packard Gulch	2	1154	53.0	1.4	2.5	55.5	4.1	0.3	19.1	7.7	53.0	11.0	95.0	20.8	8.0	0.0	10.0	0.0	32.0	39.0	9.0
Packard Gulch	3	727	49.0	1.1	3.7	34.0	6.0	0.2	14.2	8.6	64.0	14.0	99.0	30.3	18.3	0.0	24.0	0.0	35.0	47.0	2.0
Poole Creek	1	2666	66.0	1.7	3.4	15.5	17.8	0.2	0.0	13.4	61.0	3.0	93.0	11.5	17.3	0.4	20.0	20.0	18.0	48.0	0.0
Poole Creek	2	732	0.0	1.7	4.9	19.6	38.7	0.2	0.0	10.0			91.0	16.5	23.8	0.3	183.0	122.0	21.0	40.0	0.0
St. John Creek (Canyon)	1	706	109.0	1.7	3.6	25.7	9.2	0.4	0.0	11.9	48.0	4.0	84.0	13.5	17.5	0.3	0.0	0.0	5.0	51.0	0.0
St. John Creek (Canyon)	2	711	15.0	0.7	11.5	4.4	148.1	0.3	0.0	5.0	90.0	5.0	94.0	28.3	43.5	0.8	0.0	0.0	2.0	34.0	0.0
St. John Creek (Canyon)	3	470	0.0	0.3	21.6								88.0	27.7	66.4	0.6	0.0	0.0	10.0	47.0	0.0
Stouts Creek	1	2596	128.0	5.1	1.5	30.7	8.9	0.3	0.0	24.0	29.0	12.0	86.0	5.7	6.7	0.0	0.0	0.0	15.0	21.0	0.0
Stouts Creek	2	6426	749.0	3.6	2.2	28.5	14.0	0.4	0.0	27.1	30.0	19.0	62.0	18.3	39.0	0.0	0.0	0.0	24.0	21.0	0.0
Stouts Creek	3	2671	147.0	2.0	6.6	7.3	41.4	0.2	0.0	18.4	29.0	41.0	97.0	4.9	9.3	0.0	0.0	0.0	30.0	17.0	0.0
Sweat Creek	1	1132	65.0	0.9	3.3	7.6	48.8	0.2	0.0	16.9	42.0	41.0	90.0	4.0	4.4	0.2	0.0	0.0	42.0	37.0	0.0
W. Fk. Canyon Creek	1	2609	390.0	5.3	1.4	44.5	4.2	0.4	0.0	34.2	37.0	0.0	75.0	8.0	5.6	0.1	0.0	0.0	0.0	31.0	0.0
W. Fk. Canyon Creek	2	2131	243.0	4.1	3.3	44.1	3.3	0.5	0.0	33.0	49.0	0.0	73.0	8.6	7.8	0.2	49.0	12.0	0.0	35.0	0.0
W. Fk. Canyon Creek	3	3477	164.0	4.4	1.6	36.3	6.8	0.5	0.0	26.1	32.0	0.0	76.0	2.0	3.2	0.1	0.0	0.0	0.0	38.0	0.0
W. Fk. Canyon Creek	4	1924	42.0	3.7	3.7	21.9	4.6	0.5	0.0	17.6	15.0	0.0	70.0	5.6	7.9	0.3	0.0	0.0	0.0	10.0	0.0
W. Fk. Canyon Creek	5	265	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W. Fk. Canyon Creek	6	1892	183.0	2.8	2.8	30.5	6.5	0.4	0.0	19.2	45.0	2.0	81.0	4.8	7.2	0.2	0.0	0.0	5.0	42.0	0.0
W. Fk. Canyon Creek	7	1091	101.0	2.1	4.2	20.3	10.9	0.3	0.0	15.4	67.0	2.0	93.0	10.6	5.7	0.0	20.0	0.0	4.0	56.0	0.0
W. Fk. Canyon Creek	8	384	21.0	1.3	6.4	27.5	15.0	0.3	0.0	10.5	93.0	5.0	93.0	19.0	28.2	0.5	0.0	0.0	8.0	64.0	0.0
W. Fk. Canyon Creek	9	1105	0.0	0.4	20.9								98.0	27.4	43.7	2.0	30.0	0.0	7.0	60.0	0.0
Wood Creek	1	1680	0.0	3.1	1.8	55.0	12.3	0.5	0.0	16.0	80.0	10.0	87.0	1.3	0.8	0.0	0.0	0.0	44.0	35.0	0.0
Wood Creek	2	607	25.0	2.9	2.2	39.0	17.1	0.6	0.0	25.1	72.0	17.0	67.0	0.7	0.1	0.0	0.0	0.0	37.0	28.0	0.0
Wood Creek	3	855	55.0	2.7	2.0	55.0	19.0	0.5	1.1	14.4	58.0	34.0	74.0	1.3	0.9	0.0	0.0	0.0	61.0	26.0	0.0
Wood Creek	4	1128	28.0	2.3	2.6	85.0	40.1	0.4	0.0	2.0	20.0	80.0	56.0	1.7	1.2	0.0	0.0	0.0	83.0	9.0	0.0
Fate Creek Tributary	1	1516	54.0	1.6	3.4	74.6	8.4	0.5	17.2	5.8	35.0	59.0	80.0	27.9	33.0	0.7	41.0	0.0	71.0	22.0	6.0
W. Fk. Canyon Creek Trib #1	1	1910	110.0	2.4	5.8	32.4	7.8	0.4	0.0	14.1	39.0	6.0	57.0	25.3	8.5	0.0	0.0	0.0	5.0	32.0	0.0
W. Fk. Canyon Creek Trib #1	2	493	0.0	2.4	7.2	30.0	5.7	0.5	0.0	14.1	57.0	5.0	77.0	48.5	53.3	1.2	30.0	0.0	10.0	37.0	0.0
W. Fk. Canyon Creek Trib #1	3	1655	174.0	1.3	7.9	28.2	11.3	0.3	0.0	11.3	64.0	10.0	81.0	17.8	25.3	0.4	12.0	0.0	10.0	39.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
W. Fk. Canyon Creek Trib #1	4	736	0.0	0.6	15.7	1.7	490.7	0.3	0.0	4.3	75.0	15.0	93.0	14.0	18.1	0.1	20.0	0.0	10.0	59.0	0.0
Beals Creek Trib #1	1	1932	30.0	1.4	5.6	5.1	70.1	0.4	0.0	15.1	43.0	16.0	95.0	8.9	6.4	0.0	0.0	0.0	32.0	32.0	0.0
Northeast Fork Stouts Creek	1	871	0.0	1.3	4.1	7.4	36.3	0.2	0.0	12.7	39.0	18.0	95.0	14.6	24.9	0.0	0.0	0.0	18.0	31.0	0.0
Northeast Fork Stouts Creek	2	563	44.0	1.3	5.4	3.9	60.7	0.3	0.0	12.5	30.0	10.0	99.0	17.1	22.6	0.0	0.0	0.0	15.0	27.0	0.0
Stouts Creek Trib #14	1	488	0.0	1.7	12.9	7.6	34.9	0.3	0.0	20.0	20.0	50.0	99.0	0.0	0.0	0.0	0.0	0.0	29.0	11.0	0.0
Stouts Creek Trib #16	1	428	65.0	1.3	3.3	17.5	49.3	0.3	0.0	16.5	24.0	33.0	89.0	10.7	15.5	0.0	0.0	0.0	17.0	29.0	0.0
Stouts Creek Trib #16	2	446	0.0	1.4	7.5	2.8	135.2	0.4	0.0	20.0	18.0	82.0	99.0	15.0	38.2	0.0	0.0	0.0	25.0	17.0	0.0
Southwest Fork Stouts Creek	1	1365	5.0	1.7	3.7	12.1	49.6	0.5	0.0	14.8	27.0	26.0	42.0	47.8	44.4	0.0	0.0	0.0	28.0	23.0	0.0
Southwest Fork Stouts Creek	2	1568	106.0	1.5	2.5	7.4	67.0	0.4	0.0	22.6	29.0	24.0	88.0	11.5	17.4	0.0	0.0	0.0	27.0	19.0	0.0
Oshea Creek	1	2789	0.0	2.4	1.0	27.5	11.2	0.6	0.0	29.6	47.0	2.0	77.0	0.5	14.0	0.0	0.0	0.0	14.0	44.0	0.0
Oshea Creek	2	3273	19.0	2.3	2.0	14.9	15.7	0.5	0.0	23.2	45.0	1.0	93.0	3.1	6.8	0.2	20.0	0.0	5.0	38.0	0.0
Oshea Creek	3	3326	53.0	1.9	2.4	9.5	21.9	0.5	0.0	32.9	68.0	4.0	96.0	5.6	12.1	0.5	0.0	0.0	9.0	56.0	0.0
Fate Creek	1	614	0.0	2.2	1.9	82.3	3.9	0.5	6.5	6.4	67.0	18.0	81.0	6.8	4.1	0.0	0.0	0.0	29.0	43.0	17.0
Fate Creek	2	737	14.0	2.2	1.7	80.0	2.8	0.4	17.3	7.3	62.0	22.0	90.0	18.3	14.1	0.1	91.0	0.0	28.0	57.0	9.0
Fate Creek	3	775	26.0	2.5	2.6	66.0	6.3	0.5	6.2	6.7	30.0	26.0	89.0	10.3	6.8	0.3	20.0	0.0	33.0	29.0	24.0
Fate Creek	4	1403	16.0	2.3	3.5	85.0	6.6	0.5	16.2	5.2	43.0	49.0	58.0	21.3	20.1	1.1	24.0	0.0	66.0	16.0	13.0
Fate Creek	5	623	21.0	1.2	4.3	47.4	6.1	0.4	10.9	5.1	62.0	31.0	95.0	26.8	32.9	2.1	61.0	0.0	45.0	40.0	13.0
Fate Creek	6	468	35.0	0.6	10.0	31.2	16.6	0.3	2.0	5.9	18.0	83.0	95.0	16.3	15.0	0.4	0.0	0.0	44.0	16.0	36.0
East Fork Shively Creek	1	954	85.0	2.1	13.9	5.4	34.6	0.7	0.0	16.5			96.4	11.0	19.3	0.9	0.0	0.0	18.2	25.7	12.9
East Fork Shively Creek	2	1449	100.0	1.9	2.4	8.8	33.3	0.5	1.9	15.5	66.9	9.0	90.7	8.9	9.5	0.2	61.0	0.0	31.0	45.0	5.0
East Fork Shively Creek	3	576	44.0	1.3	5.3	4.0	105.1	0.0	0.0	14.8	56.0	3.0	97.0	5.7	15.4	0.3	0.0	0.0	7.0	57.0	0.0
East Fork Shively Creek	4	996	24.0	1.1	6.9	1.1	116.1	0.4	0.0	13.5	63.0	14.0	97.0	6.6	14.5	0.5	30.0	30.0	17.0	54.0	0.0
Shively Creek	1	4395	55.0	3.4	1.8	11.0	21.5	0.6	0.9	14.0	53.3	8.7	88.4	5.5	9.8	1.0	20.0	0.0	28.8	37.0	5.8
Shively Creek	2	3060	119.0	1.6	5.6	2.0	132.9	0.4	0.6	7.7	72.2	2.5	91.1	16.0	27.5	1.1	0.0	0.0	22.9	57.2	0.1
Coffee Creek	1	4627	96.0	3.7	2.3	31.7	9.6	0.8	1.3	16.8	66.8	6.0	76.1	3.5	4.5	0.3	46.0	0.0	19.6	37.7	23.0
Coffee Creek	2	4501	0.0	2.8	2.0								77.8	0.0	0.0	0.0	0.0	0.0	30.0	60.0	0.0
Coffee Creek	3	773	25.0	2.5	3.4	24.0	8.8	0.0	5.0	9.1	26.0	0.0	77.0	14.0	27.7	1.0	61.0	0.0	9.0	25.0	15.0
Coffee Creek	4	1188	27.0	2.3	3.2	16.1	20.2	0.6	3.3	13.6	78.9	3.3	81.2	19.3	27.9	1.9	61.0	0.0	11.2	49.9	27.7

						Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Coffee Creek	5	2235	210.0	1.6	6.1	18.9	16.6	0.0	5.7	8.5	46.0	21.0	96.0	22.7	92.9	3.7	488.0	366.0	16.0	27.0	8.0
Coffee Creek	6	1311	0.0	0.5	13.8	1.0	437.0	0.4	0.8	0.0	36.0	16.0	97.0	18.2	49.6	2.6	183.0	183.0	27.0	31.0	1.0
St. John Creek	1	485	0.0	3.0	2.6	11.4	12.4	0.3	0.0	14.0	27.3	17.7	68.5	2.1	0.6	0.0	0.0	0.0	27.2	25.0	25.3
St. John Creek	2	3443	60.0	2.5	1.7	17.6	9.8	0.4	4.6	20.0	41.8	15.2	89.9	12.1	10.8	0.2	91.0	0.0	26.5	37.6	13.3
St. John Creek	3	1631	116.0	2.1	2.8	23.2	11.4	0.4	5.2	17.0	31.6	13.8	88.1	12.8	7.5	0.1	61.0	0.0	24.6	31.7	6.7
St. John Creek	4	1948	53.0	1.8	4.4	17.0	14.8	0.3	7.0	15.8	33.3	11.2	90.1	15.8	10.9	0.3	81.0	41.0	18.2	30.9	10.7
St. John Creek	5	1419	35.0	1.5	8.5	11.3	28.1	0.4	4.1	17.7	38.8	21.2	88.8	19.8	14.9	0.1	20.0	0.0	18.0	34.8	12.3
St. John Creek Tributary	1	2381	64.0	1.9	3.2	9.9	20.2	0.4	3.7	12.6	39.0	13.5	92.7	17.3	7.3	0.1	76.0	0.0	22.1	36.6	3.4
St. John Creek Tributary	2	1689	20.0	1.7	9.7	6.2	28.4	0.3	1.2	11.6	33.5	18.8	92.5	21.3	30.2	1.2	168.0	46.0	11.8	25.9	15.2
Days Creek	1	1444	61.0	3.2	0.7	60.2	5.0	0.6	2.0	20.6	57.1	17.1	72.7	2.1	1.5	0.1	0.0	0.0	17.5	46.2	22.5
Days Creek	2	2060	0.0	1.0	0.1								11.1	0.0	0.0	0.0	0.0	0.0	33.3	16.7	16.7
Days Creek	3	1467	36.0	3.2	0.9	62.6	6.3	0.6	2.0	19.6	50.2	12.6	79.1	3.5	2.4	0.0	0.0	0.0	20.4	46.7	15.1
Days Creek	4	2407	150.0	3.5	0.8	66.3	8.1	0.7	3.9	20.7	57.1	14.7	82.8	5.0	3.5	0.1	0.0	0.0	22.7	49.3	13.5
Days Creek	5	3162	192.0	3.1	0.9	43.7	8.9	0.6	4.2	24.5	61.3	16.5	76.8	5.0	4.9	0.1	0.0	0.0	31.7	51.0	4.0
Days Creek	6	797	0.0	1.0	0.1								11.1	0.0	0.0	0.0	0.0	0.0	33.3	16.7	16.7
Days Creek	7	5543	610.0	2.8	0.9	44.3	8.7	0.6	8.0	24.1	65.2	14.8	81.1	10.0	7.2	0.2	47.0	7.0	33.7	52.1	1.5
Days Creek	8	5890	530.0	2.9	2.2	34.9	8.8	0.5	8.7	27.3	51.6	12.3	88.6	12.4	7.2	0.1	91.0	18.0	25.7	46.1	0.3
Days Creek	9	119	7.0	2.0	1.0	37.3	1.0	0.3	0.0	12.8			100.0	18.5	13.5	0.0	0.0	0.0	17.0	26.0	6.0
Days Creek	10	2345	196.0	1.9	9.5	23.7	4.1	0.3	10.2	10.5	33.0	18.0	99.0	27.7	70.0	4.3	238.0	55.0	19.0	30.0	3.0
South Umpqua (HUC 17100302) Sub-basin, Upper Cow Creek (HUC 1710030206) Fifth field Watershed																					
Applegate Creek	1	868.0	39.0	5.8	2.8	32.5	5.4	0.6	0.0	25.0	33.0	31.0	84.0	8.2	9.4	0.1	122.0	0.0	28.0	24.0	0.0
Applegate Creek	2	4940.0	338.0	5.3	1.1	45.4	4.3	0.5	0.9	29.2	43.0	25.0	75.0	8.2	9.6	0.1	47.0	14.0	33.0	36.0	0.0
Applegate Creek	3	2373.0	54.0	3.5	1.2	40.3	5.6	0.4	0.0	27.2	52.0	22.0	87.0	5.5	7.6	0.2	51.0	0.0	31.0	36.0	0.0
East Fork Cow Creek	1	4526.0	59.0	3.7	6.2	18.0	9.0	0.4	0.0	0.0	43.0	13.0	89.0	18.0	41.7	0.9	331.0	78.0	21.0	34.0	0.0
East Fork Cow Creek	2	1518.0	0.0	2.2	4.8	29.1	10.2	0.3	0.0	0.0	54.0	19.0	87.0	15.3	32.6	0.9	152.0	30.0	25.0	36.0	0.0
East Fork Cow Creek	3	744.0	27.0	1.5	4.0	29.4	17.3	0.3	0.0	0.0	80.0	20.0	69.0	9.7	14.5	0.1	244.0	61.0	29.0	41.0	0.0
French Creek	1	1084.0	0.0	1.4	1.4	72.8	5.6	0.4	0.0	0.0	54.0	32.0	82.0	4.3	5.8	0.2	0.0	0.0	50.0	29.0	0.0
French Creek	2	2543.0	53.0	0.9	5.0	16.5	31.1	0.3	0.0	0.0	11.0	67.0	89.0	14.4	11.7	0.1	20.0	0.0	54.0	14.0	0.0

						Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Jack Creek	1	1150.0	15.0	2.6	6.7	26.2	7.2	0.4	0.0	0.0	46.0	32.0	87.0	9.0	17.5	0.5	137.0	30.0	19.0	29.0	0.0
Jack Creek	2	1492.0	175.0	2.1	14.4	8.0	29.5	0.6	0.0	0.0	17.0	83.0	89.0	11.1	26.9	0.9	183.0	0.0	20.0	29.0	0.0
Mc Ginnis Creek	1	2431.0	80.0	0.7	6.7	6.3	116.3	0.3	0.0	33.6	58.0	38.0	92.0	16.1	35.1	1.5	61.0	37.0	34.0	58.0	0.0
Meadow Creek	1	1533.0	0.0	1.3	2.4	21.2	71.0	0.3	0.0	15.4	68.0	30.0	83.0	1.2	1.5	0.0	41.0	0.0	36.0	58.0	0.0
Meadow Creek	2	919.0	39.0	2.0	3.6	58.4	56.7	0.4	0.0	15.7	74.0	26.0	83.0	1.8	2.8	0.2	0.0	0.0	32.0	62.0	0.0
Meadow Creek	3	1640.0	103.0	0.6	9.8	2.8	512.5	0.3	0.0	21.6	68.0	32.0	89.0	19.1	31.4	0.9	24.0	0.0	33.0	62.0	0.0
Negro Creek	1	1659.0	180.0	1.5	13.9	8.5	35.4	0.4	0.0	26.7	20.0	15.0	89.0	7.2	15.4	0.6	107.0	76.0	20.0	18.0	0.0
Snow Creek	1	3715.0	453.0	3.4	1.9	52.1	10.0	0.6	0.0	21.9	36.0	24.0	66.0	4.4	7.2	0.4	17.0	9.0	37.0	34.0	0.0
Snow Creek	2	1529.0	122.0	3.0	3.3	30.2	9.9	0.6	0.0	28.5	29.0	16.0	85.0	7.3	20.5	1.4	41.0	41.0	23.0	31.0	0.0
Snow Creek	3	532.0	0.0	2.9	5.0	23.5	22.7	1.1	0.0	25.0	20.0	15.0	89.0	11.7	30.1	3.4	61.0	0.0	24.0	26.0	0.0
Snow Creek	4	2000.0	103.0	2.2	11.9	7.2	35.7	0.6	0.0	44.0	40.0	30.0	89.0	8.0	19.4	1.3	76.0	0.0	18.0	23.0	0.0
Sugar Creek	1	1534.0	211.0	1.6	4.9	23.3	14.4	0.4	0.0	27.6	64.0	15.0	87.0	2.6	3.0	0.1	0.0	0.0	24.0	54.0	0.0
Sugar Creek	2	2037.0	47.0	1.5	8.7	28.3	42.9	0.4	0.0	16.9	63.0	25.0	89.0	7.5	21.2	1.2	12.0	0.0	28.0	42.0	0.0
W. Fk. Applegate Creek	1	1880.0	141.0	1.8	4.8	27.5	11.9	0.3	1.0	14.2	35.0	38.0	89.0	15.1	22.6	0.9	15.0	0.0	41.0	25.0	0.0
Applegate Creek Trib 1	1	960.0	45.0	1.8	4.0	21.2	12.0	0.2	0.0	15.0	39.0	26.0	0.0	1.1	2.4	0.1	0.0	0.0	28.0	32.0	0.0
Applegate Creek Trib 1	2	884.0	20.0	1.2	4.0	17.8	18.7	0.2	0.0	16.5	50.0	35.0	0.0	8.9	9.7	0.0	0.0	0.0	38.0	31.0	0.0
Snow Creek Tributary Sec 7	1	1067.0	30.0	1.2	7.2	18.1	78.5	0.5	0.0	30.0	70.0	15.0	91.0	13.5	28.1	0.8	20.0	0.0	24.0	34.0	0.0
Snow Creek Tributary Sec 17	1	2536.0	64.0	1.6	9.7	13.9	40.8	0.4	0.0	0.0	63.0	29.0	89.0	12.1	22.5	0.8	0.0	0.0	23.0	44.0	0.0
East Fork Applegate Creek	1	535.0	0.0	1.5	11.8	22.7	11.1	0.3	0.0	0.0	47.0	26.0	94.0	19.1	16.8	0.4	122.0	30.0	37.0	40.0	0.0
East Fork Applegate Creek	2	1488.0	65.0	1.1	12.5	7.7	99.2	0.3	0.0	0.0	25.0	58.0	93.0	22.8	19.9	0.3	213.0	61.0	40.0	30.0	0.0
Upper Rogue (HUC 17100307) Sub-Basin, Trail Creek (HUC 1710030706) Fifth Field Watershed																					
Canyon Creek	1	928	85.0	2.1	3.9	13.7	10.9	0.5	0.0	15.7	18.0	16.0	91.0	2.6	6.0	0.8	0.0	0.0	19.0	21.0	0.0
Canyon Creek	2	2468	97.0	1.9	8.8	12.1	14.7	0.5	0.0	14.3	27.0	25.0	93.0	5.9	24.0	2.4	81.0	30.0	22.0	20.0	0.0
Canyon Creek	3	244	0.0	2.3	10.9								82.0	12.3	53.6	5.7	122.0	0.0	17.0	27.0	0.0
Chicago Creek	1	4814	0.0	2.5	5.8	2.3	181.7	0.7	0.0	11.7	11.0	16.0	99.0	7.1	16.3	0.0	0.0	0.0	19.0	19.0	0.0
Clear Creek	1	1218	0.0	1.1	10.7	2.1	51.2	0.3	0.0	8.0	19.0	21.0	93.0	7.5	23.5	1.8	20.0	0.0	20.0	20.0	0.0
Dead Horse Creek	1	1324	0.0	2.9	12.3	8.0	8.9	0.7	0.0	22.5	30.0	5.0	94.0	8.4	24.4	1.7	20.0	0.0	3.0	16.0	0.0
Romine Creek	1	4697	0.0	2.2	8.2	2.6	177.9	0.8	0.0	6.9	29.0	22.0	94.0	7.2	12.3	0.0	0.0	0.0	24.0	19.0	0.0

						Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Trail Creek	1	3829	311.0	5.2	1.0	50.4	7.7	0.9	0.0	17.8	16.0	24.0	66.0	0.3	0.5	0.0	0.0	0.0	25.0	16.0	0.0
Trail Creek	2	3879	340.0	4.1	1.7	34.1	8.5	0.6	0.0	17.6	18.0	17.0	76.0	0.4	1.7	0.1	0.0	0.0	19.0	17.0	0.0
Trail Creek	3	1036	0.0	3.9	2.8	26.0	9.3	0.6	0.0	15.3	12.0	18.0	83.0	0.1	0.2	0.0	0.0	0.0	22.0	15.0	0.0
Trail Creek	4	2119	133.0	3.7	4.6	19.0	8.3	0.7	0.0	14.5	15.0	18.0	93.0	2.3	4.9	0.5	15.0	0.0	17.0	14.0	0.0
Trail Creek	5	2064	40.0	3.1	7.0	14.8	8.5	0.5	0.0	14.4	18.0	18.0	94.0	7.1	29.1	2.8	61.0	24.0	15.0	17.0	0.0
Trail Creek	6	2534	19.0	2.5	9.1	15.6	11.5	0.7	0.0	13.3	22.0	21.0	92.0	11.1	47.7	4.5	85.0	12.0	19.0	17.0	0.0
Wall Creek	1	4343	333.0	3.9	4.7	26.8	5.3	0.7	0.2	18.7	19.0	12.0	89.0	5.1	14.7	1.6	43.0	12.0	12.0	17.0	0.0
Wall Creek	2	1076	64.0	2.3	17.1	9.3	11.7	0.5	0.0	10.0	30.0	33.0	93.0	5.9	17.7	1.6	61.0	0.0	16.0	16.0	0.0
Walpole Creek	1	3829	31.0	2.3	8.7	3.6	103.8	0.7	0.0	9.2	31.0	31.0	93.0	12.6	17.3	0.0	0.0	0.0	26.0	20.0	0.0
West Fork Trail Creek	1	3805	112.0	6.6	3.2	27.0	12.6	0.7	0.0	15.8	35.0	31.0	62.0	2.5	2.5	0.0	0.0	0.0	28.0	27.0	0.0
West Fork Trail Creek	2	6867	536.0	5.4	2.2	12.3	15.9	0.7	0.0	16.0	28.0	25.0	83.0	6.0	7.2	0.0	12.1	0.0	25.0	23.0	0.0
West Fork Trail Creek	3	1000	0.0	2.7	5.4	1.9	122.0	0.6	0.0	4.9	30.0	25.0	90.0	12.5	34.7	0.0	60.3	60.3	22.0	21.0	0.0
Canyon Creek Tributary Sec 31	1	827	0.0	2.0	10.9	6.6	17.5	0.4	0.0	12.5	23.0	27.0	94.0	7.4	32.6	2.8	0.0	0.0	24.0	23.0	0.0
Upper Rogue (HUC 17100307) Sub-Basin, Shady Cove-Rogue River (HUC 1710030707) Fifth Field Watershed																					
Brush Creek	1	2510	136.0	4.7	3.6	0.3	145.8	0.2	0.0	14.5			54.0	6.6	6.0	0.3	85.0	37.0	5.0	36.0	9.0
Brush Creek	2	890	35.0	2.7	9.7	0.5	160.8	0.5	0.0	8.6			39.0	6.0	7.5	0.3	0.0	0.0	2.0	29.0	16.0
Indian Creek	1	2746	38.0	3.7	2.4	12.9	11.2	0.4	0.0	10.1	25.0	16.0	43.0	1.0	0.2	0.0	0.0	0.0	17.0	27.0	10.0
Indian Creek	2	2745	60.0	2.6	3.8	21.5	8.4	0.4	1.8	13.8	19.0	11.0	64.0	7.9	3.9	0.1	24.0	0.0	13.0	17.0	14.0
Lewis Creek	1	2478	19.0	2.8	2.6	17.3	12.3	0.4	0.0	9.0	28.0	0.0	54.0	1.0	1.1	0.0	0.0	0.0	3.0	24.0	0.0
Lewis Creek	2	797	52.0	2.3	9.5	12.0	15.3	0.2	0.0	8.0	45.0	5.0	65.0	2.1	3.8	0.4	0.0	0.0	8.0	30.0	0.0
Lewis Creek	3	1450	95.0	1.7	13.2	12.3	12.5	0.4	0.0	10.0	32.0	6.0	79.0	10.2	20.1	1.1	20.0	0.0	11.0	33.0	0.0
Trail Creek	1	3829	311.0	5.2	1.0	50.4	7.7	0.9	0.0	17.8	16.0	24.0	66.0	0.3	0.5	0.0	0.0	0.0	25.0	16.0	0.0
Little Butte Creek	1	5057	1262.0	15.6	2.5	39.7	5.2	0.5	0.0	68.9	42.0	15.0	48.0	0.5	0.4	0.0	0.0	0.0	23.0	35.0	0.0
Upper Rogue (HUC 17100307) Sub-Basin, Big Butte Creek (HUC 1710030704) Fifth Field Watershed																					
Box Creek	1	401	0.0	2.8	5.1	15.2	8.3	0.7	0.0	14.2	34.0	8.0	79.0	8.2	9.4	0.7	0.0	0.0	8.0	27.0	0.0
Box Creek	2	2188	0.0	2.3	8.6	5.8	37.4	0.6	0.0	16.2	23.0	10.0	92.0	10.2	32.6	2.3	30.0	15.0	11.0	17.0	0.0
Box Creek	3	3865	72.0	2.5	5.6	6.3	40.6	0.4	0.0	17.5	30.0	15.0	71.0	6.0	16.5	0.8	46.0	30.0	20.0	26.0	0.0
Crowfoot Creek	1	1815	35.0	2.7	3.7	16.5	14.6	0.5	0.0	27.0	22.0	6.0	69.0	2.5	1.2	0.1	15.0	0.0	4.0	19.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Dog Creek	1	360	6.0	2.9	6.0	12.8	5.4	0.4	0.0	11.1	16.0	11.0	81.0	6.1	1.7	0.0	0.0	0.0	19.0	17.0	0.0
Dog Creek	2	1365	0.0	3.0	7.3	8.9	12.0	0.7	0.0	12.5	19.0	13.0	86.0	8.2	12.8	0.9	0.0	0.0	19.0	14.0	0.0
Dog Creek	3	778	0.0	2.0	6.6	3.7	28.0	0.4	0.0	11.4	16.0	16.0	86.0	6.4	6.9	0.3	0.0	0.0	16.0	11.0	0.0
Dog Creek	4	2413	12.0	1.9	9.4	3.8	27.1	0.5	0.0	9.1	21.0	12.0	87.0	15.0	34.8	2.8	37.0	12.2	13.0	17.0	0.0
Dog Creek	5	1696	0.0	1.4	13.1	3.3	54.6	0.3	0.0	7.6	25.0	26.0	79.0	15.2	26.5	0.8	0.0	0.0	29.0	22.0	0.0
Jackass Creek	1	2131	876.0	2.1	3.5	12.4	18.4	0.3	0.0	12.8	24.0	36.0	53.0	2.1	3.2	0.1	12.0	0.0	39.0	22.0	0.0
Jackass Creek	2	1394	107.0	2.6	4.6	10.6	23.3	0.2	0.0	12.9	23.0	35.0	62.0	4.9	6.0	0.1	30.0	0.0	32.0	20.0	0.0
Jackass Creek	3	2047	493.0	2.4	4.8	12.0	25.8	0.3	0.0	15.4	27.0	40.0	67.0	6.0	8.3	0.3	41.0	0.0	49.0	22.0	0.0
Mcneil Creek	2	1133	139.0	2.2	1.8	44.5	12.2	0.4	1.6	8.0	13.0	34.0	59.0	4.7	2.0	0.1	0.0	0.0	30.0	16.0	2.0
Mcneil Creek	3	1046	7.0	2.4	2.4	47.3	8.1	0.7	0.9	10.9	28.0	39.0	66.0	3.4	5.6	0.4	30.0	0.0	32.0	23.0	14.0
Mcneil Creek	4	646	33.0	2.0	1.6	58.7	10.2	0.6	2.9	9.2	16.0	63.0	53.0	4.0	1.5	0.0	0.0	0.0	50.0	16.0	21.0
South Fork Clark Creek	1	4786	262.0	2.6	5.9	3.3	75.2	0.4	0.6	11.4	33.0	22.0	87.0	8.1	15.9	0.4	75.0	7.0	23.0	29.0	8.0
Twincheria Creek	1	1330	13.0	4.3	0.8	45.3	7.5	0.4	0.0	10.8	54.0	14.0	48.0	9.7	22.4	1.1	0.0	0.0	43.0	26.0	0.0
Twincheria Creek	2	618	0.0	3.4	2.2	28.5	9.7	0.5	0.0	8.0	63.0	11.0	68.0	9.1	19.6	0.6	122.0	61.0	41.0	38.0	0.0
Twincheria Creek	3	1512	122.0	3.4	4.3	17.4	29.0	0.4	0.0	11.1	63.0	13.0	64.0	6.9	17.7	0.4	91.0	0.0	30.0	26.0	0.0
Twincheria Creek	4	1165	70.0	3.4	5.8	14.8	23.5	0.4	0.0	12.0	65.0	11.0	88.0	16.1	32.7	1.4	274.0	91.0	25.0	45.0	0.0
North Fork Big Butte Creek	1	2273	405.0	6.4	2.8	9.2	11.5	0.6	0.0	12.0	11.0	5.0	75.0	11.1	29.6	1.1	91.0	24.4	4.0	8.0	0.0
North Fork Big Butte Creek	2	2452	76.0	6.0	0.8	19.8	24.3	0.8	0.0	21.2	19.0	11.0	55.0	2.7	6.9	0.4	61.0	0.0	15.0	18.0	0.0
North Fork Big Butte Creek	3	1297	85.0	6.8	1.3	21.2	9.5	0.7	0.0	21.6	13.0	4.0	72.0	5.7	19.3	0.7	61.0	42.7	9.0	11.0	0.0
North Fork Big Butte Creek	4	4923	296.0	4.7	1.2	28.2	13.1	0.6	0.0	14.3	32.0	31.0	58.0	3.1	4.0	0.2	0.0	0.0	35.0	26.0	0.0
North Fork Big Butte Creek	5	1457	107.0	4.5	1.7	41.5	9.3	0.6	0.0	13.2	34.0	31.0	63.0	2.7	9.3	0.5	0.0	0.0	39.0	31.0	0.0
North Fork Big Butte Creek	6	1832	45.0	3.9	1.6	39.6	9.1	0.6	0.0	13.3	26.0	32.0	62.0	3.4	9.7	0.5	0.0	0.0	38.0	22.0	0.0
North Fork Big Butte Creek	7	1193	23.0	3.3	2.2	17.9	15.4	0.3	0.0	12.3	36.0	26.0	72.0	3.3	13.1	1.1	91.0	0.0	33.0	31.0	0.0
North Fork Big Butte Creek	8	3529	130.0	3.1	1.9	29.5	11.9	0.4	0.0	11.6	23.0	49.0	65.0	6.7	27.6	1.8	30.0	6.0	56.0	20.0	0.0
North Fork Big Butte Creek	9	1354	70.0	2.3	3.4	7.1	28.5	0.3	0.0	9.5	30.0	47.0	86.0	5.5	20.6	1.6	46.0	0.0	48.0	26.0	0.0
North Fork Big Butte Creek	10	1527	69.0	1.5	4.8	7.1	37.0	0.2	0.0	5.0	30.0	60.0	82.0	12.0	48.0	3.2	122.0	18.3	52.0	24.0	0.0
Clark Creek	2	890	195.0	3.3	7.4	6.9	29.0	0.8	0.0	11.9	25.0	3.0	83.0	12.4	25.2	1.5	122.0	0.0	8.0	20.0	18.0
Clark Creek	3	850	36.0	4.1	9.3	8.6	27.3	0.8	1.1	10.8	30.0	4.0	79.0	7.6	18.3	1.3	30.0	0.0	8.0	20.0	29.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Clark Creek	4	3934	392.0	3.8	3.7	9.0	18.9	0.4	1.4	14.6	40.0	0.0	89.0	5.4	6.2	0.3	26.0	0.0	15.0	26.0	12.0
Clark Creek (surveyed as SF Clk)	5	885	23.0	3.2	5.2	3.4	38.2	0.5	1.1	13.7	22.0	1.0	97.0	4.4	6.9	0.2	30.0	0.0	8.0	20.0	13.0
South Fork Big Butte Creek	1	1298	272.0	7.3	1.7	27.0	13.0	1.0	0.0	14.3	5.0	7.0	67.0	3.9	8.7	0.4	30.0	0.0	8.0	6.0	0.0
South Fork Big Butte Creek	2	881	0.0	12.1	1.9	19.2	13.3	0.8	0.0	15.7	7.0	12.0	62.0	4.7	3.6	0.1	0.0	0.0	20.0	6.0	0.0
South Fork Big Butte Creek	3	1218	114.0	14.9	1.3	12.5	11.5	1.2	0.0	22.9	5.0	5.0	55.0	2.3	3.1	0.1	30.0	0.0	12.0	6.0	0.0
South Fork Big Butte Creek	4	1923	176.0	13.4	0.2	29.7	8.0	0.9	0.0	21.9	12.0	52.0	46.0	2.0	2.4	0.0	0.0	0.0	28.0	10.0	0.0
South Fork Big Butte Creek	5	2778	22.0	15.4	0.9	40.2	9.3	1.5	0.0	20.7	23.0	30.0	46.0	0.9	1.3	0.0	0.0	0.0	16.0	9.0	0.0
South Fork Big Butte Creek	6	2380	185.0	14.6	1.0	20.9	18.6	0.8	0.0	21.9	23.0	23.0	49.0	2.8	6.2	0.2	61.0	30.0	24.0	18.0	0.0
South Fork Big Butte Creek	7	1532	29.0	12.2	1.6	50.2	9.7	0.6	0.0	18.0	30.0	28.0	58.0	2.8	7.1	0.1	20.0	0.0	25.0	26.0	0.0
Upper Rogue (HUC 17100307) Sub-basin, Little Butte Creek (HUC 1710030708) Fifth field Watershed																					
Antelope Creek	1	2617	124.0	4.8	1.0	24.6	0.0	0.4	0.0	1.9	61.0	39.0	26.0	0.0	0.0	0.0	0.0	0.0	55.0	42.0	0.0
Antelope Creek	2	334	0.0	5.1	1.1	24.6	0.0	0.5	0.0	12.0	63.0	35.0	53.0	0.0	0.0	0.0	0.0	0.0	41.0	48.0	0.0
Antelope Creek	3	7157	154.0	4.6	1.1	20.5	0.0	0.6	0.0	23.5	58.0	40.0	59.0	0.0	0.0	0.0	0.0	0.0	48.0	46.0	0.0
Antelope Creek	4	3063	282.0	5.6	1.6	24.9	0.0	0.6	0.0	15.5	64.0	32.0	31.0	0.0	0.0	0.0	0.0	0.0	37.0	56.0	0.0
Antelope Creek	5	3104	510.0	5.4	2.0	14.9	0.0	0.6	0.0	13.8	68.0	25.0	24.0	0.0	0.0	0.0	0.0	0.0	30.0	58.0	0.0
Antelope Creek	6	338	170.0	4.8	1.7	22.8	0.0	0.6	0.0	11.0	65.0	20.0	33.0	0.0	0.0	0.0	0.0	0.0	24.0	50.0	0.0
Conde Creek	1	2583	0.0	0.0	0.0								100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conde Creek	2	1811	166.0	1.6	6.7	9.3	13.8	0.3	0.0	9.8	12.0	42.0	48.0	2.0	4.3	0.2	0.0	0.0	38.0	14.0	0.0
Conde Creek	3	886	185.0	1.5	2.8	17.7	60.5	0.3	0.0	8.3	10.0	45.0	52.0	1.5	1.4	0.0	0.0	0.0	42.0	12.0	0.0
Conde Creek	4	666	22.0	0.9	3.1					10.0			27.0	0.3	0.5	0.0	0.0	0.0	59.0	6.0	0.0
Deer Creek	1	415	0.0	4.5	6.5								92.0	4.1	3.2	0.0	60.3	0.0	25.0	28.0	0.0
Deer Creek	2	326	15.0	2.7	5.3	10.2	15.9	0.4	0.0	12.7	31.0	35.0	100.0	10.4	19.6	2.0	0.0	0.0	37.0	32.0	0.0
Deer Creek	3	1849	51.0	2.6	8.9	2.9	28.9	0.3	0.0	17.8	33.0	34.0	99.0	12.2	22.6	1.0	301.7	60.3	33.0	25.0	0.0
Deer Creek	4	1992	10.0	1.9	15.3	0.2	511.4	0.3	0.0	12.7	25.0	29.0	95.0	20.5	27.8	2.0	241.4	0.0	33.0	27.0	0.0
Lake Creek	1	2555	65.0	3.5	3.4	9.5	19.7	0.4	0.0	46.4	49.0	19.0	90.0	3.6	1.0	0.0	60.3	0.0	27.0	42.0	0.0
Lake Creek	2	1179	159.0	3.9	4.5	7.9	29.0	0.4	0.0	22.8	38.0	34.0	98.0	3.6	1.7	0.0	42.2	0.0	34.0	32.0	0.0
Lake Creek	3	5976	731.0	4.4	5.9	1.6	57.4	0.4	0.0	28.4	39.0	28.0	95.0	11.9	13.4	1.0	90.5	6.0	26.0	37.0	0.0
Lake Creek	4	1045	0.0	3.4	5.1								76.0	8.2	3.9	0.0	60.3	0.0	37.0	39.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach					Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
		PRICHNLL	SECCHNLL	WIDTH	GRADIENT	PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK
Lake Creek	5	642	0.0	2.4	5.1	2.5	47.2	0.4	0.0	125.0	48.0	45.0	94.0	7.8	7.2	0.0	0.0	0.0	46.0	40.0	0.0
Lick Creek	1	2342	124.0	3.0	1.9	34.7	8.2	0.7	0.0	17.8	31.0	29.0	41.0	0.6	0.5	0.0	0.0	0.0	36.0	28.0	0.0
Lick Creek	2	1526	194.0	2.5	3.2	20.4	13.6	0.5	0.0	15.2	33.0	25.0	52.0	0.9	1.4	0.1	0.0	0.0	24.0	24.0	0.0
Lick Creek	3	1972	0.0	0.0	0.0								100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lick Creek	4	2092	195.0	2.3	8.0	16.7	11.3	0.4	0.4	11.4	35.0	20.0	75.0	5.8	5.1	0.2	0.0	0.0	18.0	25.0	0.0
Lick Creek	5	1543	73.0	1.6	8.4	12.2	20.9	0.3	1.2	7.0	10.0	50.0	86.0	13.4	29.9	1.9	0.0	0.0	21.0	30.0	0.0
Lost Creek	1	1701	94.0	3.2	3.8	18.5	9.1	0.3	0.0	21.5	38.0	30.0	94.0	5.9	2.2	0.0	0.0	0.0	32.0	35.0	0.0
Lost Creek	2	2118	353.0	3.4	3.1	13.7	8.5	0.4	0.0	22.9	38.0	37.0	100.0	9.1	6.1	0.0	42.2	6.0	35.0	28.0	0.0
Lost Creek	3	1519	36.0	3.6	7.7	22.1	6.3	0.5	0.0	12.8	33.0	45.0	100.0	19.6	27.7	2.0	48.3	12.1	38.0	23.0	0.0
Lost Creek	4	1262	11.0	4.4	9.4	17.4	7.1	0.6	0.0	18.9	27.0	36.0	99.0	11.3	10.2	1.0	96.5	18.1	27.0	24.0	0.0
Lost Creek	5	1360	83.0	4.0	5.9	18.1	7.1	0.6	0.0	34.5	38.0	40.0	100.0	26.2	36.7	2.0	307.7	78.4	34.0	23.0	0.0
Lost Creek	6	761	68.0	7.8	21.4					30.0			100.0	12.9	9.2	0.0	0.0	0.0	11.0	12.0	0.0
Lost Creek	7	471	0.0	120.0	0.0	100.0	0.0	5.0	0.0				100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Lost Creek	8	1279	58.0	3.4	9.9	11.7	9.6	0.6	0.0	160.0	0.0	100.0	96.0	13.6	15.8	1.0	199.1	78.4	32.0	17.0	0.0
Salt Creek	1	2778	179.0	3.4	1.5	38.6	6.2	0.6	0.0	16.4	19.0	25.0	74.0	1.9	0.9	0.0	0.0	0.0	37.0	17.0	0.0
Salt Creek	2	1758	44.0	3.1	2.7	13.3	17.2	0.5	0.0	14.9	13.0	24.0	71.0	2.3	1.4	0.1	0.0	0.0	26.0	12.0	0.0
Salt Creek	3	2826	113.0	2.8	4.8	8.5	24.2	0.5	0.0	5.0	25.0	15.0	78.0	9.1	14.8	1.1	12.0	0.0	23.0	17.0	0.0
Salt Creek	4	2252	124.0	2.2	7.3	5.9	21.9	0.4	0.0	9.2	27.0	18.0	75.0	14.6	29.3	1.9	30.0	0.0	22.0	24.0	0.0
Salt Creek	5	742	135.0	1.1	10.2	0.8	127.1	0.4	0.0	8.5	31.0	45.0	81.0	14.0	16.5	0.4	0.0	0.0	43.0	26.0	0.0
Salt Creek	6	1646	193.0	1.3	12.3								70.0	11.2	30.6	2.4	30.0	0.0	32.0	28.0	0.0
Soda Creek	1	5966	122.0	3.0	8.2	12.1	16.3	0.6	0.0	13.7	40.0	20.0	97.0	18.2	20.5	1.0	205.2	30.2	30.0	20.0	0.0
Soda Creek	2	1457	7.0	1.8	12.2	0.8	161.8	0.5	0.0	17.0	32.0	45.0	83.0	16.1	18.7	1.0	121.3	60.3	36.0	15.0	0.0
Soda Creek	3	682	0.0	1.1	4.0	7.7	250.6	0.3	0.0	0.0	26.0	53.0	56.0	3.7	7.1	1.0	122.0	0.0	67.0	19.0	0.0
S.Fk. Little Butte Creek	1	6475	591.0	8.1	1.3	29.0	4.6	0.6	0.0	53.3	47.0	12.0	46.0	4.4	2.1	0.0	8.0	0.0	20.0	42.0	0.0
S.Fk. Little Butte Creek	2	1105	337.0	6.0	1.8	31.4	4.0	0.5	0.0	26.5	40.0	25.0	75.0	5.7	1.4	0.0	30.0	0.0	19.0	36.0	0.0
S.Fk. Little Butte Creek	3	2572	557.0	7.4	1.5	32.0	4.7	0.6	0.0	40.5	47.0	17.0	61.0	4.9	4.0	0.0	20.0	0.0	22.0	39.0	0.0
S.Fk. Little Butte Creek	4	2048	424.0	8.4	1.3	36.1	5.2	0.8	0.0	53.7	46.0	13.0	69.0	4.1	2.2	0.0	30.0	0.0	19.0	37.0	0.0
S.Fk. Little Butte Creek	5	3333	361.0	7.5	1.3	28.9	7.0	0.6	0.3	50.9	42.0	15.0	77.0	5.0	4.1	0.0	41.0	0.0	22.0	31.0	0.0

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	Riffle Conditions WDRATIO	RIVGRAV	RIFSNDOR	Shade SHADE	Large Woody Debris LWDPIECE1	LWDVOL1	KEYLWD1	Riparian Conifers CON_20PLUS	CON_36PLUS	Substrate in Reach PCTSNDOR	PCTGRAVEL	PCTBEDROCK
S.Fk. Little Butte Creek	6	2164	676.0	6.1	1.9	36.3	4.0	0.6	0.0	35.4	41.0	25.0	70.0	9.2	10.9	1.0	20.0	0.0	28.0	36.0	0.0
S.Fk. Little Butte Creek	7	2490	501.0	6.2	2.6	24.4	5.0	0.6	0.0	28.2	41.0	20.0	68.0	10.5	8.9	0.0	30.0	0.0	20.0	34.0	0.0
S.Fk. Little Butte Creek	8	2969	878.0	6.1	2.9	22.1	6.6	0.5	0.0	27.1	34.0	37.0	85.0	13.9	12.3	0.0	12.0	0.0	30.0	26.0	0.0
S.Fk. Little Butte Creek	9	817	220.0	7.9	4.4	15.5	5.0	0.4	0.0	35.0	20.0	20.0	90.0	21.1	72.5	5.0	152.0	30.0	27.0	29.0	0.0
S.Fk. Little Butte Creek	10	2973	531.0	7.6	6.3	4.9	19.9	0.7	0.0	35.3	33.0	41.0	92.0	23.1	26.3	2.0	122.0	0.0	23.0	22.0	0.0
S.Fk. Little Butte Creek	11	1678	53.0	7.8	3.8	4.4	33.0	0.9	0.0	12.0	19.0	14.0	81.0	4.3	5.9	0.0	0.0	0.0	14.0	16.0	0.0
Wasson Creek	1	791	12.0	3.3	7.3	32.5	8.4	0.3	0.0	14.3	38.0	21.0	76.0	2.5	2.9	0.0	0.0	0.0	17.0	21.0	0.0
Wasson Creek	2	2714	105.0	3.0	10.6	6.5	14.3	0.5	0.7	12.9	29.0	10.0	83.0	11.5	19.2	0.6	0.0	0.0	12.0	25.0	0.0
Wasson Creek	3	1815	93.0	2.2	9.6	6.4	27.7	0.4	0.5	11.0	33.0	23.0	85.0	11.3	19.9	0.6	46.0	0.0	24.0	27.0	0.0
Yew Creek	1	1476	0.0	1.2	11.3	2.0	118.6	0.4	0.0	8.8	27.0	38.0	84.0	9.8	20.7	1.2	0.0	0.0	43.0	23.0	0.0
North Fork Little Butte Creek	1	2883	161.0	6.0	2.5	26.2	4.6	0.6	0.0	24.8	42.0	20.0	80.0	4.0	1.9	0.0	0.0	0.0	24.0	32.0	0.0
Little Butte Creek	1	5057	1262.0	15.6	2.5	39.7	5.2	0.5	0.0	68.9	42.0	15.0	48.0	0.5	0.4	0.0	0.0	0.0	23.0	35.0	0.0
Little Butte Creek	2	22357	1587.0	11.6	1.0	51.2	6.6	0.6	0.0	66.2	47.0	9.0	65.0	1.4	1.1	0.0	5.0	0.0	17.0	36.0	0.0

Data Attribute Names and Descriptions Used in Aquatic Habitat Benchmark Analysis and Stream Substrate Analysis (ODFW Aquatic Inventories Project Habitat and Reach Data Coverages Metadata Date: February 2011)

Reach – Stream Reach Number sampled for habitat attributes
PRICHNLL – Length (m) of Primary Channel
SECCHNLL – Length (m) of Secondary Channel
WIDTH-Average Channel Width (meters). Width of the wetted portion of the channel.
GRADIENT-Average of unit gradients (percent slope) for the reach, weighted by unit length.

Pool Habitat Conditions
PCTPOOL-Combined percentage (by area) of scour and dammed pools in reach
CWPOOL-Channel widths/pool. A pool frequency measure calculated by dividing the number of pools by the number of active channel width equivalents in the reach.
RESIDPD-Average residual depth of pool (meters)
COMPOOL_KM-Number of pools with >3 pieces of LWD /kilometer of total reach length.

Riffle Conditions
WDRATIO-Width to Depth ratio (calculated as active channel width to active channel depth).
RIFGRAV- Average percent of gravel in surface substrate of riffle units only. No value is given for reaches without riffles.
RIFSNDOR- Average percent of sand, silt, and organics in surface substrate of riffle units only. No value is given for reach without riffles.

Shade
SHADE-Amount of shade provided to stream by riparian vegetation and topography (percentage of 180 degrees).

Large Woody Debris
LWDPIECE1-Pieces of large woody debris/100meters of primary stream length.
LWDVOL1-Volume of large woody debris/100meters of primary stream length

Subbasin Fifth Field Watershed Stream Name	Reach	PRICHNLL	SECCHNLL	WIDTH	GRADIENT	Pool Habitat Conditions				Riffle Conditions			Shade	Large Woody Debris			Riparian Conifers		Substrate in Reach		
						PCTPOOL	CWPOOL	RESIDPD	COMPOOL_KM	WDRATIO	RIVGRAV	RIFSNDOR	SHADE	LWDPIECE1	LWDVOL1	KEYLWD1	CON_20PLUS	CON_36PLUS	PCTSNDOR	PCTGRAVEL	PCTBEDROCK

KEYLWD-Key pieces (>0.60m diameter and >12m long) inof large woody debris/100m of primary stream length

Riparian Conifers
CON_20PLUS- Conifers > 50cm dbh/1000ft (305m) of stream length
CON_36PLUS- Conifers > 90cm dbh/1000ft (305m) of stream length

Substrate in Reach
PCTSNDOR-Average percent of sand, silt, and organics in surface substrate of all units
PCTGRAVEL-Average percent of gravel in surface substrate of all units.
PCTBEDROCK – Average percent bedrock in surface substrate of all units (only if reported after 1999).

APPENDIX Y

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction for the Pacific Connector Pipeline Project

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

Subbasin / Fifth Field Watershed / Stream Name	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Coos Sub-basin (HUC 17100304), Coos Bay Frontal Pacific Ocean (HUC 1710030403) Fifth Field Watershed																							
Big Creek	1	5.5	0.8	0.3	84.0	5.0	3.76	6.16	0.61	0.060	2.47	0.66	0.014	4.02	0.06	0.03	0.14	56.0	0.29	0.01	2286	85.1	19.5
Cox Canyon Creek	1	2.0	0.5	0.5	33.0	7.0	0.75	2.41	0.31	0.060	0.41	0.54	0.014	1.08	0.04	0.01	0.13	22.0	2.37	0.00	3045	113.3	26.0
Cox Canyon Creek	2	1.4	0.6	1.1	38.0	3.0	0.48	1.90	0.25	0.060	0.34	0.70	0.014	0.29	0.05	0.00	0.19	25.3	1.73	0.01	3096	115.2	26.4
Cox Canyon Creek	3	0.7	0.3	5.9	38.0	2.0	0.12	0.95	0.13	0.060	0.12	1.02	0.014	0.15	0.02	0.00	0.27	25.3	1.73	0.01	6405	238.4	54.6
Fourth Creek	1	1.8	0.2	2.6	70.0	18.0	0.32	1.97	0.16	0.060	0.26	0.80	0.014	1.43	0.02	0.00	0.17	46.7	0.44	0.00	8885	330.6	75.7
Fourth Creek	3	2.1	0.2	2.2	88.0	2.0	0.38	2.27	0.17	0.060	0.29	0.75	0.014	1.73	0.02	0.00	0.15	58.7	0.26	0.00	9238	343.8	78.7
Joe Ney Slough (North Fork)	1	30.0	0.3	0.1	100.0	0.0	8.91	30.25	0.29	0.060	2.08	0.23	0.014	29.45	0.02	0.03	0.04	66.7	0.20	0.00	5600	208.4	47.7
Joe Ney Slough (North Fork)	2	24.7	0.3	0.1	100.0	0.0	7.32	24.95	0.29	0.060	1.70	0.23	0.014	24.15	0.02	0.02	0.04	66.7	0.20	0.00	5601	208.4	47.7
Joe Ney Slough (North Fork)	3	4.4	0.4	0.5	100.0	0.0	1.6	4.73	0.34	0.060	0.92	0.57	0.014	3.66	0.03	0.01	0.12	66.7	0.20	0.00	4626	172.1	39.4
Palouse Creek	1	7.0	1.0	0.1	50.0	0.0	6	7.83	0.77	0.060	2.65	0.44	0.014	5.16	0.08	0.04	0.09	33.3	0.93	0.01	1581	58.8	13.5
Palouse Creek	2	4.5	0.7	0.4	35.0	9.0	2.66	5.08	0.52	0.060	1.82	0.68	0.014	3.21	0.05	0.03	0.15	23.3	2.08	0.01	2186	81.4	18.6
Palouse Creek	3	6.3	0.8	0.5	22.0	32.0	4.4	6.96	0.63	0.060	3.82	0.87	0.014	4.82	0.06	0.05	0.18	14.7	5.91	0.01	1760	65.5	15.0
Palouse Creek	4	7.6	0.6	0.5	19.0	46.0	4.2	8.10	0.52	0.060	3.20	0.76	0.014	6.49	0.05	0.05	0.15	12.7	8.22	0.01	2225	82.8	19.0
Palouse Creek	5	7.1	0.7	1.7	7.0	36.0	4.48	7.68	0.58	0.060	6.80	1.52	0.014	5.81	0.05	0.10	0.31	4.7	77.91	0.02	1651	61.5	14.1
Palouse Creek	6	7.0	0.5	2.4	7.0	25.0	3.25	7.41	0.44	0.060	4.84	1.49	0.014	6.08	0.04	0.07	0.29	4.7	77.91	0.01	2295	85.4	19.6
Joe Ney Slough (South Fork)	1	4.0	0.3	0.5	100.0	0.0	1.11	4.25	0.26	0.060	0.53	0.48	0.014	3.45	0.02	0.01	0.10	66.7	0.20	0.00	6053	225.2	51.6
Joe Ney Slough (South Fork)	2	3.0	0.3	0.2	100.0	0.0	0.81	3.25	0.25	0.060	0.24	0.30	0.014	2.45	0.02	0.00	0.06	66.7	0.20	0.00	5823	216.7	49.6
Sullivan Creek	1	2.9	0.2	6.8	18.0	28.0	0.54	3.07	0.18	0.060	0.74	1.37	0.014	2.53	0.02	0.01	0.27	12.0	9.29	0.00	6942	258.3	59.2
Sullivan Creek	2	3.6	0.4	3.7	42.0	21.0	1.28	3.93	0.33	0.060	1.94	1.52	0.014	2.86	0.03	0.03	0.31	28.0	1.38	0.01	4226	157.2	36.0
Sullivan Creek	3	2.0	0.3	3.5	53.0	19.0	0.51	2.25	0.23	0.060	0.59	1.16	0.014	1.45	0.02	0.01	0.25	35.3	0.82	0.01	5829	216.9	49.7
Tarheel Creek	1	15.0	0.7	1.3	71.0	0.0	10.01	15.58	0.64	0.060	14.16	1.41	0.014	13.71	0.05	0.20	0.27	47.3	0.42	0.01	2644	98.4	22.5
Tarheel Creek	4	1.2	0.2	3.2	91.0	1.0	0.2	1.37	0.15	0.060	0.17	0.83	0.014	0.83	0.02	0.00	0.18	60.7	0.24	0.00	9546	355.2	81.4
Palouse Creek - Trib F	1	6.0	0.5	6.6	6.0	17.0	2.75	6.41	0.43	0.060	6.69	2.43	0.014	5.08	0.04	0.10	0.49	4.0	110.25	0.02	2328	86.6	19.8
Palouse Creek - Trib A	1	3.3	0.6	6.2	13.0	54.0	1.62	3.80	0.43	0.060	3.81	2.35	0.014	2.19	0.05	0.05	0.52	8.7	19.33	0.02	2330	86.7	19.9
Palouse Creek - Trib A	2	3.6	0.5	11.6	11.0	26.0	1.55	4.01	0.39	0.060	4.67	3.01	0.014	2.68	0.04	0.07	0.64	7.3	28.15	0.02	2730	101.6	23.3
Winchester Creek	1	4.6	0.7	1.0	98.0	1.0	2.73	5.18	0.53	0.060	2.97	1.09	0.014	3.31	0.05	0.04	0.23	65.3	0.20	0.01	2828	105.2	24.1
Winchester Creek	2	4.5	0.9	1.0	98.0	2.0	3.24	5.25	0.62	0.060	3.92	1.21	0.014	2.84	0.07	0.05	0.27	65.3	0.20	0.02	2250	83.7	19.2
Winchester Creek	3	3.7	0.7	0.9	99.0	1.0	2.1	4.28	0.49	0.060	2.07	0.98	0.014	2.41	0.05	0.03	0.22	66.0	0.20	0.01	2837	105.6	24.2
Winchester Creek	4	3.0	0.7	0.7	95.0	5.0	1.61	3.58	0.45	0.060	1.32	0.82	0.014	1.71	0.05	0.02	0.19	63.3	0.22	0.01	2804	104.4	23.9
Winchester Creek	5	1.8	0.6	1.2	91.0	8.0	0.72	2.30	0.31	0.060	0.61	0.84	0.014	0.69	0.05	0.01	0.22	60.7	0.24	0.01	3403	126.6	29.0
Coquille Sub-basin (HUC 17100305), North Fork Coquille River (HUC 1710030504) Fifth Field Watershed																							
Honcho Creek	1	3.8	0.3	4.2	11.0	15.0	1.05	4.05	0.26	0.050	1.75	1.67	0.020	3.26	0.03	0.04	0.38	7.3	28.15	0.01	3451	128.4	29.4
Honcho Creek	2	4.0	0.3	10.8	8.0	16.0	1.11	4.25	0.26	0.050	2.98	2.69	0.020	3.46	0.03	0.06	0.62	5.3	57.68	0.02	3365	125.2	28.7

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

Subbasin Fifth Field Watershed Stream Name	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area ($meter^2$)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q ($meter^3$ per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, $meter^3$)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Vaughns Creek Tributary 1	1	4.8	0.4	3.8	27.0	32.0	1.76	5.13	0.34	0.050	3.36	1.91	0.020	4.08	0.04	0.07	0.44	18.0	3.73	0.02	3168	117.9	27.0
Vaughns Creek	1	5.4	0.5	5.5	24.0	23.0	2.45	5.81	0.42	0.050	6.46	2.64	0.020	4.50	0.05	0.13	0.62	16.0	4.86	0.03	2551	94.9	21.7
Vaughns Creek	2	7.0	0.7	2.4	18.0	37.0	4.41	7.58	0.58	0.050	9.52	2.16	0.020	5.74	0.07	0.20	0.51	12.0	9.29	0.03	1687	62.8	14.4
Vaughns Creek	3	8.3	0.5	7.2	8.0	29.0	3.9	8.71	0.45	0.050	12.25	3.14	0.020	7.40	0.05	0.25	0.71	5.3	57.68	0.03	2041	76.0	17.4
Alder Creek	1	9.6	0.8	1.9	10.0	41.0	7.04	10.26	0.69	0.050	15.10	2.14	0.020	8.16	0.08	0.31	0.50	6.7	34.89	0.04	1299	48.3	11.1
Alder Creek	2	5.9	0.7	7.6	4.0	23.0	3.64	6.48	0.56	0.050	13.66	3.75	0.020	4.64	0.07	0.28	0.90	2.7	274.75	0.06	1298	48.3	11.1
Alder Creek	3	8.5	0.5	1.3	11.0	48.0	4	8.91	0.45	0.050	5.35	1.34	0.020	7.60	0.05	0.11	0.30	7.3	28.15	0.01	2020	75.2	17.2
Alder Creek	4	4.6	0.6	6.9	10.0	32.0	2.4	5.10	0.47	0.050	7.63	3.18	0.020	3.52	0.06	0.16	0.77	6.7	34.89	0.04	1815	67.5	15.5
Alder Creek	5	4.8	0.9	14.5	14.0	26.0	3.51	5.55	0.63	0.050	19.71	5.61	0.020	3.18	0.09	0.39	1.45	9.3	16.35	0.12	1390	51.7	11.8
North Fork Cherry Creek	1	6.2	0.5	2.9	20.0	17.0	2.85	6.61	0.43	0.050	5.54	1.94	0.020	5.30	0.05	0.11	0.45	13.3	7.32	0.02	2382	88.6	20.3
North Fork Cherry Creek	2	3.4	0.4	3.1	12.0	27.0	1.2	3.73	0.32	0.050	1.98	1.65	0.020	2.68	0.04	0.04	0.40	8.0	23.14	0.02	2659	98.9	22.7
North Fork Cherry Creek	3	2.7	0.4	18.7	11.0	17.0	0.92	3.03	0.30	0.050	3.59	3.91	0.020	1.98	0.04	0.07	0.97	7.3	28.15	0.04	2843	105.8	24.2
South Fork Cherry Creek	1	5.5	0.6	8.0	9.0	18.0	2.94	6.00	0.49	0.050	10.34	3.52	0.020	4.42	0.06	0.21	0.84	6.0	44.24	0.05	1782	66.3	15.2
South Fork Cherry Creek	2	5.0	0.5	2.5	17.0	31.0	2.25	5.41	0.42	0.050	3.96	1.76	0.020	4.10	0.05	0.08	0.42	11.3	10.56	0.02	2292	85.3	19.5
South Fork Cherry Creek	3	2.0	0.6	9.8	3.0	29.0	0.84	2.50	0.34	0.050	2.54	3.03	0.020	0.92	0.06	0.04	0.87	2.0	525.19	0.05	1495	55.6	12.7
Little North Fork Coquille River	1	6.4	0.4	2.0	24.0	31.0	2.4	6.73	0.36	0.050	3.41	1.42	0.020	5.68	0.04	0.07	0.32	16.0	4.86	0.01	2995	111.5	25.5
Little North Fork Coquille River	2	3.4	0.3	4.3	24.0	30.0	0.93	3.65	0.25	0.050	1.55	1.67	0.020	2.86	0.03	0.03	0.39	16.0	4.86	0.01	4075	151.7	34.7
Moon Creek Tributary 1	1	6.3	0.4	2.8	23.0	37.0	2.36	6.63	0.36	0.050	3.97	1.68	0.020	5.58	0.04	0.08	0.38	15.3	5.35	0.01	3014	112.2	25.7
Moon Creek Tributary 1	2	5.0	1.7	4.6	24.0	32.0	5.61	6.41	0.88	0.050	22.02	3.93	0.020	1.93	0.17	0.34	1.16	16.0	4.86	0.18	859	32.0	7.3
Little Cherry Creek	2	5.8	0.5	7.2	13.0	20.0	2.65	6.21	0.43	0.050	8.06	3.04	0.020	4.90	0.05	0.17	0.71	8.7	19.33	0.03	2267	84.4	19.3
Little Cherry Creek	3	4.8	0.5	9.7	9.0	22.0	2.15	5.21	0.41	0.050	7.42	3.45	0.020	3.90	0.05	0.15	0.82	6.0	44.24	0.04	2132	79.3	18.2
Moon Creek	1	10.0	0.7	1.1	22.0	11.0	6.51	10.58	0.62	0.050	9.88	1.52	0.020	8.74	0.07	0.20	0.35	14.7	5.91	0.02	1693	63.0	14.4
Moon Creek	2	7.2	0.5	1.5	27.0	24.0	3.35	7.61	0.44	0.050	4.75	1.42	0.020	6.30	0.05	0.10	0.32	18.0	3.73	0.02	2459	91.5	21.0
Moon Creek	3	3.2	0.5	3.0	35.0	28.0	1.35	3.61	0.37	0.050	2.43	1.80	0.020	2.30	0.05	0.05	0.45	23.3	2.08	0.02	2713	100.9	23.1
Moon Creek	4	3.1	0.4	1.9	64.0	34.0	1.08	3.43	0.31	0.050	1.38	1.28	0.020	2.38	0.04	0.03	0.31	42.7	0.53	0.01	3705	137.9	31.6
Mast Creek	1	2.5	0.5	1.7	52.0	16.0	1	2.91	0.34	0.050	1.28	1.28	0.020	1.60	0.05	0.03	0.33	34.7	0.85	0.02	2899	107.9	24.7
Mast Creek	2	2.8	0.3	1.7	73.0	19.0	0.75	3.05	0.25	0.050	0.77	1.02	0.020	2.26	0.03	0.02	0.24	48.7	0.40	0.01	4952	184.3	42.2
Mast Creek	3	3.3	0.4	3.3	81.0	10.0	1.16	3.63	0.32	0.050	1.97	1.70	0.020	2.58	0.04	0.04	0.41	54.0	0.31	0.02	3987	148.4	34.0
Mast Creek	4	2.0	0.2	3.4	83.0	13.0	0.36	2.17	0.17	0.050	0.40	1.11	0.020	1.64	0.02	0.01	0.26	55.3	0.30	0.01	7677	285.7	65.4
Cherry Creek	1	8.4	0.3	0.7	22.0	26.0	2.43	8.65	0.28	0.050	1.74	0.72	0.020	7.86	0.03	0.04	0.16	14.7	5.91	0.00	3666	136.4	31.2
Cherry Creek	2	11.0	0.8	3.4	17.0	17.0	8.16	11.66	0.70	0.050	23.72	2.91	0.020	9.56	0.08	0.49	0.67	11.3	10.56	0.05	1489	55.4	12.7
Cherry Creek	3	9.8	0.6	1.1	14.0	32.0	5.52	10.30	0.54	0.050	7.64	1.38	0.020	8.72	0.06	0.16	0.31	9.3	16.35	0.02	1778	66.2	15.2
Cherry Creek	4	8.5	0.8	4.1	9.0	31.0	6.16	9.16	0.67	0.050	19.14	3.11	0.020	7.06	0.08	0.40	0.73	6.0	44.24	0.06	1317	49.0	11.2
Cherry Creek	5	7.3	0.5	2.7	16.0	18.0	3.4	7.71	0.44	0.050	6.47	1.90	0.020	6.40	0.05	0.13	0.43	10.7	12.11	0.02	2262	84.2	19.3

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Coak Creek	1	3.2	0.4	1.1	58.0	23.0	1.12	3.53	0.32	0.050	1.09	0.98	0.020	2.48	0.04	0.02	0.24	38.7	0.67	0.01	3539	131.7	30.2
Coak Creek	2	2.8	0.3	1.8	69.0	27.0	0.75	3.05	0.25	0.050	0.79	1.05	0.020	2.26	0.03	0.02	0.25	46.0	0.45	0.01	4906	182.6	41.8
Coak Creek	3	1.8	0.3	8.0	12.0	13.0	0.45	2.05	0.22	0.050	0.93	2.06	0.020	1.26	0.03	0.02	0.52	8.0	23.14	0.01	3665	136.4	31.2
Bay Creek	1	3.4	0.4	0.6	85.0	9.0	1.2	3.73	0.32	0.050	0.87	0.73	0.020	2.68	0.04	0.02	0.17	56.7	0.28	0.01	3729	138.7	31.8
Bay Creek	2	3.3	0.4	1.7	65.0	17.0	1.16	3.63	0.32	0.050	1.41	1.22	0.020	2.58	0.04	0.03	0.29	43.3	0.52	0.01	3695	137.5	31.5
Bay Creek	3	2.6	0.4	1.7	83.0	13.0	0.88	2.93	0.30	0.050	1.03	1.17	0.020	1.88	0.04	0.02	0.29	55.3	0.30	0.01	3910	145.5	33.3
Giles Creek	1	9.0	1.0	3.4	29.0	34.0	8	9.83	0.81	0.050	25.72	3.21	0.020	7.19	0.10	0.53	0.77	19.3	3.17	0.07	1357	50.5	11.6
Giles Creek	2	4.8	1.0	2.8	43.0	42.0	3.8	5.63	0.68	0.050	9.79	2.58	0.020	2.99	0.10	0.19	0.68	28.7	1.31	0.06	1487	55.3	12.7
Giles Creek	3	2.6	0.7	6.4	19.0	20.0	1.33	3.18	0.42	0.050	3.76	2.83	0.020	1.34	0.07	0.07	0.79	12.7	8.22	0.05	1849	68.8	15.8
Giles Creek Trib B	1	3.0	1.5	7.1	19.0	29.0	2.25	4.24	0.53	0.050	7.86	3.49	0.020	0.29	0.15	0.02	1.17	12.7	8.22	0.09	1697	63.1	14.5
Giles Creek Trib A	1	3.0	0.5	11.5	31.0	34.0	1.25	3.41	0.37	0.050	4.34	3.47	0.020	2.10	0.05	0.09	0.88	20.7	2.73	0.04	2814	104.7	24.0
Hudson Creek	1	6.7	0.5	1.6	35.0	19.0	3.1	7.11	0.44	0.050	4.51	1.45	0.020	5.80	0.05	0.09	0.33	23.3	2.08	0.02	2607	97.0	22.2
Wimer Creek	1	4.0	0.3	0.6	59.0	16.0	1.11	4.25	0.26	0.050	0.70	0.63	0.020	3.46	0.03	0.01	0.15	39.3	0.64	0.00	4500	167.5	38.4
Wimer Creek	2	3.8	0.2	0.7	98.0	2.0	0.72	3.97	0.18	0.050	0.39	0.54	0.020	3.44	0.02	0.01	0.12	65.3	0.20	0.00	7363	274.0	62.8
Steele Creek	1	2.4	0.3	1.6	94.0	4.0	0.63	2.65	0.24	0.050	0.61	0.97	0.020	1.86	0.03	0.01	0.24	62.7	0.22	0.01	5222	194.3	44.5
Steele Creek	2	2.7	0.4	0.8	99.0	1.0	0.92	3.03	0.30	0.050	0.74	0.81	0.020	1.98	0.04	0.02	0.20	66.0	0.20	0.01	3919	145.8	33.4
Steele Creek	3	2.2	0.4	2.0	92.0	8.0	0.72	2.53	0.28	0.050	0.88	1.22	0.020	1.48	0.04	0.02	0.31	61.3	0.24	0.01	4045	150.5	34.5
Steele Creek	4	6.1	0.5	0.4	25.0	32.0	2.8	6.51	0.43	0.050	2.02	0.72	0.020	5.20	0.05	0.04	0.17	16.7	4.43	0.01	2284	85.0	19.5
Steele Creek	5	6.8	0.6	0.5	39.0	41.0	3.72	7.30	0.51	0.050	3.36	0.90	0.020	5.72	0.06	0.07	0.21	26.0	1.63	0.01	2136	79.5	18.2
Woodward Creek	1	3.9	0.4	2.1	33.0	49.0	1.4	4.23	0.33	0.050	1.94	1.39	0.020	3.18	0.04	0.04	0.33	22.0	2.37	0.01	3226	120.0	27.5
Woodward Creek	2	1.3	0.2	1.2	45.0	43.0	0.22	1.47	0.15	0.050	0.14	0.62	0.020	0.94	0.02	0.00	0.15	30.0	1.18	0.00	6492	241.6	55.3
Woodward Creek	3	1.3	0.2	1.2	43.0	40.0	0.22	1.47	0.15	0.050	0.14	0.62	0.020	0.94	0.02	0.00	0.15	28.7	1.31	0.00	6430	239.3	54.8
Blair Creek	1	2.0	0.2	1.2	56.0	39.0	0.36	2.17	0.17	0.050	0.24	0.66	0.020	1.64	0.02	0.00	0.16	37.3	0.72	0.00	6743	250.9	57.5
Blair Creek	2	3.3	0.5	0.8	93.0	6.0	1.4	3.71	0.38	0.050	1.31	0.93	0.020	2.40	0.05	0.03	0.23	62.0	0.23	0.01	3137	116.7	26.7
Blair Creek	3	13.9	0.8	0.5	18.0	17.0	10.48	14.56	0.72	0.050	11.90	1.14	0.020	12.46	0.08	0.25	0.26	12.0	9.29	0.02	1380	51.4	11.8
Steele Creek Tributary A	1	13.3	0.7	1.9	19.0	28.0	8.82	13.88	0.64	0.050	17.97	2.04	0.020	12.04	0.07	0.37	0.46	12.7	8.22	0.03	1679	62.5	14.3
North Fork Coquille River	3	8.5	0.6	5.9	16.0	21.0	4.74	9.00	0.53	0.050	15.02	3.17	0.020	7.42	0.06	0.31	0.72	10.7	12.11	0.04	1974	73.5	16.8
Middle Creek (X)	1	12.8	1.0	0.2	38.0	22.0	11.8	13.63	0.87	0.050	9.59	0.81	0.020	10.99	0.10	0.20	0.19	25.3	1.73	0.02	1259	46.9	10.7
Middle Creek (X)	2	17.2	1.0	0.4	16.0	30.0	16.2	18.03	0.90	0.050	19.08	1.18	0.020	15.39	0.10	0.40	0.27	10.7	12.11	0.03	1081	40.2	9.2
Middle Creek (X)	3	17.6	0.9	1.0	18.0	21.0	15.03	18.35	0.82	0.050	26.32	1.75	0.020	15.98	0.09	0.55	0.39	12.0	9.29	0.03	1274	47.4	10.9
Middle Creek (X)	4	15.6	0.7	0.6	21.0	22.0	10.43	16.18	0.64	0.050	12.06	1.16	0.020	14.34	0.07	0.25	0.26	14.0	6.56	0.02	1627	60.6	13.9
Middle Creek (X)	5	13.6	0.8	0.9	20.0	18.0	10.24	14.26	0.72	0.050	15.58	1.52	0.020	12.16	0.08	0.32	0.34	13.3	7.32	0.03	1449	53.9	12.4
Middle Creek (Z)	7	3.5	0.3	7.8	8.0	55.0	0.96	3.75	0.26	0.050	2.16	2.25	0.020	2.96	0.03	0.04	0.52	5.3	57.68	0.02	3321	123.6	28.3
Middle Creek (Y)	6	8.5	0.5	1.2	24.0	28.0	4	8.91	0.45	0.050	5.14	1.28	0.020	7.60	0.05	0.11	0.29	16.0	4.86	0.01	2372	88.3	20.2

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

Subbasin Fifth Field Watershed Stream Name	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Johns Creek	1	3.2	0.3	2.0	29.0	54.0	0.87	3.45	0.25	0.050	0.98	1.13	0.020	2.66	0.03	0.02	0.26	19.3	3.17	0.01	4100	152.6	34.9
Johns Creek	2	4.3	0.3	3.9	22.0	38.0	1.2	4.55	0.26	0.050	1.95	1.62	0.020	3.76	0.03	0.04	0.37	14.7	5.91	0.01	3975	147.9	33.9
Johns Creek	3	2.6	0.3	6.2	13.0	29.0	0.69	2.85	0.24	0.050	1.34	1.94	0.020	2.06	0.03	0.03	0.46	8.7	19.33	0.01	3654	136.0	31.2
Coquille Sub-basin (HUC 17100305), East Fork Coquille River (HUC 1710030503) Fifth Field Watershed																							
Knapper Creek	1	5.2	0.3	3.4	71.0	18.0	1.47	5.45	0.27	0.050	2.26	1.54	0.020	4.66	0.03	0.05	0.34	47.33	0.42	0.01	5113	190.3	43.6
Knapper Creek	2	2.9	0.2	15.2	35.0	14.0	0.54	3.07	0.18	0.050	1.32	2.45	0.020	2.54	0.02	0.03	0.55	23.33	2.08	0.01	6907	257.0	58.9
Lost Creek	1	10.5	1.1	3.5	23.0	18.0	10.34	11.41	0.91	0.050	36.23	3.50	0.020	8.51	0.11	0.73	0.82	15.33	5.35	0.09	1197	44.6	10.2
Lost Creek	2	9.0	0.6	1.3	18.0	15.0	5.04	9.50	0.53	0.050	7.53	1.49	0.020	7.92	0.06	0.15	0.34	12.00	9.29	0.02	1914	71.2	16.3
Dead Horse Creek	1	7.1	0.4	6.3	37.0	25.0	2.68	7.43	0.36	0.050	6.82	2.54	0.020	6.38	0.04	0.14	0.57	24.67	1.83	0.02	3496	130.1	29.8
Dead Horse Creek	2	4.4	0.5	22.6	18.0	21.0	1.95	4.81	0.41	0.050	10.15	5.21	0.020	3.50	0.05	0.20	1.23	12.00	9.29	0.06	2598	96.7	22.1
Dead Horse Creek	3	2.8	0.4	4.7	50.0	37.0	0.96	3.13	0.31	0.050	1.89	1.97	0.020	2.08	0.04	0.04	0.48	33.33	0.93	0.02	3718	138.4	31.7
Sf Camas Creek, Tributary A	1	5.0	0.4	5.6	5.0	18.0	1.84	5.33	0.35	0.050	4.28	2.33	0.020	4.28	0.04	0.09	0.53	3.33	166.22	0.02	2288	85.1	19.5
South Fork Camas Creek	1	6.0	0.5	6.9	10.0	15.0	2.75	6.41	0.43	0.050	8.21	2.99	0.020	5.10	0.05	0.17	0.69	6.67	34.89	0.03	2168	80.7	18.5
Camas Creek	1	13.6	0.6	1.7	8.0	14.0	7.8	14.10	0.55	0.050	13.71	1.76	0.020	12.52	0.06	0.28	0.39	5.33	57.68	0.02	1629	60.6	13.9
Camas Creek	2	12.7	0.6	3.1	5.0	10.0	7.26	13.20	0.55	0.050	17.16	2.36	0.020	11.62	0.06	0.35	0.52	3.33	166.22	0.03	1516	56.4	12.9
Camas Creek	3	10.9	0.6	1.9	4.0	22.0	6.18	11.40	0.54	0.050	11.33	1.83	0.020	9.82	0.06	0.23	0.41	2.67	274.75	0.02	1417	52.7	12.1
Camas Creek	4	6.1	0.5	4.5	6.0	52.0	2.8	6.51	0.43	0.050	6.77	2.42	0.020	5.20	0.05	0.14	0.55	4.00	110.25	0.03	1909	71.1	16.3
Middle Fork Brummit Creek	1	7.8	0.3	7.0	4.0	13.0	2.25	8.05	0.28	0.050	5.09	2.26	0.020	7.26	0.03	0.10	0.49	2.67	274.75	0.01	2877	107.1	24.5
Middle Fork Brummit Creek	2	7.1	0.3	9.1	8.0	24.0	2.04	7.35	0.28	0.050	5.24	2.57	0.020	6.56	0.03	0.11	0.56	5.33	57.68	0.02	3370	125.4	28.7
Middle Fork Brummit Creek	3	5.2	0.4	5.1	8.0	27.0	1.92	5.53	0.35	0.050	4.28	2.23	0.020	4.48	0.04	0.09	0.51	5.33	57.68	0.02	2515	93.6	21.4
Middle Fork Brummit Creek	4	4.3	0.3	12.8	35.0	26.0	1.2	4.55	0.26	0.050	3.53	2.94	0.020	3.76	0.03	0.07	0.67	23.33	2.08	0.02	4682	174.2	39.9
Camas Creek Sec13 Tributary	1	5.7	0.4	12.1	30.0	26.0	2.12	6.03	0.35	0.050	7.35	3.46	0.020	4.98	0.04	0.15	0.78	20.00	2.94	0.03	3450	128.4	29.4
East Fork Brummit Creek	1	16.2	0.5	4.1	16.0	15.0	7.85	16.61	0.47	0.050	19.28	2.46	0.020	15.30	0.05	0.39	0.53	10.67	12.11	0.03	2325	86.5	19.8
East Fork Brummit Creek	2	13.2	0.5	4.8	14.0	17.0	6.35	13.61	0.47	0.050	16.73	2.64	0.020	12.30	0.05	0.34	0.58	9.33	16.35	0.03	2278	84.8	19.4
East Fork Brummit Creek	3	8.3	0.5	3.5	25.0	19.0	3.9	8.71	0.45	0.050	8.54	2.19	0.020	7.40	0.05	0.17	0.49	16.67	4.43	0.02	2543	94.6	21.7
East Fork Brummit Creek	4	10.5	0.4	2.4	20.0	40.0	4.04	10.83	0.37	0.050	6.49	1.61	0.020	9.78	0.04	0.13	0.35	13.33	7.32	0.01	2936	109.2	25.0
East Fork Brummit Creek	5	10.4	0.7	1.9	16.0	14.0	6.79	10.98	0.62	0.050	13.59	2.00	0.020	9.13	0.07	0.28	0.45	10.67	12.11	0.03	1643	61.1	14.0
East Fork Brummit Creek	6	6.4	0.4	5.0	47.0	25.0	2.4	6.73	0.36	0.050	5.40	2.25	0.020	5.68	0.04	0.11	0.50	31.33	1.07	0.02	3641	135.5	31.0
West Fork Brummit Creek	1	10.8	0.9	0.7	82.0	15.0	8.91	11.55	0.77	0.050	12.54	1.41	0.020	9.17	0.09	0.25	0.32	54.67	0.31	0.03	1753	65.2	14.9
West Fork Brummit Creek	2	10.7	0.9	3.2	28.0	16.0	8.82	11.45	0.77	0.050	26.52	3.01	0.020	9.07	0.09	0.54	0.69	18.67	3.43	0.06	1497	55.7	12.8
West Fork Brummit Creek	3	13.9	0.7	5.3	31.0	18.0	9.24	14.48	0.64	0.050	31.53	3.41	0.020	12.63	0.07	0.64	0.76	20.67	2.73	0.05	1974	73.5	16.8
West Fork Brummit Creek	4	13.6	0.7	5.9	29.0	14.0	9.03	14.18	0.64	0.050	32.47	3.60	0.020	12.33	0.07	0.66	0.80	19.33	3.17	0.05	1956	72.8	16.7
West Fork Brummit Creek	5	12.7	0.6	4.8	29.0	29.0	7.26	13.20	0.55	0.050	21.36	2.94	0.020	11.62	0.06	0.43	0.65	19.33	3.17	0.04	2239	83.3	19.1
West Fork Brummit Creek	6	11.8	0.8	2.3	32.0	43.0	8.8	12.46	0.71	0.050	21.17	2.41	0.020	10.35	0.08	0.43	0.54	21.33	2.54	0.04	1691	62.9	14.4
West Fork Brummit Creek	7	5.3	0.7	3.4	31.0	45.0	3.22	5.88	0.55	0.050	7.95	2.47	0.020	4.03	0.07	0.16	0.60	20.67	2.73	0.04	1955	72.7	16.7

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

Subbasin Fifth Field Watershed Stream Name	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area ($meter^2$)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q ($meter^3$ per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, $meter^3$)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
West Fork Brummit Creek	8	4.4	0.3	16.3	52.0	28.0	1.23	4.65	0.26	0.050	4.09	3.33	0.020	3.86	0.03	0.08	0.75	34.67	0.85	0.02	5144	191.4	43.8
West Fork Brummit Creek	9	2.8	0.3	3.3	69.0	23.0	0.75	3.05	0.25	0.050	1.07	1.43	0.020	2.26	0.03	0.02	0.34	46.00	0.45	0.01	5105	190.0	43.5
Karl Creek	2	9.4	0.5	2.1	18.0	20.0	4.45	9.81	0.45	0.050	7.61	1.71	0.020	8.50	0.05	0.15	0.38	12.00	9.29	0.02	2318	86.2	19.8
Karl Creek	3	6.2	0.4	4.9	44.0	31.0	2.32	6.53	0.36	0.050	5.15	2.22	0.020	5.48	0.04	0.10	0.50	29.33	1.24	0.02	3589	133.5	30.6
Karl Creek	4	11.4	0.5	0.7	55.0	39.0	5.45	11.81	0.46	0.050	5.44	1.00	0.020	10.50	0.05	0.11	0.22	36.67	0.75	0.01	2788	103.7	23.8
Karl Creek	5	4.3	0.3	9.5	17.0	20.0	1.2	4.55	0.26	0.050	3.04	2.54	0.020	3.76	0.03	0.06	0.57	11.33	10.56	0.02	3969	147.7	33.8
Karl Creek	1	9.8	0.6	3.2	20.0	25.0	5.52	10.30	0.54	0.050	13.03	2.36	0.020	8.72	0.06	0.26	0.53	13.33	7.32	0.03	2036	75.8	17.4
China Creek Tributary A	1	3.8	0.5	12.2	6.0	13.0	1.65	4.21	0.39	0.050	6.17	3.74	0.020	2.90	0.05	0.12	0.90	4.00	110.25	0.04	2010	74.8	17.1
China Creek	1	7.1	0.5	6.5	7.0	16.0	3.3	7.51	0.44	0.050	9.72	2.95	0.020	6.20	0.05	0.20	0.67	4.67	77.91	0.03	2003	74.5	17.1
China Creek	2	5.6	0.4	7.3	6.0	11.0	2.08	5.93	0.35	0.050	5.59	2.69	0.020	4.88	0.04	0.11	0.61	4.00	110.25	0.02	2404	89.5	20.5
Bills Creek	1	3.9	0.4	14.2	15.0	15.0	1.4	4.23	0.33	0.050	5.05	3.61	0.020	3.18	0.04	0.10	0.85	10.00	14.00	0.03	3015	112.2	25.7
Steel Creek	1	10.2	0.4	1.6	9.0	25.0	3.92	10.53	0.37	0.050	5.13	1.31	0.020	9.48	0.04	0.10	0.29	6.00	44.24	0.01	2437	90.7	20.8
Steel Creek	2	8.3	0.6	2.1	13.0	23.0	4.62	8.80	0.53	0.050	8.72	1.89	0.020	7.22	0.06	0.18	0.43	8.67	19.33	0.02	1827	68.0	15.6
Steel Creek	3	6.4	0.4	8.3	6.0	16.0	2.4	6.73	0.36	0.050	6.95	2.90	0.020	5.68	0.04	0.14	0.65	4.00	110.25	0.02	2415	89.9	20.6
South Fk Elk Creek Tributary #2	1	5.6	0.5	2.7	7.0	54.0	2.55	6.01	0.42	0.050	4.73	1.85	0.020	4.70	0.05	0.10	0.43	4.67	77.91	0.02	1929	71.8	16.4
South Fk Elk Creek Tributary #2	2	3.0	0.6	7.4	16.0	69.0	1.44	3.50	0.41	0.050	4.34	3.01	0.020	1.92	0.06	0.08	0.78	10.67	12.11	0.04	2061	76.7	17.6
South Fork Elk Creek	1	10.3	0.4	1.2	26.0	34.0	3.96	10.63	0.37	0.050	4.49	1.13	0.020	9.58	0.04	0.09	0.25	17.33	4.06	0.01	3007	111.9	25.6
South Fork Elk Creek	2	7.4	0.3	1.8	14.0	37.0	2.13	7.65	0.28	0.050	2.44	1.14	0.020	6.86	0.03	0.05	0.25	9.33	16.35	0.01	3524	131.1	30.0
South Fork Elk Creek	3	6.7	0.4	1.7	24.0	27.0	2.52	7.03	0.36	0.050	3.32	1.32	0.020	5.98	0.04	0.07	0.29	16.00	4.86	0.01	3010	112.0	25.7
South Fork Elk Creek	4	4.3	0.4	10.2	9.0	17.0	1.56	4.63	0.34	0.050	4.82	3.09	0.020	3.58	0.04	0.10	0.72	6.00	44.24	0.03	2665	99.2	22.7
Elk Creek Sec33 Tributary	1	3.8	0.4	11.5	8.0	41.0	1.36	4.13	0.33	0.050	4.40	3.23	0.020	3.08	0.04	0.09	0.76	5.33	57.68	0.03	2618	97.4	22.3
Elk Creek	1	9.4	0.6	0.5	34.0	52.0	5.28	9.90	0.53	0.050	4.91	0.93	0.020	8.32	0.06	0.10	0.21	22.67	2.22	0.01	2095	78.0	17.9
Elk Creek	2	10.6	0.5	0.9	16.0	21.0	5.05	11.01	0.46	0.050	5.70	1.13	0.020	9.70	0.05	0.12	0.25	10.67	12.11	0.01	2175	80.9	18.5
Elk Creek	3	5.3	0.6	2.0	26.0	17.0	2.82	5.80	0.49	0.050	4.93	1.75	0.020	4.22	0.06	0.10	0.41	17.33	4.06	0.02	2120	78.9	18.1
Elk Creek	4	4.3	0.5	2.4	41.0	27.0	1.9	4.71	0.40	0.050	3.21	1.69	0.020	3.40	0.05	0.06	0.40	27.33	1.45	0.02	2794	104.0	23.8
Elk Creek	5	3.3	0.4	13.1	15.0	14.0	1.16	3.63	0.32	0.050	3.92	3.38	0.020	2.58	0.04	0.08	0.81	10.00	14.00	0.03	3012	112.1	25.7
Yankee Run	1	6.9	0.9	1.6	37.0	42.0	5.4	7.65	0.71	0.050	10.83	2.01	0.020	5.27	0.09	0.22	0.48	24.67	1.83	0.04	1548	57.6	13.2
Yankee Run	2	7.5	0.9	1.4	41.0	51.0	5.94	8.25	0.72	0.050	11.30	1.90	0.020	5.87	0.09	0.23	0.45	27.33	1.45	0.04	1570	58.4	13.4
Yankee Run	3	3.2	0.4	1.7	43.0	45.0	1.12	3.53	0.32	0.050	1.36	1.21	0.020	2.48	0.04	0.03	0.29	28.67	1.31	0.01	3431	127.7	29.2
Yankee Run, Tributary 1	1	4.2	0.4	1.3	37.0	46.0	1.52	4.53	0.34	0.050	1.67	1.10	0.020	3.48	0.04	0.03	0.26	24.67	1.83	0.01	3271	121.7	27.9
Weekly Creek Tributary B	1	2.4	0.3	6.9	32.0	13.0	0.63	2.65	0.24	0.050	1.27	2.02	0.020	1.86	0.03	0.03	0.48	21.33	2.54	0.01	4501	167.5	38.4
Weekly Creek	1	4.4	0.3	1.0	65.0	31.0	1.23	4.65	0.26	0.050	1.01	0.82	0.020	3.86	0.03	0.02	0.19	43.33	0.52	0.01	4755	176.9	40.5
Weekly Creek	2	6.7	0.4	2.8	34.0	33.0	2.52	7.03	0.36	0.050	4.26	1.69	0.020	5.98	0.04	0.09	0.38	22.67	2.22	0.01	3313	123.3	28.2
Weekly Creek	3	5.8	0.4	2.5	32.0	26.0	2.16	6.13	0.35	0.050	3.41	1.58	0.020	5.08	0.04	0.07	0.36	21.33	2.54	0.01	3257	121.2	27.8

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area ($meter^2$)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q ($meter^3$ per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, $meter^3$)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Weekly Creek	4	5.4	0.4	2.1	28.0	17.0	2	5.73	0.35	0.050	2.87	1.44	0.020	4.68	0.04	0.06	0.33	18.67	3.43	0.01	3144	117.0	26.8
Weekly Creek	5	4.0	1.5	7.0	23.0	16.0	3.75	5.24	0.72	0.050	15.87	4.23	0.020	1.29	0.14	0.21	1.27	15.33	5.35	0.16	1015	37.8	8.6
Weekly Creek	6	3.8	0.3	9.2	21.0	20.0	1.05	4.05	0.26	0.050	2.59	2.47	0.020	3.26	0.03	0.05	0.56	14.00	6.56	0.02	4147	154.3	35.4
Hantz Creek	1	3.8	0.5	2.4	17.0	30.0	1.65	4.21	0.39	0.050	2.74	1.66	0.020	2.90	0.05	0.05	0.40	11.33	10.56	0.02	2326	86.6	19.8
Hantz Creek	2	3.7	0.4	3.1	28.0	59.0	1.32	4.03	0.33	0.050	2.21	1.67	0.020	2.98	0.04	0.04	0.39	18.67	3.43	0.01	3213	119.6	27.4
Hantz Creek	3	2.9	0.5	11.7	15.0	20.0	1.2	3.31	0.36	0.050	4.17	3.48	0.020	2.00	0.05	0.08	0.88	10.00	14.00	0.04	2450	91.2	20.9
Weekly Creek Sec31 Tributary	1	2.7	0.4	3.9	17.0	56.0	0.92	3.03	0.30	0.050	1.64	1.78	0.020	1.98	0.04	0.03	0.44	11.33	10.56	0.02	2940	109.4	25.1
Weekly Creek Sec31 Tributary	2	3.2	0.4	2.0	15.0	54.0	1.12	3.53	0.32	0.050	1.47	1.32	0.020	2.48	0.04	0.03	0.32	10.00	14.00	0.01	2769	103.0	23.6
Weekly Creek Sec31 Tributary	3	1.7	0.2	7.6	9.0	50.0	0.3	1.87	0.16	0.050	0.49	1.63	0.020	1.34	0.02	0.01	0.39	6.00	44.24	0.01	5061	188.3	43.1
Coquille Sub-basin (HUC 17100305), Middle Fork Coquille River (HUC 1710030501) Fifth Field Watershed																							
Upper Rock Creek Sec18 Trib.	1	6.7	0.4	6.6	18.0	43.0	2.52	7.03	0.36	0.050	6.53	2.59	0.020	5.98	0.04	0.13	0.58	12.00	9.29	0.02	3023	112.5	25.8
Upper Rock Creek Sec18 Trib.	2	6.3	0.5	3.5	19.0	45.0	2.9	6.71	0.43	0.050	6.20	2.14	0.020	5.40	0.05	0.12	0.49	12.67	8.22	0.02	2415	89.9	20.6
Upper Rock Creek Sec18 Trib.	3	2.5	0.3	9.0	25.0	48.0	0.66	2.75	0.24	0.050	1.53	2.32	0.020	1.96	0.03	0.03	0.55	16.67	4.43	0.02	4338	161.4	37.0
Slater Creek	1	7.4	0.6	2.8	9.0	30.0	4.08	7.90	0.52	0.050	8.79	2.15	0.020	6.31	0.06	0.18	0.49	6.00	44.24	0.03	1721	64.1	14.7
Slater Creek	2	6.4	0.5	0.2	36.0	60.0	2.95	6.81	0.43	0.050	1.51	0.51	0.020	5.50	0.05	0.03	0.12	24.00	1.95	0.01	2429	90.4	20.7
Slater Creek	3	7.2	0.4	3.1	7.0	25.0	2.72	7.53	0.36	0.050	4.86	1.79	0.020	6.48	0.04	0.10	0.40	4.67	77.91	0.02	2394	89.1	20.4
Slater Creek	4	6.5	0.4	5.5	5.0	18.0	2.44	6.83	0.36	0.050	5.76	2.36	0.020	5.78	0.04	0.12	0.53	3.33	166.22	0.02	2290	85.2	19.5
Slater Creek	5	5.3	0.4	10.1	6.0	29.0	1.96	5.63	0.35	0.050	6.16	3.14	0.020	4.58	0.04	0.12	0.71	4.00	110.25	0.03	2450	91.2	20.9
Upper Rock Creek Tributary 1	1	5.0	0.2	3.9	18.0	28.0	0.96	5.17	0.19	0.050	1.23	1.29	0.020	4.64	0.02	0.02	0.28	12.00	9.29	0.01	5653	210.4	48.2
Lake Creek	1	8.5	1.1	14.9	5.0	7.0	8.14	9.41	0.86	0.050	57.05	7.01	0.020	6.51	0.11	1.14	1.69	3.33	166.22	0.17	934	34.7	8.0
Lake Creek	2	16.0	1.2	4.0	22.0	45.0	17.76	16.99	1.05	0.050	73.16	4.12	0.020	13.83	0.11	1.47	0.93	14.67	5.91	0.11	1100	40.9	9.4
Little Rock Creek	1	5.3	0.7	12.5	14.0	21.0	3.22	5.88	0.55	0.050	15.24	4.73	0.020	4.03	0.07	0.30	1.14	9.33	16.35	0.08	1760	65.5	15.0
Sandy Creek Tributary B	1	4.8	0.3	10.2	6.0	19.0	1.35	5.05	0.27	0.050	3.58	2.65	0.020	4.26	0.03	0.07	0.59	4.00	110.25	0.02	3207	119.4	27.3
Sandy (R5) Creek	1	5.7	0.3	26.3	9.0	16.0	1.62	5.95	0.27	0.050	6.98	4.31	0.020	5.16	0.03	0.14	0.95	6.00	44.24	0.03	3641	135.5	31.0
Sandy Creek Tributary H	1	3.0	0.2	7.2	10.0	32.0	0.56	3.17	0.18	0.050	0.95	1.69	0.020	2.64	0.02	0.02	0.38	6.67	34.89	0.01	5150	191.6	43.9
Big Creek Tributary A	1	3.5	0.3	7.4	1.0	24.0	0.96	3.75	0.26	0.050	2.11	2.19	0.020	2.96	0.03	0.04	0.50	0.67	6235.03	0.01	2174	80.9	18.5
Slide Creek	1	7.1	0.4	2.8	43.0	36.0	2.68	7.43	0.36	0.050	4.54	1.70	0.020	6.38	0.04	0.09	0.38	28.67	1.31	0.01	3493	130.0	29.8
Slide Creek	2	5.2	0.4	3.1	33.0	16.0	1.92	5.53	0.35	0.050	3.34	1.74	0.020	4.48	0.04	0.07	0.40	22.00	2.37	0.01	3326	123.8	28.4
Slide Creek	3	3.0	0.3	8.6	19.0	28.0	0.81	3.25	0.25	0.050	1.88	2.32	0.020	2.46	0.03	0.04	0.54	12.67	8.22	0.02	4075	151.6	34.7
Swamp Creek Tributary A	1	3.0	0.3	4.3	40.0	17.0	0.81	3.25	0.25	0.050	1.33	1.64	0.020	2.46	0.03	0.03	0.38	26.67	1.54	0.01	4620	171.9	39.4
Slide Creek, Tributary A	1	3.1	0.3	13.3	15.0	23.0	0.84	3.35	0.25	0.050	2.44	2.90	0.020	2.56	0.03	0.05	0.67	10.00	14.00	0.02	3952	147.1	33.7
Slide Creek, Tributary D	1	3.6	0.4	8.3	14.0	31.0	1.28	3.93	0.33	0.050	3.49	2.73	0.020	2.88	0.04	0.07	0.64	9.33	16.35	0.02	2915	108.5	24.9
Slide Creek, Tributary E	2	2.7	0.4	10.9	24.0	29.0	0.92	3.03	0.30	0.050	2.74	2.98	0.020	1.98	0.04	0.05	0.73	16.00	4.86	0.03	3324	123.7	28.3
Frenchie Creek	1	4.3	0.4	6.6	12.0	37.0	1.56	4.63	0.34	0.050	3.88	2.49	0.020	3.58	0.04	0.08	0.58	8.00	23.14	0.02	2787	103.7	23.8

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Frenchie Creek	2	3.3	0.5	11.3	10.0	36.0	1.4	3.71	0.38	0.050	4.91	3.51	0.020	2.40	0.05	0.10	0.86	6.67	34.89	0.04	2246	83.6	19.1
Belieu Creek	1	4.2	0.4	4.7	22.0	55.0	1.52	4.53	0.34	0.050	3.18	2.09	0.020	3.48	0.04	0.06	0.49	14.67	5.91	0.02	3119	116.1	26.6
Belieu Creek	2	3.5	0.3	7.3	17.0	60.0	0.96	3.75	0.26	0.050	2.09	2.18	0.020	2.96	0.03	0.04	0.50	11.33	10.56	0.01	3944	146.8	33.6
Belieu Creek	3	2.2	0.3	5.7	22.0	66.0	0.57	2.45	0.23	0.050	1.03	1.81	0.020	1.66	0.03	0.02	0.44	14.67	5.91	0.01	4147	154.3	35.3
Brownson Creek Tributary A	1	3.2	0.4	2.0	45.0	26.0	1.12	3.53	0.32	0.050	1.47	1.32	0.020	2.48	0.04	0.03	0.32	30.00	1.18	0.01	3503	130.4	29.9
Rasler Creek	1	5.2	0.4	4.5	40.0	21.0	1.92	5.53	0.35	0.050	4.02	2.10	0.020	4.48	0.04	0.08	0.48	26.67	1.54	0.02	3523	131.1	30.0
Rasler Creek	2	4.2	0.5	10.6	13.0	12.0	1.85	4.61	0.40	0.050	6.55	3.54	0.020	3.30	0.05	0.13	0.84	8.67	19.33	0.04	2356	87.7	20.1
Myrtle Creek	1	18.6	0.7	0.5	22.0	36.0	12.53	19.18	0.65	0.050	13.34	1.06	0.020	17.33	0.07	0.27	0.23	14.67	5.91	0.02	1656	61.6	14.1
Myrtle Creek	2	11.6	0.5	0.8	38.0	38.0	5.55	12.01	0.46	0.050	5.93	1.07	0.020	10.70	0.05	0.12	0.23	25.33	1.73	0.01	2605	96.9	22.2
Myrtle Creek	3	11.8	0.6	0.7	20.0	41.0	6.72	12.30	0.55	0.050	7.52	1.12	0.020	10.71	0.06	0.15	0.25	13.33	7.32	0.01	1907	71.0	16.3
Myrtle Creek	4	10.6	0.5	8.5	19.0	22.0	5.05	11.01	0.46	0.050	17.51	3.47	0.020	9.70	0.05	0.35	0.76	12.67	8.22	0.04	2505	93.2	21.3
Myrtle Creek	5	9.5	0.6	0.4	55.0	40.0	5.34	10.00	0.53	0.050	4.45	0.83	0.020	8.41	0.06	0.09	0.19	36.67	0.75	0.01	2304	85.7	19.6
Myrtle Creek	6	7.7	0.6	6.7	33.0	30.0	4.26	8.20	0.52	0.050	14.26	3.35	0.020	6.61	0.06	0.29	0.76	22.00	2.37	0.04	2353	87.6	20.1
Cole Creek	1	9.6	0.5	1.3	30.0	50.0	4.55	10.01	0.45	0.050	6.13	1.35	0.020	8.70	0.05	0.12	0.30	20.00	2.94	0.01	2535	94.3	21.6
Cole Creek	2	6.2	0.6	6.7	15.0	39.0	3.36	6.70	0.50	0.050	10.98	3.27	0.020	5.11	0.06	0.22	0.76	10.00	14.00	0.04	1997	74.3	17.0
Snow Creek	1	9.4	0.6	4.6	10.0	30.0	5.28	9.90	0.53	0.050	14.90	2.82	0.020	8.31	0.06	0.30	0.63	6.67	34.89	0.04	1796	66.8	15.3
Lower Rock Creek	1	13.5	2.0	0.5	29.0	20.0	23	15.16	1.52	0.050	42.95	1.87	0.020	9.88	0.19	0.85	0.46	19.33	3.17	0.09	663	24.7	5.7
Lower Rock Creek	2	13.3	1.8	0.8	28.0	15.0	20.7	14.79	1.40	0.050	46.33	2.24	0.020	10.04	0.17	0.92	0.54	18.67	3.43	0.09	741	27.6	6.3
Lower Rock Creek	3	14.7	1.9	0.4	36.0	47.0	24.32	16.27	1.49	0.050	40.21	1.65	0.020	11.26	0.18	0.80	0.40	24.00	1.95	0.07	719	26.8	6.1
Lower Rock Creek	4	14.5	1.8	1.4	28.0	21.0	22.86	15.99	1.43	0.050	68.65	3.00	0.020	11.24	0.17	1.37	0.72	18.67	3.43	0.12	759	28.2	6.5
Lower Rock Creek	5	14.5	1.4	1.0	28.0	23.0	18.34	15.66	1.17	0.050	40.75	2.22	0.020	11.97	0.13	0.82	0.52	18.67	3.43	0.07	943	35.1	8.0
Lower Rock Creek	6	14.2	1.7	1.7	31.0	16.0	21.25	15.61	1.36	0.050	68.07	3.20	0.020	11.13	0.16	1.36	0.76	20.67	2.73	0.12	825	30.7	7.0
Lower Rock Creek	7	11.9	1.8	6.0	29.0	17.0	18.18	13.39	1.36	0.050	109.20	6.01	0.020	8.64	0.17	2.16	1.48	19.33	3.17	0.25	819	30.5	7.0
Lower Rock Creek	8	10.4	1.2	2.8	31.0	23.0	11.04	11.39	0.97	0.050	36.18	3.28	0.020	8.23	0.11	0.72	0.78	20.67	2.73	0.09	1169	43.5	10.0
Salmon Creek	1	4.6	0.5	1.2	21.0	49.0	2.05	5.01	0.41	0.050	2.47	1.21	0.020	3.70	0.05	0.05	0.28	14.00	6.56	0.01	2359	87.8	20.1
Salmon Creek	2	3.9	0.3	4.0	18.0	44.0	1.08	4.15	0.26	0.050	1.76	1.63	0.020	3.36	0.03	0.04	0.37	12.00	9.29	0.01	3881	144.4	33.1
Salmon Creek	3	2.6	0.3	12.6	15.0	41.0	0.69	2.85	0.24	0.050	1.90	2.76	0.020	2.06	0.03	0.04	0.65	10.00	14.00	0.02	3952	147.1	33.7
Smith Creek	1	3.8	0.6	3.8	30.0	49.0	1.92	4.30	0.45	0.050	4.37	2.28	0.020	2.71	0.06	0.09	0.57	20.00	2.94	0.03	2273	84.6	19.4
Smith Creek	2	3.0	0.5	8.7	11.0	33.0	1.25	3.41	0.37	0.050	3.77	3.02	0.020	2.10	0.05	0.07	0.76	7.33	28.15	0.04	2271	84.5	19.4
King Creek	1	4.3	0.4	3.1	27.0	48.0	1.56	4.63	0.34	0.050	2.66	1.70	0.020	3.58	0.04	0.05	0.39	18.00	3.73	0.01	3195	118.9	27.2
Mcmullen Creek	1	3.1	0.2	3.6	21.0	58.0	0.58	3.27	0.18	0.050	0.70	1.20	0.020	2.74	0.02	0.01	0.27	14.00	6.56	0.01	5834	217.1	49.7
Indian Creek	1	4.5	0.4	1.9	26.0	39.0	1.64	4.83	0.34	0.050	2.20	1.34	0.020	3.78	0.04	0.04	0.31	17.33	4.06	0.01	3099	115.3	26.4
Indian Creek	2	4.6	0.4	1.7	28.0	34.0	1.68	4.93	0.34	0.050	2.14	1.27	0.020	3.88	0.04	0.04	0.29	18.67	3.43	0.01	3131	116.5	26.7
Indian Creek	3	5.3	0.4	3.0	28.0	41.0	1.96	5.63	0.35	0.050	3.36	1.71	0.020	4.58	0.04	0.07	0.39	18.67	3.43	0.01	3208	119.4	27.3

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]							
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Indian Creek	4	5.1	0.4	3.2	35.0	22.0	1.88	5.43	0.35	0.050	3.32	1.76	0.020	4.38	0.04	0.07	0.40	23.33	2.08	0.02	3373	125.5	28.8
Shields Creek	1	6.8	0.7	4.8	6.0	22.0	4.27	7.38	0.58	0.050	12.99	3.04	0.020	5.53	0.07	0.26	0.71	4.00	110.25	0.05	1405	52.3	12.0
Shields Creek	2	6.1	0.7	13.3	9.0	22.0	3.78	6.68	0.57	0.050	18.86	4.99	0.020	4.83	0.07	0.38	1.18	6.00	44.24	0.08	1604	59.7	13.7
Fall Creek	1	3.4	0.3	2.2	21.0	22.0	0.93	3.65	0.25	0.050	1.11	1.19	0.020	2.86	0.03	0.02	0.27	14.00	6.56	0.01	3908	145.4	33.3
Fall Creek	2	4.2	0.3	8.8	22.0	33.0	1.17	4.45	0.26	0.050	2.85	2.44	0.020	3.66	0.03	0.06	0.55	14.67	5.91	0.02	4193	156.0	35.7
Fall Creek	3	3.0	0.3	1.9	51.0	20.0	0.81	3.25	0.25	0.050	0.88	1.09	0.020	2.46	0.03	0.02	0.25	34.00	0.89	0.01	4687	174.4	40.0
Brownson Creek	1	5.8	0.4	0.6	12.0	77.0	2.16	6.13	0.35	0.050	1.67	0.77	0.020	5.08	0.04	0.03	0.17	8.00	23.14	0.01	2495	92.8	21.3
Brownson Creek	2	3.6	0.4	1.6	21.0	68.0	1.28	3.93	0.33	0.050	1.53	1.20	0.020	2.88	0.04	0.03	0.28	14.00	6.56	0.01	2948	109.7	25.1
Brownson Creek	3	5.2	0.4	0.9	23.0	66.0	1.92	5.53	0.35	0.050	1.80	0.94	0.020	4.48	0.04	0.04	0.21	15.33	5.35	0.01	2916	108.5	24.9
Brownson Creek	4	3.5	0.3	2.4	4.0	55.0	0.96	3.75	0.26	0.050	1.20	1.25	0.020	2.96	0.03	0.02	0.29	2.67	274.75	0.01	2767	103.0	23.6
Axe Creek	1	4.2	0.4	3.7	12.0	62.0	1.52	4.53	0.34	0.050	2.82	1.86	0.020	3.48	0.04	0.06	0.43	8.00	23.14	0.02	2716	101.1	23.2
Bear Pen Creek	1	4.8	0.4	3.5	16.0	47.0	1.76	5.13	0.34	0.050	3.23	1.83	0.020	4.08	0.04	0.06	0.42	10.67	12.11	0.02	2874	107.0	24.5
Big Creek	1	10.5	0.6	0.5	22.0	48.0	5.94	11.00	0.54	0.050	5.57	0.94	0.020	9.41	0.06	0.11	0.21	14.67	5.91	0.01	1918	71.4	16.3
Big Creek	3	12.6	0.6	0.4	21.0	40.0	7.2	13.10	0.55	0.050	6.11	0.85	0.020	11.51	0.06	0.12	0.19	14.00	6.56	0.01	1878	69.9	16.0
Big Creek	4	12.3	0.6	0.4	21.0	43.0	7.02	12.80	0.55	0.050	5.95	0.85	0.020	11.21	0.06	0.12	0.19	14.00	6.56	0.01	1878	69.9	16.0
Big Creek	6	11.8	0.5	0.4	25.0	46.0	5.65	12.21	0.46	0.050	4.27	0.76	0.020	10.90	0.05	0.09	0.17	16.67	4.43	0.01	2311	86.0	19.7
Big Creek	7	10.8	0.6	0.6	14.0	51.0	6.12	11.30	0.54	0.050	6.30	1.03	0.020	9.71	0.06	0.13	0.23	9.33	16.35	0.01	1758	65.4	15.0
Big Creek	8	10.7	0.5	1.0	11.0	41.0	5.1	11.11	0.46	0.050	6.07	1.19	0.020	9.80	0.05	0.12	0.26	7.33	28.15	0.01	2027	75.4	17.3
Big Creek	9	9.7	0.5	2.5	10.0	24.0	4.6	10.11	0.45	0.050	8.60	1.87	0.020	8.80	0.05	0.17	0.41	6.67	34.89	0.02	2072	77.1	17.7
Big Creek	10	5.6	0.4	2.6	16.0	38.0	2.08	5.93	0.35	0.050	3.34	1.60	0.020	4.88	0.04	0.07	0.36	10.67	12.11	0.01	2832	105.4	24.1
Big Creek	11	4.0	0.3	6.2	2.0	28.0	1.11	4.25	0.26	0.050	2.26	2.04	0.020	3.46	0.03	0.05	0.46	1.33	1308.85	0.01	2492	92.7	21.2
Swamp Creek	1	6.7	0.4	1.6	28.0	20.0	2.52	7.03	0.36	0.050	3.22	1.28	0.020	5.98	0.04	0.06	0.28	18.67	3.43	0.01	3113	115.8	26.5
Swamp Creek	2	6.5	0.6	0.8	74.0	22.0	3.54	7.00	0.51	0.050	4.02	1.14	0.020	5.41	0.06	0.08	0.26	49.33	0.38	0.01	2539	94.5	21.6
Swamp Creek	3	5.0	0.4	2.7	56.0	21.0	1.84	5.33	0.35	0.050	2.98	1.62	0.020	4.28	0.04	0.06	0.37	37.33	0.72	0.01	3696	137.6	31.5
Sandy Creek Tributary A	1	6.2	0.5	7.6	23.0	19.0	2.85	6.61	0.43	0.050	8.96	3.15	0.020	5.30	0.05	0.18	0.72	15.33	5.35	0.03	2604	96.9	22.2
Sandy Creek Tributary E	1	2.5	0.4	5.0	16.0	69.0	0.84	2.83	0.30	0.050	1.67	1.99	0.020	1.78	0.04	0.03	0.49	10.67	12.11	0.02	2953	109.9	25.2
Sandy Creek Tributary E	2	2.6	0.4	9.3	27.0	43.0	0.88	2.93	0.30	0.050	2.41	2.73	0.020	1.88	0.04	0.05	0.68	18.00	3.73	0.03	3387	126.0	28.9
Sandy Creek	1	10.0	0.9	0.4	26.0	69.0	8.19	10.75	0.76	0.050	8.64	1.06	0.020	8.37	0.09	0.17	0.24	17.33	4.06	0.02	1348	50.2	11.5
Sandy Creek	3	11.6	0.7	0.7	12.0	43.0	7.63	12.18	0.63	0.050	9.35	1.23	0.020	10.33	0.07	0.19	0.27	8.00	23.14	0.02	1483	55.2	12.6
Sandy Creek	4	11.0	0.7	1.5	12.0	34.0	7.21	11.58	0.62	0.050	12.88	1.79	0.020	9.73	0.07	0.26	0.40	8.00	23.14	0.03	1535	57.1	13.1
Sandy Creek	5	8.0	0.6	2.0	8.0	45.0	4.44	8.50	0.52	0.050	8.15	1.83	0.020	6.91	0.06	0.16	0.42	5.33	57.68	0.02	1653	61.5	14.1
Sandy Creek	6	7.1	0.6	7.3	8.0	33.0	3.9	7.60	0.51	0.050	13.51	3.46	0.020	6.01	0.06	0.27	0.79	5.33	57.68	0.05	1754	65.3	15.0
Sandy Creek	7	4.3	0.5	3.4	9.0	53.0	1.9	4.71	0.40	0.050	3.82	2.01	0.020	3.40	0.05	0.08	0.48	6.00	44.24	0.02	2071	77.0	17.6
Sandy Creek	8	5.0	0.5	8.7	6.0	66.0	2.25	5.41	0.42	0.050	7.39	3.29	0.020	4.10	0.05	0.15	0.77	4.00	110.25	0.04	1979	73.6	16.9

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

Subbasin Fifth Field Watershed Stream Name	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area ($meter^2$)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q ($meter^3$ per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, $meter^3$)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Upper Rock Creek	1	17.3	0.7	0.7	28.0	3.0	11.62	17.88	0.65	0.050	14.59	1.26	0.020	16.03	0.07	0.29	0.27	18.67	3.43	0.02	1769	65.8	15.1
Upper Rock Creek	2	15.9	0.7	3.5	32.0	5.0	10.64	16.48	0.65	0.050	29.74	2.80	0.020	14.63	0.07	0.60	0.61	21.33	2.54	0.04	1957	72.8	16.7
Upper Rock Creek	3	18.7	0.7	8.0	27.0	7.0	12.6	19.28	0.65	0.050	53.68	4.26	0.020	17.43	0.07	1.08	0.93	18.00	3.73	0.06	1958	72.9	16.7
Upper Rock Creek	4	13.6	0.7	1.3	45.0	13.0	9.03	14.18	0.64	0.050	15.24	1.69	0.020	12.33	0.07	0.31	0.37	30.00	1.18	0.02	2012	74.9	17.2
Upper Rock Creek	5	10.6	0.8	5.3	22.0	19.0	7.84	11.26	0.70	0.050	28.35	3.62	0.020	9.15	0.08	0.57	0.82	14.67	5.91	0.06	1631	60.7	13.9
Upper Rock Creek	6	6.3	1.0	1.0	56.0	42.0	5.3	7.13	0.74	0.050	8.70	1.64	0.020	4.49	0.10	0.17	0.41	37.33	0.72	0.04	1511	56.2	12.9
Upper Rock Creek	7	3.0	0.4	2.2	47.0	46.0	1.04	3.33	0.31	0.050	1.42	1.37	0.020	2.28	0.04	0.03	0.33	31.33	1.07	0.01	3555	132.3	30.3
South Umpqua (HUC 17100302) Sub-basin, Olalla Creek-Lookingglass Creek (HUC 1710030212) Fifth Field Watershed																							
Bear Creek (Berry)	1	5.1	0.4	1.3	14.0	45.0	1.88	5.43	0.35	0.050	2.11	1.12	0.028	4.39	0.05	0.06	0.29	9.33	16.35	0.01	2213	82.3	18.9
Bear Creek (Berry)	2	4.9	0.4	1.3	12.0	52.0	1.8	5.23	0.34	0.050	2.02	1.12	0.028	4.19	0.05	0.06	0.29	8.00	23.14	0.01	2143	79.8	18.3
Bear Creek (Berry)	3	3.9	0.6	2.0	9.0	43.0	1.98	4.40	0.45	0.050	3.29	1.66	0.028	2.84	0.07	0.09	0.47	6.00	44.24	0.03	1422	52.9	12.1
Bear Creek (Berry)	4	3.3	0.4	5.2	10.0	38.0	1.16	3.63	0.32	0.050	2.47	2.13	0.028	2.59	0.05	0.07	0.58	6.67	34.89	0.03	2209	82.2	18.8
Berry Creek	1	11.6	0.2	1.4	11.0	34.0	2.28	11.77	0.19	0.050	1.81	0.79	0.028	11.25	0.02	0.05	0.19	7.33	28.15	0.00	4018	149.5	34.2
Berry Creek	3	8.0	1.1	1.1	19.0	42.0	7.59	8.91	0.85	0.050	14.31	1.88	0.028	6.06	0.13	0.40	0.52	12.67	8.22	0.07	914	34.0	7.8
Berry Creek	4	6.7	0.5	2.3	23.0	37.0	3.1	7.11	0.44	0.050	5.40	1.74	0.028	5.82	0.06	0.15	0.45	15.33	5.35	0.03	2043	76.0	17.4
Berry Creek	5	3.9	0.4	8.9	41.0	32.0	1.4	4.23	0.33	0.050	4.00	2.85	0.028	3.19	0.05	0.11	0.76	27.33	1.45	0.04	3036	113.0	25.9
Byron Creek	1	6.6	0.8	3.7	11.0	21.0	4.64	7.26	0.64	0.050	13.24	2.85	0.028	5.19	0.09	0.37	0.78	7.33	28.15	0.07	1157	43.1	9.9
Byron Creek	2	4.2	0.5	2.8	23.0	30.0	1.85	4.61	0.40	0.050	3.37	1.82	0.028	3.32	0.06	0.09	0.49	15.33	5.35	0.03	2075	77.2	17.7
Byron Creek	3	2.8	0.4	4.5	46.0	30.0	0.96	3.13	0.31	0.050	1.85	1.93	0.028	2.09	0.05	0.05	0.54	30.67	1.12	0.02	3038	113.1	25.9
Coarse Gold Creek	1	4.2	0.3	2.3	20.0	44.0	1.17	4.45	0.26	0.050	1.46	1.25	0.028	3.67	0.04	0.04	0.32	13.33	7.32	0.01	3204	119.2	27.3
Coarse Gold Creek	2	2.6	0.2	4.1	7.0	20.0	0.48	2.77	0.17	0.050	0.60	1.26	0.028	2.25	0.02	0.02	0.33	4.67	77.91	0.01	3863	143.8	32.9
Olalla Creek	1	15.3	0.6	1.2	6.0	12.0	8.82	15.80	0.56	0.050	13.10	1.49	0.028	14.24	0.07	0.37	0.37	4.00	110.25	0.03	1254	46.7	10.7
Olalla Creek	2	13.3	0.5	2.2	6.0	21.0	6.4	13.71	0.47	0.050	11.42	1.78	0.028	12.42	0.06	0.32	0.44	4.00	110.25	0.03	1529	56.9	13.0
Olalla Creek	3	10.7	0.5	7.9	5.0	21.0	5.1	11.11	0.46	0.050	17.06	3.34	0.028	9.82	0.06	0.48	0.84	3.33	166.22	0.05	1560	58.1	13.3
Olalla Creek	4	16.2	0.5	5.2	6.0	20.0	7.85	16.61	0.47	0.050	21.72	2.77	0.028	15.32	0.06	0.61	0.68	4.00	110.25	0.04	1588	59.1	13.5
Olalla Creek	5	10.2	0.5	1.6	22.0	25.0	4.85	10.61	0.46	0.050	7.28	1.50	0.028	9.32	0.06	0.20	0.38	14.67	5.91	0.02	1984	73.8	16.9
Olalla Creek	6	6.1	0.6	1.0	35.0	40.0	3.3	6.60	0.50	0.050	4.16	1.26	0.028	5.04	0.07	0.12	0.33	23.33	2.08	0.02	1817	67.6	15.5
Olalla Creek	7	6.6	0.4	4.0	22.0	35.0	2.48	6.93	0.36	0.050	5.00	2.02	0.028	5.89	0.05	0.14	0.51	14.67	5.91	0.02	2554	95.0	21.8
Olalla Creek	8	5.4	0.6	13.1	24.0	37.0	2.88	5.90	0.49	0.050	12.93	4.49	0.028	4.34	0.07	0.36	1.21	16.00	4.86	0.08	1888	70.3	16.1
Shields Creek	1	9.7	1.1	0.3	44.0	29.0	9.46	10.61	0.89	0.050	9.60	1.01	0.028	7.76	0.13	0.27	0.27	29.33	1.24	0.03	1024	38.1	8.7
Shields Creek	2	4.0	0.6	1.4	49.0	36.0	2.04	4.50	0.45	0.050	2.85	1.40	0.028	2.94	0.07	0.08	0.39	32.67	0.97	0.03	1998	74.4	17.0
Shields Creek	3	4.8	0.5	8.9	60.0	22.0	2.15	5.21	0.41	0.050	7.11	3.31	0.028	3.92	0.06	0.20	0.88	40.00	0.62	0.05	2668	99.3	22.7
Thompson Creek	1	9.2	0.5	1.0	10.0	36.0	4.35	9.61	0.45	0.050	5.13	1.18	0.028	8.32	0.06	0.14	0.30	6.67	34.89	0.02	1647	61.3	14.0
Thompson Creek	2	7.4	0.4	1.4	9.0	31.0	2.8	7.73	0.36	0.050	3.37	1.20	0.028	6.69	0.05	0.09	0.30	6.00	44.24	0.01	2016	75.0	17.2

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction																							
	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Thompson Creek	3	6.0	0.4	9.2	11.0	36.0	2.24	6.33	0.35	0.050	6.80	3.03	0.028	5.29	0.05	0.19	0.78	7.33	28.15	0.04	2293	85.3	19.5
Thompson Creek	4	5.1	0.5	1.4	14.0	50.0	2.3	5.51	0.42	0.050	3.04	1.32	0.028	4.22	0.06	0.09	0.35	9.33	16.35	0.02	1805	67.2	15.4
Thompson Creek	5	5.5	0.4	7.5	14.0	39.0	2.04	5.83	0.35	0.050	5.55	2.72	0.028	4.79	0.05	0.16	0.70	9.33	16.35	0.03	2393	89.0	20.4
Thompson Creek	6	4.5	0.4	1.4	21.0	59.0	1.64	4.83	0.34	0.050	1.89	1.15	0.028	3.79	0.05	0.05	0.30	14.00	6.56	0.01	2422	90.1	20.6
Thompson Creek	7	2.0	0.4	2.0	5.0	44.0	0.64	2.33	0.27	0.050	0.76	1.19	0.028	1.29	0.05	0.02	0.35	3.33	166.22	0.02	1859	69.2	15.9
Wildcat Creek	1	5.5	0.6	4.5	20.0	27.0	2.94	6.00	0.49	0.050	7.76	2.64	0.028	4.44	0.07	0.22	0.71	13.33	7.32	0.05	1731	64.4	14.8
Wildcat Creek	2	4.0	0.6	7.9	17.0	24.0	2.04	4.50	0.45	0.050	6.77	3.32	0.028	2.94	0.07	0.19	0.93	11.33	10.56	0.06	1729	64.3	14.7
Willingham Creek	1	6.1	0.7	3.1	9.0	19.0	3.78	6.68	0.57	0.050	9.11	2.41	0.028	4.86	0.08	0.25	0.65	6.00	44.24	0.05	1246	46.4	10.6
Willingham Creek	2	5.2	0.7	3.8	24.0	31.0	3.15	5.78	0.54	0.050	8.19	2.60	0.028	3.96	0.08	0.23	0.72	16.00	4.86	0.06	1551	57.7	13.2
Willingham Creek	3	4.9	0.6	1.2	35.0	24.0	2.58	5.40	0.48	0.050	3.46	1.34	0.028	3.84	0.07	0.10	0.36	23.33	2.08	0.03	1839	68.4	15.7
Willingham Creek	4	3.9	0.5	1.5	33.0	40.0	1.7	4.31	0.39	0.050	2.24	1.32	0.028	3.02	0.06	0.06	0.36	22.00	2.37	0.02	2180	81.1	18.6
Willingham Creek	5	2.9	0.6	4.9	44.0	37.0	1.38	3.40	0.41	0.050	3.35	2.43	0.028	1.84	0.07	0.09	0.72	29.33	1.24	0.05	2094	77.9	17.8
Little Muley Creek	1	2.9	0.3	1.4	21.9	37.4	0.78	3.15	0.25	0.050	0.73	0.93	0.028	2.37	0.04	0.02	0.25	14.60	5.97	0.01	3209	119.4	27.4
Little Muley Creek	2	3.0	0.3	2.1	23.4	38.6	0.81	3.25	0.25	0.050	0.93	1.15	0.028	2.47	0.04	0.03	0.31	15.60	5.14	0.01	3312	123.3	28.2
Little Muley Creek	3	3.0	0.3	7.5	17.0	31.2	0.81	3.25	0.25	0.050	1.76	2.17	0.028	2.47	0.04	0.05	0.58	11.33	10.56	0.02	3280	122.0	28.0
Little Muley Creek	4	3.1	0.3	10.1	21.5	30.0	0.84	3.35	0.25	0.050	2.12	2.53	0.028	2.57	0.04	0.06	0.67	14.33	6.22	0.02	3490	129.9	29.8
Little Muley Creek	5	2.4	0.3	2.8	37.7	33.3	0.63	2.65	0.24	0.050	0.81	1.28	0.028	1.87	0.04	0.02	0.35	25.13	1.76	0.01	3725	138.6	31.8
Little Muley Creek	6	2.1	0.3	1.3	64.9	20.3	0.54	2.35	0.23	0.050	0.46	0.86	0.028	1.57	0.04	0.01	0.24	43.27	0.52	0.01	4048	150.6	34.5
Muns Creek	1	4.8	0.5	1.5	17.5	68.3	2.15	5.21	0.41	0.050	2.92	1.36	0.028	3.92	0.06	0.08	0.36	11.67	9.89	0.02	1900	70.7	16.2
Muns Creek	2	5.7	0.4	0.9	24.1	35.5	2.12	6.03	0.35	0.050	2.00	0.94	0.028	4.99	0.05	0.06	0.24	16.07	4.81	0.01	2437	90.7	20.8
Muns Creek	3	5.9	0.3	1.0	18.9	37.5	1.68	6.15	0.27	0.050	1.41	0.84	0.028	5.37	0.04	0.04	0.21	12.60	8.32	0.01	3042	113.2	25.9
Muns Creek	4	5.4	0.4	1.7	23.7	30.3	2	5.73	0.35	0.050	2.59	1.29	0.028	4.69	0.05	0.07	0.33	15.80	5.00	0.02	2501	93.1	21.3
Muns Creek	5	3.7	0.4	1.4	50.9	38.2	1.32	4.03	0.33	0.050	1.48	1.12	0.028	2.99	0.05	0.04	0.30	33.93	0.89	0.01	2927	108.9	24.9
Muns Creek	6	4.2	0.3	1.4	27.3	26.0	1.17	4.45	0.26	0.050	1.14	0.97	0.028	3.67	0.04	0.03	0.25	18.20	3.63	0.01	3346	124.5	28.5
Muns Creek	7	2.3	0.3	3.2	36.7	32.1	0.6	2.55	0.24	0.050	0.82	1.36	0.028	1.77	0.04	0.02	0.37	24.47	1.87	0.01	3730	138.8	31.8
Muns Creek	8	3.0	0.3	5.2	17.9	23.2	0.81	3.25	0.25	0.050	1.46	1.81	0.028	2.47	0.04	0.04	0.48	11.93	9.40	0.02	3261	121.4	27.8
Muns Creek	9	3.1	0.4	2.8	80.5	16.4	1.08	3.43	0.31	0.050	1.67	1.55	0.028	2.39	0.05	0.05	0.42	53.67	0.32	0.02	3337	124.2	28.4
Muns Creek	10	4.5	0.2	1.5	42.6	35.5	0.86	4.67	0.18	0.050	0.68	0.79	0.028	4.15	0.02	0.02	0.20	28.40	1.33	0.00	5377	200.1	45.8
South Umpqua (HUC 17100302) Sub-basin, Clark Branch-South Umpqua River (HUC 1710030211) Fifth Field Watershed																							
Barrett Creek	1	3.1	0.4	2.8	6.0	46.0	1.08	3.43	0.31	0.050	1.67	1.55	0.028	2.39	0.05	0.05	0.43	4.00	110.25	0.02	1927	71.7	16.4
Barrett Creek	2	3.5	0.6	8.4	3.0	35.0	1.74	4.00	0.44	0.050	5.79	3.33	0.028	2.44	0.07	0.16	0.95	2.00	525.19	0.07	1206	44.9	10.3
Clark Branch Creek	2	6.2	0.9	1.6	39.0	35.0	4.77	6.95	0.69	0.050	9.39	1.97	0.028	4.61	0.11	0.26	0.55	26.00	1.63	0.06	1304	48.5	11.1
Kent Creek	1	5.3	0.5	1.9	14.0	79.0	2.4	5.71	0.42	0.050	3.71	1.55	0.028	4.42	0.06	0.10	0.41	9.33	16.35	0.02	1825	67.9	15.6
Kent Creek	2	3.7	0.4	2.3	15.0	62.0	1.32	4.03	0.33	0.050	1.90	1.44	0.028	2.99	0.05	0.05	0.39	10.00	14.00	0.02	2309	85.9	19.7

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

Subbasin Fifth Field Watershed Stream Name	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Kent Creek	3	2.1	0.4	2.1	11.0	68.0	0.68	2.43	0.28	0.050	0.84	1.24	0.028	1.39	0.05	0.02	0.36	7.33	28.15	0.02	2190	81.5	18.7
Kent Creek	4	2.3	0.2	2.9	30.0	54.0	0.42	2.47	0.17	0.050	0.44	1.05	0.028	1.95	0.02	0.01	0.28	20.00	2.94	0.01	5162	192.1	44.0
Kent Creek	5	1.3	0.3	7.0	14.0	56.0	0.3	1.55	0.19	0.050	0.53	1.77	0.028	0.77	0.04	0.01	0.54	9.33	16.35	0.02	3223	119.9	27.5
Myrtle Cr.	1	16.7	0.9	0.4	31.0	39.0	14.22	17.45	0.82	0.050	15.70	1.10	0.028	15.11	0.11	0.44	0.28	20.67	2.73	0.03	1151	42.8	9.8
Rice Creek	1	6.1	0.6	0.9	8.0	81.0	3.3	6.60	0.50	0.050	3.95	1.20	0.028	5.04	0.07	0.11	0.32	5.33	57.68	0.02	1322	49.2	11.3
Rice Creek	2	6.4	0.5	1.1	3.0	71.0	2.95	6.81	0.43	0.050	3.54	1.20	0.028	5.52	0.06	0.10	0.31	2.00	525.19	0.02	1284	47.8	10.9
Rice Creek	3	6.3	0.5	1.3	14.0	64.0	2.9	6.71	0.43	0.050	3.78	1.30	0.028	5.42	0.06	0.11	0.34	9.33	16.35	0.02	1790	66.6	15.3
Rice Creek	4	3.6	0.3	2.3	10.0	56.0	0.99	3.85	0.26	0.050	1.21	1.23	0.028	3.07	0.04	0.03	0.32	6.67	34.89	0.01	2767	103.0	23.6
Van Dine Creek	1	3.6	0.5	12.1	15.0	30.0	1.55	4.01	0.39	0.050	5.72	3.69	0.028	2.72	0.06	0.16	1.02	10.00	14.00	0.06	2028	75.5	17.3
W.Fk. Willis Creek	1	5.4	0.5	0.9	21.0	57.0	2.45	5.81	0.42	0.050	2.61	1.07	0.028	4.52	0.06	0.07	0.28	14.00	6.56	0.02	1921	71.5	16.4
W.Fk. Willis Creek	2	6.2	0.5	1.6	22.0	50.0	2.85	6.61	0.43	0.050	4.11	1.44	0.028	5.32	0.06	0.12	0.38	14.67	5.91	0.02	1988	74.0	16.9
W.Fk. Willis Creek	3	5.9	0.5	1.3	20.0	43.0	2.7	6.31	0.43	0.050	3.49	1.29	0.028	5.02	0.06	0.10	0.34	13.33	7.32	0.02	1931	71.9	16.5
Willis Creek	1	8.4	0.7	1.0	29.0	51.0	5.39	8.98	0.60	0.050	7.67	1.42	0.028	7.16	0.08	0.22	0.37	19.33	3.17	0.03	1504	56.0	12.8
W.Fk. Willis Creek	5	4.5	0.5	6.1	17.0	27.0	2	4.91	0.41	0.050	5.43	2.71	0.028	3.62	0.06	0.15	0.73	11.33	10.56	0.04	2009	74.8	17.1
W.Fk. Willis Creek	4	4.5	0.5	1.8	17.0	36.0	2	4.91	0.41	0.050	2.95	1.47	0.028	3.62	0.06	0.08	0.40	11.33	10.56	0.02	1902	70.8	16.2
W.Fk. Willis Creek	6	3.5	0.5	18.6	11.0	27.0	1.5	3.91	0.38	0.050	6.83	4.55	0.028	2.62	0.06	0.19	1.27	7.33	28.15	0.07	1938	72.1	16.5
East Fork Willis Creek	1	5.6	0.6	1.6	41.0	41.0	3	6.10	0.49	0.050	4.73	1.58	0.028	4.54	0.07	0.13	0.42	27.33	1.45	0.03	1917	71.3	16.3
East Fork Willis Creek	3	4.8	0.5	1.5	20.0	59.0	2.15	5.21	0.41	0.050	2.92	1.36	0.028	3.92	0.06	0.08	0.36	13.33	7.32	0.02	1950	72.5	16.6
East Fork Willis Creek	4	3.5	0.5	15.4	16.0	36.0	1.5	3.91	0.38	0.050	6.21	4.14	0.028	2.62	0.06	0.17	1.15	10.67	12.11	0.07	2080	77.4	17.7
Judd Creek	1	6.5	1.1	2.1	15.0	32.0	5.94	7.41	0.80	0.050	14.85	2.50	0.028	4.56	0.13	0.41	0.72	10.00	14.00	0.09	899	33.4	7.7
Judd Creek	2	6.0	0.7	4.1	11.0	28.0	3.71	6.58	0.56	0.050	10.25	2.76	0.028	4.76	0.08	0.29	0.75	7.33	28.15	0.06	1314	48.9	11.2
Judd Creek	3	5.9	0.6	7.2	12.0	26.0	3.18	6.40	0.50	0.050	10.71	3.37	0.028	4.84	0.07	0.30	0.90	8.00	23.14	0.06	1582	58.9	13.5
Judd Creek	4	6.3	0.6	9.5	11.0	34.0	3.42	6.80	0.50	0.050	13.34	3.90	0.028	5.24	0.07	0.38	1.03	7.33	28.15	0.07	1571	58.5	13.4
Judd Creek	5	3.2	0.3	11.6	11.0	54.0	0.87	3.45	0.25	0.050	2.37	2.72	0.028	2.67	0.04	0.07	0.72	7.33	28.15	0.03	3041	113.2	25.9
Lane Creek	1	3.4	0.7	3.6	10.0	37.0	1.89	3.98	0.47	0.050	4.37	2.31	0.028	2.16	0.08	0.12	0.68	6.67	34.89	0.05	1305	48.5	11.1
Lane Creek	2	3.0	0.6	2.8	13.0	41.0	1.44	3.50	0.41	0.050	2.67	1.85	0.028	1.94	0.07	0.07	0.55	8.67	19.33	0.04	1573	58.5	13.4
Lane Creek	3	2.9	0.4	5.8	5.0	35.0	1	3.23	0.31	0.050	2.20	2.20	0.028	2.19	0.05	0.06	0.61	3.33	166.22	0.03	1920	71.4	16.4
Lane Creek	4	1.7	0.3	21.0	4.0	38.0	0.42	1.95	0.22	0.050	1.38	3.29	0.028	1.17	0.04	0.04	0.95	2.67	274.75	0.03	2564	95.4	21.9
South Umpqua (HUC 17100302) Sub-basin, Myrtle Creek (HUC 1710030210) Fifth Field Watershed																							
Bilger Creek	1	6.2	0.5	1.5	19.0	32.0	2.85	6.61	0.43	0.050	3.98	1.40	0.028	5.32	0.06	0.11	0.37	12.67	8.22	0.02	1919	71.4	16.4
Bilger Creek	2	4.8	0.5	2.2	22.0	25.0	2.15	5.21	0.41	0.050	3.53	1.64	0.028	3.92	0.06	0.10	0.44	14.67	5.91	0.03	2020	75.2	17.2
Bilger Creek	3	4.4	0.5	1.4	19.0	23.0	1.95	4.81	0.41	0.050	2.53	1.30	0.028	3.52	0.06	0.07	0.35	12.67	8.22	0.02	1923	71.5	16.4
Buck Fork Creek	1	4.9	0.4	2.5	48.0	34.0	1.8	5.23	0.34	0.050	2.79	1.55	0.028	4.19	0.05	0.08	0.41	32.00	1.02	0.02	2944	109.5	25.1
Buck Fork Creek	2	3.9	0.4	4.1	41.0	32.0	1.4	4.23	0.33	0.050	2.71	1.94	0.028	3.19	0.05	0.08	0.52	27.33	1.45	0.02	2921	108.7	24.9

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

Subbasin Fifth Field Watershed Stream Name	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Buck Fork Creek	3	2.8	0.2	6.9	51.0	23.0	0.52	2.97	0.18	0.050	0.86	1.65	0.028	2.45	0.02	0.02	0.43	34.00	0.89	0.01	5979	222.5	51.0
Buck Fork Creek	4	1.0	0.2	15.0	44.0	46.0	0.16	1.17	0.14	0.050	0.33	2.06	0.028	0.65	0.02	0.01	0.61	29.33	1.24	0.01	6150	228.9	52.4
Frozen Creek	1	5.2	0.5	1.4	37.0	50.0	2.35	5.61	0.42	0.050	3.11	1.32	0.028	4.32	0.06	0.09	0.35	24.67	1.83	0.02	2206	82.1	18.8
Frozen Creek	2	3.6	0.4	1.8	58.0	28.0	1.28	3.93	0.33	0.050	1.63	1.27	0.028	2.89	0.05	0.05	0.34	38.67	0.67	0.02	3032	112.8	25.8
Frozen Creek	3	4.0	0.3	5.0	49.0	24.0	1.11	4.25	0.26	0.050	2.03	1.83	0.028	3.47	0.04	0.06	0.47	32.67	0.97	0.02	3993	148.6	34.0
Frozen Creek	4	1.9	0.3	7.1	58.0	27.0	0.48	2.15	0.22	0.050	0.94	1.96	0.028	1.37	0.04	0.03	0.56	38.67	0.67	0.02	4263	158.6	36.3
Lee Creek	1	4.6	0.4	2.7	44.0	39.0	1.68	4.93	0.34	0.050	2.69	1.60	0.028	3.89	0.05	0.08	0.42	29.33	1.24	0.02	2902	108.0	24.7
Lee Creek	2	2.8	0.2	5.1	59.0	23.0	0.52	2.97	0.18	0.050	0.74	1.41	0.028	2.45	0.02	0.02	0.37	39.33	0.64	0.01	6081	226.3	51.8
W. Fk. Frozen Creek	1	3.0	0.4	2.9	31.0	38.0	1.04	3.33	0.31	0.050	1.63	1.57	0.028	2.29	0.05	0.05	0.43	20.67	2.73	0.02	2726	101.4	23.2
W. Fk. Frozen Creek	2	1.1	0.2	7.2	24.0	38.0	0.18	1.27	0.14	0.050	0.26	1.46	0.028	0.75	0.02	0.01	0.42	16.00	4.86	0.01	5214	194.0	44.4
W. Fk. Frozen Creek	3	1.5	0.2	32.1	13.0	19.0	0.26	1.67	0.16	0.050	0.85	3.29	0.028	1.15	0.02	0.02	0.91	8.67	19.33	0.02	4852	180.6	41.4
Letitia Creek	1	4.4	0.4	1.6	28.0	29.0	1.6	4.73	0.34	0.050	1.96	1.23	0.028	3.69	0.05	0.06	0.32	18.67	3.43	0.02	2579	96.0	22.0
Letitia Creek	3	3.8	0.4	2.2	28.0	21.0	1.36	4.13	0.33	0.050	1.92	1.41	0.028	3.09	0.05	0.05	0.38	18.67	3.43	0.02	2622	97.6	22.4
Letitia Creek	4	2.8	0.3	2.0	54.0	32.0	0.75	3.05	0.25	0.050	0.83	1.11	0.028	2.27	0.04	0.02	0.30	36.00	0.78	0.01	3930	146.3	33.5
Letitia Creek	5	15.7	0.3	1.8	70.0	28.0	4.62	15.95	0.29	0.050	5.43	1.17	0.028	15.17	0.04	0.15	0.29	46.67	0.44	0.01	4082	151.9	34.8
Letitia Creek	6	2.3	0.3	1.8	53.0	41.0	0.6	2.55	0.24	0.050	0.61	1.02	0.028	1.77	0.04	0.02	0.28	35.33	0.82	0.01	3912	145.6	33.3
Letitia Creek	7	1.3	0.2	11.7	49.0	33.0	0.22	1.47	0.15	0.050	0.43	1.93	0.028	0.95	0.02	0.01	0.54	32.67	0.97	0.01	6155	229.1	52.5
Louis Creek	1	5.6	0.3	2.8	28.0	56.0	1.59	5.85	0.27	0.050	2.23	1.40	0.028	5.07	0.04	0.06	0.36	18.67	3.43	0.01	3448	128.3	29.4
Louis Creek	2	4.9	0.3	1.4	27.0	42.0	1.38	5.15	0.27	0.050	1.36	0.98	0.028	4.37	0.04	0.04	0.25	18.00	3.73	0.01	3320	123.5	28.3
Louis Creek	4	4.0	0.3	1.3	26.0	61.0	1.11	4.25	0.26	0.050	1.03	0.93	0.028	3.47	0.04	0.03	0.24	17.33	4.06	0.01	3289	122.4	28.0
Louis Creek	5	4.0	0.3	1.3	30.0	43.0	1.11	4.25	0.26	0.050	1.03	0.93	0.028	3.47	0.04	0.03	0.24	20.00	2.94	0.01	3390	126.1	28.9
Louis Creek	7	3.6	0.3	1.7	54.0	29.0	0.99	3.85	0.26	0.050	1.04	1.05	0.028	3.07	0.04	0.03	0.28	36.00	0.78	0.01	3887	144.7	33.1
Louis Creek	8	4.1	0.2	2.4	72.0	26.0	0.78	4.27	0.18	0.050	0.78	1.00	0.028	3.75	0.02	0.02	0.25	48.00	0.41	0.01	6112	227.4	52.1
Louis Creek	9	2.8	0.2	3.0	41.0	38.0	0.52	2.97	0.18	0.050	0.56	1.09	0.028	2.45	0.02	0.02	0.28	27.33	1.45	0.01	5500	204.7	46.9
Myrtle Cr.	1	16.7	0.9	0.4	31.0	39.0	14.22	17.45	0.82	0.050	15.70	1.10	0.028	15.11	0.11	0.45	0.28	20.67	2.73	0.03	1149	42.8	9.8
N. Fk. Myrtle Creek	2	10.4	0.9	0.8	17.0	38.0	8.55	11.15	0.77	0.050	12.82	1.50	0.028	8.81	0.11	0.36	0.39	11.33	10.56	0.04	1049	39.1	8.9
N. Fk. Myrtle Creek	3	12.9	0.7	0.8	18.0	47.0	8.54	13.48	0.63	0.050	11.27	1.32	0.028	11.66	0.08	0.32	0.34	12.00	9.29	0.03	1339	49.8	11.4
N. Fk. Myrtle Creek	4	10.5	0.4	1.0	26.0	45.0	4.04	10.83	0.37	0.050	4.19	1.04	0.028	9.79	0.05	0.12	0.26	17.33	4.06	0.01	2468	91.9	21.0
N. Fk. Myrtle Creek	6	9.6	0.3	0.9	30.0	31.0	2.79	9.85	0.28	0.050	2.28	0.82	0.028	9.07	0.04	0.06	0.20	20.00	2.94	0.01	3315	123.4	28.3
N. Fk. Myrtle Creek	7	8.9	0.4	1.4	29.0	29.0	3.4	9.23	0.37	0.050	4.13	1.22	0.028	8.19	0.05	0.12	0.31	19.33	3.17	0.01	2566	95.5	21.9
N. Fk. Myrtle Creek	8	4.6	0.3	1.9	43.0	17.0	1.29	4.85	0.27	0.050	1.47	1.14	0.028	4.07	0.04	0.04	0.29	28.67	1.31	0.01	3714	138.2	31.7
N. Fk. Myrtle Creek	9	3.5	0.3	3.5	50.0	26.0	0.96	3.75	0.26	0.050	1.45	1.51	0.028	2.97	0.04	0.04	0.40	33.33	0.93	0.01	3953	147.1	33.7
Riser Creek	1	4.0	0.4	1.9	64.0	35.0	1.44	4.33	0.33	0.050	1.91	1.32	0.028	3.29	0.05	0.05	0.35	42.67	0.53	0.02	3097	115.3	26.4
Riser Creek	2	4.6	0.2	1.6	93.0	5.0	0.88	4.77	0.18	0.050	0.72	0.82	0.028	4.25	0.02	0.02	0.21	62.00	0.23	0.00	6329	235.5	54.0

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction																									
	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]						
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area ($meter^2$)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q ($meter^3$ per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, $meter^3$)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Riser Creek	3	4.2	0.2	4.6	80.0	15.0	0.8	4.37	0.18	0.050	1.11	1.38	0.028	3.85	0.02	0.03	0.35	53.33	0.32	0.01	6434	239.4	54.8
Riser Creek	4	0.4	0.1	17.4	49.0	35.0	0.03	0.48	0.06	0.050	0.04	1.31	0.028	0.22	0.01	0.00	0.40	32.67	0.97	0.00	12336	459.1	105.2
Slide Creek	1	4.3	0.5	1.2	54.0	39.0	1.9	4.71	0.40	0.050	2.27	1.20	0.028	3.42	0.06	0.06	0.32	36.00	0.78	0.02	2380	88.6	20.3
Slide Creek	2	4.9	0.3	1.3	71.0	25.0	1.38	5.15	0.27	0.050	1.31	0.95	0.028	4.37	0.04	0.04	0.24	47.33	0.42	0.01	4056	150.9	34.6
Slide Creek	3	5.9	0.2	2.3	83.0	13.0	1.14	6.07	0.19	0.050	1.13	1.00	0.028	5.55	0.02	0.03	0.25	55.33	0.30	0.01	6274	233.5	53.5
Slide Creek	4	1.0	0.2	10.5	75.0	17.0	0.16	1.17	0.14	0.050	0.28	1.72	0.028	0.65	0.02	0.01	0.51	50.00	0.37	0.01	6771	252.0	57.7
Myrtle Cr.(S.Fk.)	1	12.6	0.9	0.5	33.0	25.0	10.53	13.35	0.79	0.050	12.72	1.21	0.028	11.01	0.11	0.36	0.31	22.00	2.37	0.03	1179	43.9	10.0
Myrtle Cr.(S.Fk.)	2	14.0	0.8	0.7	40.0	23.0	10.56	14.66	0.72	0.050	14.20	1.34	0.028	12.59	0.09	0.40	0.34	26.67	1.54	0.03	1390	51.7	11.8
Myrtle Cr.(S.Fk.)	4	10.5	1.0	1.0	27.0	10.0	9.5	11.33	0.84	0.050	16.90	1.78	0.028	8.74	0.12	0.48	0.47	18.00	3.73	0.05	1060	39.4	9.0
Myrtle Cr.(S.Fk.)	6	6.8	0.9	1.7	24.0	6.0	5.31	7.55	0.70	0.050	10.96	2.06	0.028	5.21	0.11	0.31	0.57	16.00	4.86	0.06	1176	43.8	10.0
Myrtle Cr.(S.Fk.)	7	5.6	0.5	2.4	27.0	13.0	2.55	6.01	0.42	0.050	4.46	1.75	0.028	4.72	0.06	0.13	0.46	18.00	3.73	0.03	2113	78.6	18.0
Myrtle Cr.(S.Fk.)	8	5.6	0.5	4.4	36.0	17.0	2.55	6.01	0.42	0.050	6.04	2.37	0.028	4.72	0.06	0.17	0.62	24.00	1.95	0.04	2307	85.8	19.7
Myrtle Cr.(S.Fk.)	9	5.8	0.6	14.9	30.0	17.0	3.12	6.30	0.50	0.050	15.08	4.83	0.028	4.74	0.07	0.43	1.29	20.00	2.94	0.09	1980	73.7	16.9
Myrtle Cr.(S.Fk.)	10	4.9	0.5	1.4	53.0	34.0	2.2	5.31	0.41	0.050	2.89	1.31	0.028	4.02	0.06	0.08	0.35	35.33	0.82	0.02	2381	88.6	20.3
Myrtle Cr.(S.Fk.)	11	5.2	0.6	8.3	20.0	21.0	2.76	5.70	0.48	0.050	9.81	3.55	0.028	4.14	0.07	0.28	0.96	13.33	7.32	0.07	1774	66.0	15.1
Myrtle Cr.(S.Fk.)	12	5.5	0.8	5.8	78.0	15.0	3.76	6.16	0.61	0.050	13.03	3.46	0.028	4.09	0.09	0.36	0.97	52.00	0.34	0.09	1784	66.4	15.2
Myrtle Cr.(S.Fk.)	13	5.3	0.4	19.4	41.0	17.0	1.96	5.63	0.35	0.050	8.54	4.36	0.028	4.59	0.05	0.24	1.13	27.33	1.45	0.05	3120	116.1	26.6
Weaver Creek	1	5.0	0.6	3.0	35.0	16.0	2.64	5.50	0.48	0.050	5.61	2.12	0.028	3.94	0.07	0.16	0.58	23.33	2.08	0.04	1908	71.0	16.3
Weaver Creek	2	4.8	0.6	2.7	52.0	25.0	2.52	5.30	0.48	0.050	5.05	2.00	0.028	3.74	0.07	0.14	0.55	34.67	0.85	0.04	2066	76.9	17.6
Weaver Creek	3	4.1	0.7	4.9	41.0	25.0	2.38	4.68	0.51	0.050	6.71	2.82	0.028	2.86	0.08	0.19	0.81	27.33	1.45	0.06	1762	65.6	15.0
Weaver Creek	4	2.8	0.9	20.0	40.0	21.0	1.71	3.55	0.48	0.050	9.41	5.50	0.028	1.21	0.11	0.21	1.80	26.67	1.54	0.17	1559	58.0	13.3
South Umpqua (HUC 17100302) Sub-Basin, Days Creek-South Umpqua River (HUC 1710030205) Fifth Field Watershed																							
Alder Creek	1	2.6	0.3	3.6	18.8	41.9	0.69	2.85	0.24	0.050	1.02	1.47	0.028	2.07	0.04	0.03	0.03	12.53	8.42	0.02	152	5.7	1.3
Alder Creek	2	2.3	0.3	5.1	16.3	37.4	0.6	2.55	0.24	0.050	1.03	1.72	0.028	1.77	0.04	0.03	0.03	10.87	11.61	0.02	129	4.8	1.1
Alder Creek	3	2.3	0.3	8.8	15.3	38.4	0.6	2.55	0.24	0.050	1.36	2.26	0.028	1.77	0.04	0.03	0.04	10.20	13.39	0.02	171	6.4	1.5
Beals Creek	1	6.3	0.8	1.2	27.0	68.0	4.4	6.96	0.63	0.050	7.10	1.61	0.028	4.89	0.09	0.09	0.20	18.00	3.73	0.02	1211	45.1	10.3
Beals Creek	2	6.1	0.8	1.1	27.0	54.0	4.24	6.76	0.63	0.050	6.52	1.54	0.028	4.69	0.09	0.09	0.18	18.00	3.73	0.02	1059	39.4	9.0
Beals Creek	3	5.7	0.9	1.3	28.0	45.0	4.32	6.45	0.67	0.050	7.54	1.75	0.028	4.11	0.11	0.10	0.21	18.67	3.43	0.02	987	36.7	8.4
Beals Creek	4	2.5	0.6	3.0	12.0	40.0	1.14	3.00	0.38	0.050	2.07	1.82	0.028	1.44	0.07	0.06	0.06	8.00	23.14	0.04	111	4.1	0.9
Canyon Creek	1	14.0	1.0	1.3	2.0	29.0	13	14.83	0.88	0.050	27.15	2.09	0.028	12.24	0.12	0.12	0.76	1.33	1308.85	0.01	5944	221.2	50.7
Canyon Creek	2	10.5	0.9	1.1	3.0	31.0	8.64	11.25	0.77	0.050	15.20	1.76	0.028	8.91	0.11	0.10	0.43	2.00	525.19	0.01	2796	104.0	23.8
Canyon Creek	3	6.3	1.0	1.5	3.0	39.0	5.3	7.13	0.74	0.050	10.65	2.01	0.028	4.54	0.12	0.11	0.30	2.00	525.19	0.02	892	33.2	7.6
Canyon Creek	4	5.4	0.8	1.6	1.0	43.0	3.68	6.06	0.61	0.050	6.67	1.81	0.028	3.99	0.09	0.09	0.19	0.67	6235.03	0.02	465	17.3	4.0
Canyon Creek	5	3.8	0.7	5.2	3.0	50.0	2.17	4.38	0.50	0.050	6.20	2.86	0.028	2.57	0.08	0.08	0.17	2.00	525.19	0.03	404	15.0	3.4

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Canyon Creek	6	1.0	0.3	5.8	32.0	34.0	0.21	1.25	0.17	0.050	0.31	1.47	0.028	0.47	0.04	0.03	0.01	21.33	2.54	0.07	12	0.4	0.1
Corn Creek	1	4.5	0.5	2.6	48.0	22.0	2	4.91	0.41	0.050	3.54	1.77	0.028	3.62	0.06	0.06	0.10	32.00	1.02	0.02	754	28.1	6.4
Corn Creek	2	3.3	0.6	3.5	43.0	29.0	1.62	3.80	0.43	0.050	3.44	2.12	0.028	2.24	0.07	0.07	0.10	28.67	1.31	0.03	379	14.1	3.2
Corn Creek	3	1.9	0.2	9.4	49.0	17.0	0.34	2.07	0.16	0.050	0.63	1.84	0.028	1.55	0.02	0.02	0.02	32.67	0.97	0.01	122	4.6	1.0
E.Fk.Poole Creek	1	3.4	0.5	4.6	17.0	57.0	1.45	3.81	0.38	0.050	3.26	2.25	0.028	2.52	0.06	0.06	0.09	11.33	10.56	0.02	391	14.6	3.3
East Fork Stouts Creek	1	3.3	0.1	4.3	20.0	25.0	0.32	3.38	0.09	0.050	0.28	0.86	0.028	3.12	0.01	0.01	0.01	13.33	7.32	0.00	164	6.1	1.4
East Fork Stouts Creek	2	3.3	0.1	2.8	26.0	26.0	0.32	3.38	0.09	0.050	0.22	0.69	0.028	3.12	0.01	0.01	0.01	17.33	4.06	0.00	137	5.1	1.2
East Fork Stouts Creek	3	2.5	0.1	6.5	33.0	16.0	0.24	2.58	0.09	0.050	0.25	1.05	0.028	2.32	0.01	0.01	0.01	22.00	2.37	0.01	123	4.6	1.0
Hatchet Creek	1	7.6	0.7	3.7	21.0	25.0	4.83	8.18	0.59	0.050	13.08	2.71	0.028	6.37	0.08	0.08	0.37	14.00	6.56	0.01	3288	122.4	28.0
Hatchet Creek	2	7.0	1.3	4.1	26.0	28.0	7.41	8.08	0.92	0.050	28.33	3.82	0.028	4.71	0.15	0.14	0.79	17.33	4.06	0.03	3297	122.7	28.1
Hatchet Creek	3	4.4	1.1	11.4	29.0	17.0	3.63	5.31	0.68	0.050	19.02	5.24	0.028	2.46	0.13	0.12	0.53	19.33	3.17	0.05	1401	52.1	11.9
Jordan Creek	1	3.8	0.4	1.8	19.8	50.0	1.36	4.13	0.33	0.050	1.74	1.28	0.028	3.09	0.05	0.05	0.05	13.20	7.49	0.01	308	11.5	2.6
Jordan Creek	2	2.6	0.3	2.5	16.4	50.3	0.69	2.85	0.24	0.050	0.85	1.23	0.028	2.07	0.04	0.03	0.02	10.93	11.45	0.02	121	4.5	1.0
Lavadoure Creek	1	2.5	0.4	5.8	18.0	50.0	0.84	2.83	0.30	0.050	1.80	2.14	0.028	1.79	0.05	0.05	0.05	12.00	9.29	0.03	185	6.9	1.6
Packard Gulch	1	4.7	0.5	0.5	30.0	28.0	2.1	5.11	0.41	0.050	1.64	0.78	0.028	3.82	0.06	0.06	0.05	20.00	2.94	0.02	311	11.6	2.7
Packard Gulch	2	3.5	0.5	2.5	32.0	39.0	1.5	3.91	0.38	0.050	2.50	1.67	0.028	2.62	0.06	0.06	0.07	21.33	2.54	0.02	347	12.9	3.0
Packard Gulch	3	2.8	0.3	3.7	35.0	47.0	0.75	3.05	0.25	0.050	1.13	1.51	0.028	2.27	0.04	0.03	0.03	23.33	2.08	0.02	213	7.9	1.8
Poole Creek	1	3.9	0.4	3.4	18.0	48.0	1.4	4.23	0.33	0.050	2.47	1.76	0.028	3.19	0.05	0.05	0.07	12.00	9.29	0.01	456	17.0	3.9
Poole Creek	2	2.7	0.3	4.9	21.0	40.0	0.72	2.95	0.24	0.050	1.25	1.73	0.028	2.17	0.04	0.03	0.03	14.00	6.56	0.02	203	7.5	1.7
St. John Creek (Canyon)	1	4.9	0.4	3.6	5.0	51.0	1.8	5.23	0.34	0.050	3.35	1.86	0.028	4.19	0.05	0.05	0.09	3.33	166.22	0.01	634	23.6	5.4
St. John Creek (Canyon)	2	2.5	0.5	11.5	2.0	34.0	1	2.91	0.34	0.050	3.32	3.32	0.028	1.62	0.06	0.06	0.09	1.33	1308.85	0.03	167	6.2	1.4
St. John Creek (Canyon)	3	2.1	0.3	21.6	10.0	47.0	0.54	2.35	0.23	0.050	1.88	3.49	0.028	1.57	0.04	0.03	0.05	6.67	34.89	0.02	199	7.4	1.7
Stouts Creek	1	6.8	0.2	1.5	15.0	21.0	1.32	6.97	0.19	0.050	1.07	0.81	0.028	6.45	0.02	0.02	0.03	10.00	14.00	0.00	695	25.9	5.9
Stouts Creek	2	4.3	0.1	2.2	24.0	21.0	0.42	4.38	0.10	0.050	0.26	0.62	0.028	4.12	0.01	0.01	0.01	16.00	4.86	0.00	211	7.9	1.8
Stouts Creek	3	3.4	0.1	6.6	30.0	17.0	0.33	3.48	0.09	0.050	0.35	1.07	0.028	3.22	0.01	0.01	0.01	20.00	2.94	0.00	240	8.9	2.0
Sweat Creek	1	3.1	0.5	3.3	42.0	37.0	1.3	3.51	0.37	0.050	2.43	1.87	0.028	2.22	0.06	0.06	0.07	28.00	1.38	0.03	304	11.3	2.6
W. Fk. Canyon Creek	1	10.8	0.8	1.4	0.0	31.0	8	11.46	0.70	0.050	14.90	1.86	0.028	9.39	0.09	0.09	0.42	0.00	0	0.01	0	0.0	0.0
W. Fk. Canyon Creek	2	11.1	0.9	3.3	0.0	35.0	9.18	11.85	0.77	0.050	28.14	3.07	0.028	9.51	0.11	0.10	0.79	0.00	0	0.01	0	0.0	0.0
W. Fk. Canyon Creek	3	8.7	0.7	1.6	0.0	38.0	5.6	9.28	0.60	0.050	10.12	1.81	0.028	7.47	0.08	0.08	0.28	0.00	0	0.01	0	0.0	0.0
W. Fk. Canyon Creek	4	7.6	0.8	3.7	0.0	10.0	5.44	8.26	0.66	0.050	15.84	2.91	0.028	6.19	0.09	0.09	0.44	0.00	0	0.01	0	0.0	0.0
W. Fk. Canyon Creek	6	7.1	0.5	2.8	5.0	42.0	3.3	7.51	0.44	0.050	6.38	1.93	0.028	6.22	0.06	0.06	0.18	3.33	166.22	0.01	1511	56.2	12.9
W. Fk. Canyon Creek	7	5.0	0.5	4.2	4.0	56.0	2.25	5.41	0.42	0.050	5.14	2.28	0.028	4.12	0.06	0.06	0.14	2.67	274.75	0.01	760	28.3	6.5
W. Fk. Canyon Creek	8	3.0	0.6	6.4	8.0	64.0	1.44	3.50	0.41	0.050	4.03	2.80	0.028	1.94	0.07	0.07	0.11	5.33	57.68	0.03	277	10.3	2.4
W. Fk. Canyon Creek	9	1.8	0.3	20.9	7.0	60.0	0.45	2.05	0.22	0.050	1.50	3.33	0.028	1.27	0.04	0.03	0.04	4.67	77.91	0.03	118	4.4	1.0

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Wood Creek	1	4.7	0.6	1.8	44.0	35.0	2.46	5.20	0.47	0.050	4.01	1.63	0.028	3.64	0.07	0.07	0.11	29.33	1.24	0.02	715	26.6	6.1
Wood Creek	2	4.1	0.4	2.2	37.0	28.0	1.48	4.43	0.33	0.050	2.11	1.43	0.028	3.39	0.05	0.05	0.06	24.67	1.83	0.01	475	17.7	4.0
Wood Creek	3	4.0	0.3	2.0	61.0	26.0	1.11	4.25	0.26	0.050	1.28	1.16	0.028	3.47	0.04	0.03	0.04	40.67	0.59	0.01	415	15.4	3.5
Wood Creek	4	1.6	0.2	2.6	83.0	9.0	0.28	1.77	0.16	0.050	0.26	0.94	0.028	1.25	0.02	0.02	0.01	55.33	0.30	0.02	43	1.6	0.4
Fate Creek Tributary	1	2.8	0.5	3.4	71.0	22.0	1.15	3.21	0.36	0.050	2.14	1.86	0.028	1.92	0.06	0.06	0.06	47.33	0.42	0.03	257	9.6	2.2
W. Fk. Canyon Creek Trib #1	1	6.6	0.7	5.8	5.0	32.0	4.13	7.18	0.58	0.050	13.76	3.33	0.028	5.37	0.08	0.08	0.39	3.33	166.22	0.01	2175	80.9	18.5
W. Fk. Canyon Creek Trib #1	2	7.2	0.6	7.2	10.0	37.0	3.96	7.70	0.51	0.050	13.64	3.45	0.028	6.14	0.07	0.07	0.38	6.67	34.89	0.01	3307	123.1	28.2
W. Fk. Canyon Creek Trib #1	3	4.2	0.6	7.9	10.0	39.0	2.16	4.70	0.46	0.050	7.23	3.35	0.028	3.14	0.07	0.07	0.20	6.67	34.89	0.02	864	32.2	7.4
W. Fk. Canyon Creek Trib #1	4	1.5	0.4	15.7	10.0	59.0	0.44	1.83	0.24	0.050	1.35	3.06	0.028	0.79	0.05	0.04	0.04	6.67	34.89	0.05	56	2.1	0.5
Beals Creek Trib #1	1	3.5	0.6	5.6	32.0	32.0	1.74	4.00	0.44	0.050	4.73	2.72	0.028	2.44	0.07	0.07	0.13	21.33	2.54	0.03	547	20.3	4.7
Northeast Fork Stouts Creek	1	4.0	0.2	4.1	18.0	31.0	0.76	4.17	0.18	0.050	0.99	1.30	0.028	3.65	0.02	0.02	0.03	12.00	9.29	0.01	379	14.1	3.2
Northeast Fork Stouts Creek	2	5.0	0.3	5.4	15.0	27.0	1.41	5.25	0.27	0.050	2.73	1.94	0.028	4.47	0.04	0.03	0.08	10.00	14.00	0.01	901	33.5	7.7
Stouts Creek Trib #14	1	3.5	0.1	12.9	29.0	11.0	0.34	3.58	0.09	0.050	0.51	1.49	0.028	3.32	0.01	0.01	0.01	19.33	3.17	0.00	367	13.6	3.1
Stouts Creek Trib #16	1	2.0	0.1	3.3	17.0	29.0	0.19	2.08	0.09	0.050	0.14	0.74	0.028	1.82	0.01	0.01	0.00	11.33	10.56	0.01	44	1.6	0.4
Stouts Creek Trib #16	2	3.3	0.2	7.5	25.0	17.0	0.62	3.47	0.18	0.050	1.08	1.74	0.028	2.95	0.02	0.02	0.03	16.67	4.43	0.01	361	13.4	3.1
Southwest Fork Stouts Creek	1	2.3	0.3	3.7	28.0	23.0	0.6	2.55	0.24	0.050	0.88	1.47	0.028	1.77	0.04	0.03	0.02	18.67	3.43	0.02	121	4.5	1.0
Southwest Fork Stouts Creek	2	2.5	0.2	2.5	27.0	19.0	0.46	2.67	0.17	0.050	0.45	0.98	0.028	2.15	0.02	0.02	0.01	18.00	3.73	0.01	104	3.9	0.9
Oshea Creek	1	6.5	0.5	1.0	14.0	44.0	3	6.91	0.43	0.050	3.44	1.15	0.028	5.62	0.06	0.06	0.10	9.33	16.35	0.01	866	32.2	7.4
Oshea Creek	2	6.8	0.4	2.0	5.0	38.0	2.56	7.13	0.36	0.050	3.66	1.43	0.028	6.09	0.05	0.05	0.10	3.33	166.22	0.01	1006	37.4	8.6
Oshea Creek	3	5.0	0.3	2.4	9.0	56.0	1.41	5.25	0.27	0.050	1.82	1.29	0.028	4.47	0.04	0.03	0.05	6.00	44.24	0.01	520	19.4	4.4
Fate Creek	1	4.7	0.7	1.9	29.0	43.0	2.8	5.28	0.53	0.050	5.06	1.81	0.028	3.47	0.08	0.08	0.14	19.33	3.17	0.02	694	25.8	5.9
Fate Creek	2	4.5	0.6	1.7	28.0	57.0	2.34	5.00	0.47	0.050	3.68	1.57	0.028	3.44	0.07	0.07	0.10	18.67	3.43	0.02	561	20.9	4.8
Fate Creek	3	4.7	0.7	2.6	33.0	29.0	2.8	5.28	0.53	0.050	5.92	2.11	0.028	3.47	0.08	0.08	0.17	22.00	2.37	0.02	846	31.5	7.2
Fate Creek	4	3.2	0.6	3.5	66.0	16.0	1.56	3.70	0.42	0.050	3.28	2.10	0.028	2.14	0.07	0.07	0.09	44.00	0.50	0.03	378	14.1	3.2
Fate Creek	5	2.8	0.6	4.3	45.0	40.0	1.32	3.30	0.40	0.050	2.97	2.25	0.028	1.74	0.07	0.07	0.08	30.00	1.18	0.04	258	9.6	2.2
Fate Creek	6	2.5	0.4	10.0	44.0	16.0	0.84	2.83	0.30	0.050	2.36	2.81	0.028	1.79	0.05	0.05	0.07	29.33	1.24	0.03	301	11.2	2.6
East Fork Shively Creek	1	7.5	0.5	13.9	18.2	25.7	3.5	7.91	0.44	0.050	15.15	4.33	0.028	6.62	0.06	0.06	0.42	12.13	9.06	0.01	5411	201.3	46.1
East Fork Shively Creek	2	5.2	0.4	2.4	31.0	45.0	1.92	5.53	0.35	0.050	2.94	1.53	0.028	4.49	0.05	0.05	0.08	20.67	2.73	0.01	862	32.1	7.3
East Fork Shively Creek	3	3.0	0.2	5.3	7.0	57.0	0.56	3.17	0.18	0.050	0.81	1.45	0.028	2.65	0.02	0.02	0.02	4.67	77.91	0.01	182	6.8	1.6
East Fork Shively Creek	4	2.9	0.2	6.9	17.0	54.0	0.54	3.07	0.18	0.050	0.89	1.65	0.028	2.55	0.02	0.02	0.02	11.33	10.56	0.01	234	8.7	2.0
Shively Creek	1	6.1	0.4	1.8	28.8	37.0	2.28	6.43	0.35	0.050	3.06	1.34	0.028	5.39	0.05	0.05	0.09	19.20	3.22	0.01	1063	39.6	9.1
Shively Creek	2	5.1	0.7	5.6	22.9	57.2	3.08	5.68	0.54	0.050	9.69	3.15	0.028	3.87	0.08	0.08	0.27	15.27	5.40	0.02	1490	55.4	12.7
Coffee Creek	1	8.8	0.5	2.3	19.6	37.7	4.15	9.21	0.45	0.050	7.40	1.78	0.028	7.92	0.06	0.06	0.21	13.07	7.67	0.01	3002	111.7	25.6
Coffee Creek	3	5.0	1.5	3.4	9.0	25.0	5.25	6.24	0.84	0.050	17.25	3.29	0.028	2.35	0.18	0.15	0.48	6.00	44.24	0.07	720	26.8	6.1

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area ($meter^2$)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q ($meter^3$ per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, $meter^3$)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Coffee Creek	4	6.0	0.5	3.2	11.2	49.9	2.75	6.41	0.43	0.050	5.59	2.03	0.028	5.12	0.06	0.06	0.16	7.47	27.03	0.01	1282	47.7	10.9
Coffee Creek	5	3.6	0.7	6.1	16.0	27.0	2.03	4.18	0.49	0.050	6.20	3.05	0.028	2.37	0.08	0.08	0.17	10.67	12.11	0.03	532	19.8	4.5
Coffee Creek	6	1.5	0.3	13.8	27.0	31.0	0.36	1.75	0.21	0.050	0.93	2.59	0.028	0.97	0.04	0.03	0.03	18.00	3.73	0.03	72	2.7	0.6
St. John Creek	1	4.9	0.4	2.6	27.2	25.0	1.8	5.23	0.34	0.050	2.85	1.58	0.028	4.19	0.05	0.05	0.08	18.13	3.66	0.01	758	28.2	6.5
St. John Creek	2	5.0	0.3	1.7	26.5	37.6	1.41	5.25	0.27	0.050	1.53	1.09	0.028	4.47	0.04	0.03	0.04	17.67	3.89	0.01	541	20.1	4.6
St. John Creek	3	3.7	0.2	2.8	24.6	31.7	0.7	3.87	0.18	0.050	0.75	1.07	0.028	3.35	0.02	0.02	0.02	16.40	4.60	0.01	274	10.2	2.3
St. John Creek	4	2.8	0.2	4.4	18.2	30.9	0.52	2.97	0.18	0.050	0.68	1.31	0.028	2.45	0.02	0.02	0.02	12.13	9.06	0.01	171	6.4	1.5
St. John Creek	5	2.0	0.1	8.5	18.0	34.8	0.19	2.08	0.09	0.050	0.22	1.18	0.028	1.82	0.01	0.01	0.01	12.00	9.29	0.01	75	2.8	0.6
St. John Creek Tributary	1	2.8	0.2	3.2	22.1	36.6	0.52	2.97	0.18	0.050	0.58	1.12	0.028	2.45	0.02	0.02	0.02	14.73	5.85	0.01	150	5.6	1.3
St. John Creek Tributary	2	1.9	0.2	9.7	11.8	25.9	0.34	2.07	0.16	0.050	0.64	1.87	0.028	1.55	0.02	0.02	0.02	7.87	24.04	0.01	92	3.4	0.8
Days Creek	1	7.7	0.4	0.7	17.5	46.2	2.92	8.03	0.36	0.050	2.49	0.85	0.028	6.99	0.05	0.05	0.07	11.67	9.89	0.01	986	36.7	8.4
Days Creek	3	6.9	0.4	0.9	20.4	46.7	2.6	7.23	0.36	0.050	2.49	0.96	0.028	6.19	0.05	0.05	0.07	13.60	7.01	0.01	906	33.7	7.7
Days Creek	4	6.0	0.3	0.8	22.7	49.3	1.71	6.25	0.27	0.050	1.29	0.75	0.028	5.47	0.04	0.04	0.04	15.13	5.51	0.01	530	19.7	4.5
Days Creek	5	5.5	0.2	0.9	31.7	51.0	1.06	5.67	0.19	0.050	0.66	0.62	0.028	5.15	0.02	0.02	0.02	21.13	2.60	0.00	384	14.3	3.3
Days Creek	7	4.7	0.2	0.9	33.7	52.1	0.9	4.87	0.18	0.050	0.55	0.62	0.028	4.35	0.02	0.02	0.02	22.47	2.26	0.01	273	10.2	2.3
Days Creek	8	4.6	0.2	2.2	25.7	46.1	0.88	4.77	0.18	0.050	0.85	0.96	0.028	4.25	0.02	0.02	0.02	17.13	4.16	0.01	400	14.9	3.4
Days Creek	9	6.4	0.5	1.0	17.0	26.0	2.95	6.81	0.43	0.050	3.38	1.14	0.028	5.52	0.06	0.06	0.09	11.33	10.56	0.01	869	32.3	7.4
Days Creek	10	5.1	0.5	9.5	19.0	30.0	2.3	5.51	0.42	0.050	7.91	3.44	0.028	4.22	0.06	0.06	0.22	12.67	8.22	0.01	1731	64.4	14.8
South Umpqua (HUC 17100302) Sub-basin, Upper Cow Creek (HUC 1710030206) Fifth Field Watershed																							
Applegate Creek	1	9.9	4.0	2.8	28.0	24.0	23.6	13.21	1.79	0.050	116.26	4.93	0.028	3.02	0.56	2.49	1.80	18.67	3.43	0.82	306	11.4	2.6
Applegate Creek	2	10.1	0.7	1.1	33.0	36.0	6.58	10.68	0.62	0.050	9.99	1.52	0.028	8.90	0.10	0.38	0.44	22.00	2.37	0.04	1311	48.8	11.2
Applegate Creek	3	6.9	0.6	1.2	31.0	36.0	3.78	7.40	0.51	0.050	5.29	1.40	0.028	5.87	0.08	0.20	0.41	20.67	2.73	0.03	1506	56.0	12.8
East Fork Cow Creek	1	7.5	0.7	6.2	21.0	34.0	4.76	8.08	0.59	0.050	16.66	3.50	0.028	6.30	0.10	0.63	1.04	14.00	6.56	0.10	1294	48.2	11.0
East Fork Cow Creek	2	4.5	0.5	4.8	25.0	36.0	2	4.91	0.41	0.050	4.81	2.41	0.028	3.64	0.07	0.18	0.73	16.67	4.43	0.05	1827	68.0	15.6
East Fork Cow Creek	3	3.9	0.5	4.0	29.0	41.0	1.7	4.31	0.39	0.050	3.65	2.15	0.028	3.04	0.07	0.14	0.66	19.33	3.17	0.05	1876	69.8	16.0
French Creek	1	4.3	0.5	1.4	50.0	29.0	1.9	4.71	0.40	0.050	2.45	1.29	0.028	3.44	0.07	0.09	0.39	33.33	0.93	0.03	2002	74.5	17.1
French Creek	2	3.9	0.5	5.0	54.0	14.0	1.7	4.31	0.39	0.050	4.09	2.40	0.028	3.04	0.07	0.15	0.74	36.00	0.78	0.05	2160	80.4	18.4
Jack Creek	1	5.7	0.6	6.7	19.0	29.0	3.06	6.20	0.49	0.050	9.90	3.23	0.028	4.67	0.08	0.38	0.97	12.67	8.22	0.08	1473	54.8	12.6
Jack Creek	2	4.6	0.7	14.4	20.0	29.0	2.73	5.18	0.53	0.050	13.52	4.95	0.028	3.40	0.10	0.51	1.56	13.33	7.32	0.15	1346	50.1	11.5
Mc Ginnis Creek	1	1.9	0.3	6.7	34.0	58.0	0.48	2.15	0.22	0.050	0.91	1.91	0.028	1.38	0.04	0.03	0.60	22.67	2.22	0.02	3230	120.2	27.5
Meadow Creek	1	2.4	0.4	2.4	36.0	58.0	0.8	2.73	0.29	0.050	1.09	1.37	0.028	1.71	0.06	0.04	0.44	24.00	1.95	0.02	2387	88.8	20.3
Meadow Creek	2	2.7	0.3	3.6	32.0	62.0	0.72	2.95	0.24	0.050	1.07	1.48	0.028	2.18	0.04	0.04	0.45	21.33	2.54	0.02	3070	114.2	26.2
Meadow Creek	3	1.6	0.3	9.8	33.0	62.0	0.39	1.85	0.21	0.050	0.87	2.22	0.028	1.08	0.04	0.03	0.72	22.00	2.37	0.03	3291	122.5	28.1
Negro Creek	1	3.6	0.5	13.9	20.0	18.0	1.55	4.01	0.39	0.050	6.13	3.95	0.028	2.74	0.07	0.23	1.23	13.33	7.32	0.08	1839	68.4	15.7

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Snow Creek	1	4.9	0.4	1.9	37.0	34.0	1.8	5.23	0.34	0.050	2.44	1.35	0.028	4.21	0.06	0.09	0.40	24.67	1.83	0.02	2334	86.9	19.9
Snow Creek	2	5.3	0.4	3.3	23.0	31.0	1.96	5.63	0.35	0.050	3.52	1.80	0.028	4.61	0.06	0.13	0.52	15.33	5.35	0.03	2163	80.5	18.4
Snow Creek	3	3.9	0.4	5.0	24.0	26.0	1.4	4.23	0.33	0.050	3.00	2.14	0.028	3.21	0.06	0.11	0.64	16.00	4.86	0.04	2234	83.1	19.0
Snow Creek	4	4.0	0.4	11.9	18.0	23.0	1.44	4.33	0.33	0.050	4.77	3.31	0.028	3.31	0.06	0.18	0.99	12.00	9.29	0.05	2185	81.3	18.6
Sugar Creek	1	3.8	0.4	4.9	24.0	54.0	1.36	4.13	0.33	0.050	2.87	2.11	0.028	3.11	0.06	0.11	0.63	16.00	4.86	0.03	2233	83.1	19.0
Sugar Creek	2	2.5	0.3	8.7	28.0	42.0	0.66	2.75	0.24	0.050	1.50	2.28	0.028	1.98	0.04	0.06	0.70	18.67	3.43	0.03	3111	115.8	26.5
W. Fk. Applegate Creek	1	3.9	0.6	4.8	41.0	25.0	1.98	4.40	0.45	0.050	5.10	2.57	0.028	2.87	0.08	0.19	0.81	27.33	1.45	0.07	1724	64.1	14.7
Applegate Creek Trib 1	1	3.8	0.5	4.0	28.0	32.0	1.65	4.21	0.39	0.050	3.53	2.14	0.028	2.94	0.07	0.13	0.66	18.67	3.43	0.05	1863	69.3	15.9
Applegate Creek Trib 1	2	3.0	1.4	4.0	38.0	31.0	2.24	4.16	0.54	0.050	5.93	2.65	0.028	0.59	0.20	0.07	0.88	25.33	1.73	0.12	1063	39.6	9.1
Snow Creek Tributary Sec 7	1	3.4	2.3	7.2	24.0	34.0	3.91	6.51	0.60	0.050	14.94	3.82	0.028	0.65	0.32	0.21	2.00	16.00	4.86	0.32	846	31.5	7.2
Snow Creek Tributary Sec 17	1	2.3	0.3	9.7	23.0	44.0	0.6	2.55	0.24	0.050	1.42	2.37	0.028	1.78	0.04	0.05	0.73	15.33	5.35	0.03	3006	111.9	25.6
East Fork Applegate Creek	1	3.2	0.5	11.8	37.0	40.0	1.35	3.61	0.37	0.050	4.81	3.56	0.028	2.34	0.07	0.18	1.13	24.67	1.83	0.08	2086	77.6	17.8
East Fork Applegate Creek	2	3.0	0.5	12.5	40.0	30.0	1.25	3.41	0.37	0.050	4.52	3.62	0.028	2.14	0.07	0.17	1.16	26.67	1.54	0.08	2132	79.3	18.2
Upper Rogue (HUC 17100307) Sub-Basin, Trail Creek (HUC 1710030706) Fifth Field Watershed																							
Canyon Creek	1	7.1	0.7	3.9	19.0	21.0	4.48	7.68	0.58	0.045	13.73	3.06	0.097	6.0	0.2	1.33	1.31	12.67	8.22	0.22	748	27.8	6.4
Canyon Creek	2	5.8	0.7	8.8	22.0	20.0	3.57	6.38	0.56	0.045	15.98	4.48	0.097	4.7	0.2	1.54	1.95	14.67	5.91	0.32	806	30.0	6.9
Canyon Creek	3	4.4	0.6	10.9	17.0	27.0	2.28	4.90	0.47	0.045	10.05	4.41	0.097	3.5	0.1	0.96	1.95	11.33	10.56	0.27	896	33.3	7.6
Chicago Creek	1	5.3	0.5	5.8	19.0	19.0	2.4	5.71	0.42	0.045	7.20	3.00	0.097	4.5	0.1	0.70	1.28	12.67	8.22	0.15	1043	38.8	8.9
Clear Creek	1	3.4	0.6	10.7	20.0	20.0	1.68	3.90	0.43	0.045	6.97	4.15	0.097	2.5	0.1	0.65	1.89	13.33	7.32	0.26	941	35.0	8.0
Dead Horse Creek	1	8.3	0.9	12.3	3.0	16.0	6.66	9.05	0.74	0.045	42.32	6.35	0.097	6.9	0.2	4.08	2.74	2.00	525.19	0.59	423	15.7	3.6
Romine Creek	1	6.6	0.6	8.2	24.0	19.0	3.6	7.10	0.51	0.045	14.57	4.05	0.097	5.7	0.1	1.41	1.72	16.00	4.86	0.25	937	34.9	8.0
Trail Creek	1	16.0	0.9	1.0	25.0	16.0	13.59	16.75	0.81	0.045	26.28	1.93	0.097	14.6	0.2	2.55	0.80	16.67	4.43	0.17	581	21.6	5.0
Trail Creek	2	14.3	0.9	1.7	19.0	17.0	12.06	15.05	0.80	0.045	30.15	2.50	0.097	12.9	0.2	2.92	1.04	12.67	8.22	0.23	563	21.0	4.8
Trail Creek	3	11.2	1.0	2.8	22.0	15.0	10.2	12.03	0.85	0.045	33.98	3.33	0.097	9.7	0.2	3.29	1.41	14.67	5.91	0.34	542	20.2	4.6
Trail Creek	4	9.8	0.9	4.6	17.0	14.0	8.01	10.55	0.76	0.045	31.78	3.97	0.097	8.4	0.2	3.07	1.69	11.33	10.56	0.36	580	21.6	4.9
Trail Creek	5	8.1	0.8	7.0	15.0	17.0	5.84	8.76	0.67	0.045	26.20	4.49	0.097	6.9	0.2	2.53	1.92	10.00	14.00	0.37	644	24.0	5.5
Trail Creek	6	5.8	0.6	9.1	19.0	17.0	3.12	6.30	0.50	0.045	13.10	4.20	0.097	4.9	0.1	1.26	1.80	12.67	8.22	0.26	899	33.5	7.7
Wall Creek	1	10.4	0.8	4.7	12.0	17.0	7.68	11.06	0.69	0.045	29.01	3.78	0.097	9.2	0.2	2.81	1.59	8.00	23.14	0.31	600	22.3	5.1
Wall Creek	2	5.1	0.7	17.1	16.0	16.0	3.08	5.68	0.54	0.045	18.82	6.11	0.097	4.0	0.2	1.80	2.70	10.67	12.11	0.44	781	29.1	6.7
Walpole Creek	1	4.1	0.4	8.7	26.0	20.0	1.48	4.43	0.33	0.045	4.67	3.16	0.097	3.5	0.1	0.45	1.35	17.33	4.06	0.13	1401	52.1	11.9
West Fork Trail Creek	1	10.1	0.6	3.2	28.0	27.0	5.7	10.60	0.54	0.045	14.99	2.63	0.097	9.2	0.1	1.45	1.09	18.67	3.43	0.16	919	34.2	7.8
West Fork Trail Creek	2	9.4	0.5	2.2	25.0	23.0	4.45	9.81	0.45	0.045	8.66	1.95	0.097	8.6	0.1	0.84	0.80	16.67	4.43	0.10	1046	38.9	8.9
West Fork Trail Creek	3	8.2	0.6	5.4	22.0	21.0	4.56	8.70	0.52	0.045	15.31	3.36	0.097	7.3	0.1	1.48	1.41	14.67	5.91	0.20	898	33.4	7.7
Canyon Creek Tributary Sec 31	1	5.9	0.7	10.9	24.0	23.0	3.64	6.48	0.56	0.045	18.18	4.99	0.097	4.8	0.2	1.75	2.17	16.00	4.86	0.36	828	30.8	7.1

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

Subbasin Fifth Field Watershed Stream Name	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Upper Rogue (HUC 17100307) Sub-Basin, Shady Cove-Rogue River (HUC 1710030707) Fifth Field Watershed																							
Brush Creek	1	9.1	0.7	3.6	5.0	36.0	5.88	9.68	0.61	0.045	17.78	3.02	0.097	8.0	0.2	1.72	1.27	3.33	166.22	0.21	560	20.8	4.8
Brush Creek	2	5.8	0.7	9.7	2.0	29.0	3.57	6.38	0.56	0.045	16.78	4.70	0.097	4.7	0.2	1.61	2.05	1.33	1308.85	0.34	489	18.2	4.2
Indian Creek	1	11.3	1.2	2.4	17.0	27.0	12.12	12.29	0.99	0.045	41.33	3.41	0.097	9.5	0.3	3.97	1.47	11.33	10.56	0.42	432	16.1	3.7
Indian Creek	2	13.3	1.0	3.8	13.0	17.0	12.3	14.13	0.87	0.045	48.58	3.95	0.097	11.8	0.2	4.69	1.66	8.67	19.33	0.40	491	18.3	4.2
Lewis Creek	1	7.5	0.5	2.6	3.0	24.0	3.5	7.91	0.44	0.045	7.28	2.08	0.097	6.7	0.1	0.70	0.87	2.00	525.19	0.10	678	25.2	5.8
Lewis Creek	2	5.5	0.4	9.5	8.0	30.0	2.04	5.83	0.35	0.045	6.94	3.40	0.097	4.9	0.1	0.67	1.42	5.33	57.68	0.14	1091	40.6	9.3
Lewis Creek	3	4.1	0.3	13.2	11.0	33.0	1.14	4.35	0.26	0.045	3.77	3.31	0.097	3.6	0.1	0.36	1.38	7.33	28.15	0.10	1552	57.8	13.2
Trail Creek	1	16.0	0.9	1.0	25.0	16.0	13.59	16.75	0.81	0.045	26.28	1.93	0.097	14.6	0.2	2.54	0.80	16.67	4.43	0.17	582	21.7	5.0
Little Butte Creek	1	33.7	1.0	2.5	23.0	35.0	32.7	34.53	0.95	0.045	110.80	3.39	0.097	32.2	0.2	10.70	1.36	15.33	5.35	0.33	536	20.0	4.6
Upper Rogue (HUC 17100307) Sub-Basin, Big Butte Creek (HUC 1710030704) Fifth Field Watershed																							
Box Creek	1	5.4	0.7	5.1	8.0	27.0	3.29	5.98	0.55	0.045	11.09	3.37	0.097	4.3	0.2	1.06	1.48	5.33	57.68	0.25	637	23.7	5.4
Box Creek	2	4.2	0.7	8.6	11.0	17.0	2.45	4.78	0.51	0.045	10.23	4.17	0.097	3.1	0.2	0.97	1.89	7.33	28.15	0.31	707	26.3	6.0
Box Creek	3	6.1	0.7	5.6	20.0	26.0	3.78	6.68	0.57	0.045	13.60	3.60	0.097	5.0	0.2	1.31	1.56	13.33	7.32	0.26	772	28.7	6.6
Crowfoot Creek	1	7.1	0.5	3.7	4.0	19.0	3.3	7.51	0.44	0.045	8.15	2.47	0.097	6.3	0.1	0.79	1.03	2.67	274.75	0.12	731	27.2	6.2
Dog Creek	1	8.4	0.7	6.0	19.0	17.0	5.39	8.98	0.60	0.045	20.88	3.87	0.097	7.3	0.2	2.02	1.64	12.67	8.22	0.28	758	28.2	6.5
Dog Creek	2	6.3	0.8	7.3	19.0	14.0	4.4	6.96	0.63	0.045	19.45	4.42	0.097	5.1	0.2	1.87	1.94	12.67	8.22	0.37	684	25.5	5.8
Dog Creek	3	4.0	0.7	6.6	16.0	11.0	2.31	4.58	0.50	0.045	8.36	3.62	0.097	2.9	0.2	0.79	1.65	10.67	12.11	0.27	759	28.2	6.5
Dog Creek	4	5.6	1.1	9.4	13.0	17.0	4.95	6.51	0.76	0.045	28.09	5.68	0.097	3.9	0.3	2.61	2.62	8.67	19.33	0.66	487	18.1	4.2
Dog Creek	5	4.4	0.5	13.1	29.0	22.0	1.95	4.81	0.41	0.045	8.59	4.40	0.097	3.6	0.1	0.83	1.91	19.33	3.17	0.23	1189	44.2	10.1
Jackass Creek	1	3.9	0.4	3.5	39.0	22.0	1.4	4.23	0.33	0.045	2.78	1.99	0.097	3.3	0.1	0.27	0.85	26.00	1.63	0.08	1466	54.5	12.5
Jackass Creek	2	2.8	0.2	4.6	32.0	20.0	0.52	2.97	0.18	0.045	0.78	1.49	0.097	2.5	0.0	0.08	0.63	21.33	2.54	0.03	2705	100.7	23.1
Jackass Creek	3	4.1	0.4	4.8	49.0	22.0	1.48	4.43	0.33	0.045	3.47	2.34	0.097	3.5	0.1	0.34	1.00	32.67	0.97	0.10	1557	57.9	13.3
Mcneil Creek	2	6.1	0.8	1.8	30.0	16.0	4.24	6.76	0.63	0.045	9.26	2.18	0.097	4.9	0.2	0.89	0.96	20.00	2.94	0.18	708	26.4	6.0
Mcneil Creek	3	8.1	0.8	2.4	32.0	23.0	5.84	8.76	0.67	0.045	15.34	2.63	0.097	6.9	0.2	1.48	1.13	21.33	2.54	0.22	720	26.8	6.1
Mcneil Creek	4	6.1	0.7	1.6	50.0	16.0	3.78	6.68	0.57	0.045	7.27	1.92	0.097	5.0	0.2	0.70	0.83	33.33	0.93	0.14	884	32.9	7.5
South Fork Clark Creek	1	3.4	0.3	5.9	23.0	29.0	0.93	3.65	0.25	0.045	2.02	2.17	0.097	2.9	0.1	0.20	0.92	15.33	5.35	0.07	1752	65.2	14.9
Twincheria Creek	1	5.8	0.2	0.8	43.0	26.0	1.12	5.97	0.19	0.045	0.73	0.65	0.097	5.5	0.0	0.07	0.26	28.67	1.31	0.01	2635	98.1	22.5
Twincheria Creek	2	5.3	0.2	2.2	41.0	38.0	1.02	5.47	0.19	0.045	1.10	1.08	0.097	5.0	0.0	0.11	0.44	27.33	1.45	0.02	2732	101.7	23.3
Twincheria Creek	3	4.0	0.2	4.3	30.0	26.0	0.76	4.17	0.18	0.045	1.13	1.48	0.097	3.7	0.0	0.11	0.61	20.00	2.94	0.03	2645	98.4	22.5
Twincheria Creek	4	5.8	0.2	5.8	25.0	45.0	1.12	5.97	0.19	0.045	1.97	1.75	0.097	5.5	0.0	0.19	0.71	16.67	4.43	0.03	2570	95.6	21.9
North Fork Big Butte Creek	1	19.3	0.7	2.8	4.0	8.0	13.02	19.88	0.65	0.045	36.51	2.80	0.097	18.2	0.2	3.55	1.14	2.67	274.75	0.19	521	19.4	4.4
North Fork Big Butte Creek	2	14.9	0.6	0.8	15.0	18.0	8.58	15.40	0.56	0.045	11.55	1.35	0.097	14.0	0.1	1.12	0.55	10.00	14.00	0.08	753	28.0	6.4
North Fork Big Butte Creek	3	18.1	0.5	1.3	9.0	11.0	8.8	18.51	0.48	0.045	13.58	1.54	0.097	17.3	0.1	1.32	0.62	6.00	44.24	0.08	818	30.4	7.0

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
North Fork Big Butte Creek	4	8.6	0.6	1.2	35.0	26.0	4.8	9.10	0.53	0.045	7.63	1.59	0.097	7.7	0.1	0.74	0.66	23.33	2.08	0.10	923	34.4	7.9
North Fork Big Butte Creek	5	9.9	0.7	1.7	39.0	31.0	6.44	10.48	0.61	0.045	13.49	2.09	0.097	8.8	0.2	1.31	0.88	26.00	1.63	0.15	830	30.9	7.1
North Fork Big Butte Creek	6	8.2	0.7	1.6	38.0	22.0	5.25	8.78	0.60	0.045	10.47	2.00	0.097	7.1	0.2	1.02	0.85	25.33	1.73	0.14	827	30.8	7.1
North Fork Big Butte Creek	7	6.6	0.6	2.2	33.0	31.0	3.6	7.10	0.51	0.045	7.55	2.10	0.097	5.7	0.1	0.73	0.89	22.00	2.37	0.13	943	35.1	8.0
North Fork Big Butte Creek	8	7.1	0.6	1.9	56.0	20.0	3.9	7.60	0.51	0.045	7.66	1.96	0.097	6.2	0.1	0.74	0.83	37.33	0.72	0.12	1045	38.9	8.9
North Fork Big Butte Creek	9	5.6	0.5	3.4	48.0	26.0	2.55	6.01	0.42	0.045	5.90	2.31	0.097	4.8	0.1	0.57	0.98	32.00	1.02	0.12	1235	45.9	10.5
North Fork Big Butte Creek	10	3.6	0.6	4.8	52.0	24.0	1.8	4.10	0.44	0.045	5.06	2.81	0.097	2.7	0.1	0.48	1.27	34.67	0.85	0.18	1104	41.1	9.4
Clark Creek	2	6.2	0.6	7.4	8.0	20.0	3.36	6.70	0.50	0.045	12.82	3.82	0.097	5.3	0.1	1.24	1.63	5.33	57.68	0.23	740	27.6	6.3
Clark Creek	3	6.5	0.6	9.3	8.0	20.0	3.54	7.00	0.51	0.045	15.23	4.30	0.097	5.6	0.1	1.48	1.83	5.33	57.68	0.26	747	27.8	6.4
Clark Creek	4	6.7	0.5	3.7	15.0	26.0	3.1	7.11	0.44	0.045	7.62	2.46	0.097	5.9	0.1	0.74	1.03	10.00	14.00	0.12	966	35.9	8.2
Clark Creek (Surveyed as Sf Clk)	5	4.8	0.4	5.2	8.0	20.0	1.76	5.13	0.34	0.045	4.37	2.48	0.097	4.2	0.1	0.42	1.05	5.33	57.68	0.10	1063	39.5	9.1
South Fork Big Butte Creek	1	15.1	0.8	1.7	8.0	6.0	11.44	15.76	0.73	0.045	26.77	2.34	0.097	13.9	0.2	2.60	0.96	5.33	57.68	0.19	522	19.4	4.5
South Fork Big Butte Creek	2	16.5	0.7	1.9	20.0	6.0	11.06	17.08	0.65	0.045	25.36	2.29	0.097	15.4	0.2	2.46	0.94	13.33	7.32	0.16	720	26.8	6.1
South Fork Big Butte Creek	3	19.3	0.6	1.3	12.0	6.0	11.22	19.80	0.57	0.045	19.47	1.74	0.097	18.4	0.1	1.89	0.70	8.00	23.14	0.10	732	27.3	6.2
South Fork Big Butte Creek	4	24.0	0.4	0.2	28.0	10.0	9.44	24.33	0.39	0.045	4.99	0.53	0.097	23.4	0.1	0.48	0.21	18.67	3.43	0.02	1174	43.7	10.0
South Fork Big Butte Creek	5	20.1	0.5	0.9	16.0	9.0	9.8	20.51	0.48	0.045	12.63	1.29	0.097	19.3	0.1	1.22	0.52	10.67	12.11	0.06	907	33.8	7.7
South Fork Big Butte Creek	6	15.4	0.8	1.0	24.0	18.0	11.68	16.06	0.73	0.045	20.99	1.80	0.097	14.2	0.2	2.04	0.74	16.00	4.86	0.14	642	23.9	5.5
South Fork Big Butte Creek	7	13.4	0.4	1.6	25.0	26.0	5.2	13.73	0.38	0.045	7.65	1.47	0.097	12.8	0.1	0.74	0.59	16.67	4.43	0.06	1263	47.0	10.8
Upper Rogue (HUC 17100307) Sub-basin, Little Butte Creek (HUC 1710030708) Fifth Field Watershed																							
Antelope Creek	1	7.0	0.5	1.0	55.0	42.0	3.25	7.41	0.44	0.045	4.17	1.28	0.097	6.2	0.1	0.40	0.54	36.67	0.75	0.06	1199	44.6	10.2
Antelope Creek	2	8.0	0.4	1.1	41.0	48.0	3.04	8.33	0.36	0.045	3.62	1.19	0.097	7.4	0.1	0.35	0.49	27.33	1.45	0.05	1388	51.7	11.8
Antelope Creek	3	6.2	0.4	1.1	48.0	46.0	2.32	6.53	0.36	0.045	2.71	1.17	0.097	5.6	0.1	0.26	0.49	32.00	1.02	0.05	1441	53.6	12.3
Antelope Creek	4	6.8	0.2	1.6	37.0	56.0	1.32	6.97	0.19	0.045	1.22	0.93	0.097	6.5	0.0	0.12	0.37	24.67	1.83	0.02	2638	98.1	22.5
Antelope Creek	5	5.0	0.1	2.0	30.0	58.0	0.49	5.08	0.10	0.045	0.32	0.66	0.097	4.8	0.0	0.03	0.26	20.00	2.94	0.01	4880	181.6	41.6
Antelope Creek	6	6.7	0.1	1.7	24.0	50.0	0.66	6.78	0.10	0.045	0.40	0.61	0.097	6.5	0.0	0.04	0.24	16.00	4.86	0.01	4616	171.8	39.3
Conde Creek	2	8.9	0.4	6.7	38.0	14.0	3.4	9.23	0.37	0.045	10.05	2.96	0.097	8.3	0.1	0.97	1.21	25.33	1.73	0.12	1480	55.1	12.6
Conde Creek	3	5.9	0.5	2.8	42.0	12.0	2.7	6.31	0.43	0.045	5.70	2.11	0.097	5.1	0.1	0.55	0.89	28.00	1.38	0.11	1191	44.3	10.2
Conde Creek	4	6.1	0.5	3.1	59.0	6.0	2.8	6.51	0.43	0.045	6.24	2.23	0.097	5.3	0.1	0.60	0.94	39.33	0.64	0.11	1285	47.8	11.0
Deer Creek	1	6.1	0.8	6.5	25.0	28.0	4.24	6.76	0.63	0.045	17.60	4.15	0.097	4.9	0.2	1.68	1.82	16.67	4.43	0.34	724	26.9	6.2
Deer Creek	2	4.3	0.5	5.3	37.0	32.0	1.9	4.71	0.40	0.045	5.30	2.79	0.097	3.5	0.1	0.51	1.21	24.67	1.83	0.14	1206	44.9	10.3
Deer Creek	3	5.1	0.5	8.9	33.0	25.0	2.3	5.51	0.42	0.045	8.51	3.70	0.097	4.3	0.1	0.82	1.58	22.00	2.37	0.19	1198	44.6	10.2
Deer Creek	4	3.9	0.4	15.3	33.0	27.0	1.4	4.23	0.33	0.045	5.82	4.16	0.097	3.3	0.1	0.56	1.78	22.00	2.37	0.17	1516	56.4	12.9
Lake Creek	1	6.6	0.6	3.4	27.0	42.0	3.6	7.10	0.51	0.045	9.38	2.61	0.097	5.7	0.1	0.90	1.11	18.00	3.73	0.16	924	34.4	7.9
Lake Creek	2	7.7	1.0	4.5	34.0	32.0	6.7	8.53	0.79	0.045	26.89	4.01	0.097	6.2	0.2	2.57	1.76	22.67	2.22	0.42	616	22.9	5.2

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
Subbasin Fifth Field Watershed Stream Name	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area ($meter^2$)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q ($meter^3$ per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, $meter^3$)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Lake Creek	3	6.5	0.6	5.9	26.0	37.0	3.54	7.00	0.51	0.045	12.13	3.43	0.097	5.6	0.1	1.17	1.46	17.33	4.06	0.21	940	35.0	8.0
Lake Creek	4	4.5	0.6	5.1	37.0	39.0	2.34	5.00	0.47	0.045	7.08	3.03	0.097	3.6	0.1	0.68	1.33	24.67	1.83	0.19	1020	38.0	8.7
Lake Creek	5	3.4	0.6	5.1	46.0	40.0	1.68	3.90	0.43	0.045	4.81	2.86	0.097	2.5	0.1	0.45	1.30	30.67	1.12	0.18	1086	40.4	9.3
Lick Creek	1	11.2	1.0	1.9	36.0	28.0	10.2	12.03	0.85	0.045	27.99	2.74	0.097	9.7	0.2	2.70	1.16	24.00	1.95	0.28	592	22.0	5.0
Lick Creek	2	7.9	0.6	3.2	24.0	24.0	4.38	8.40	0.52	0.045	11.28	2.58	0.097	7.0	0.1	1.09	1.08	16.00	4.86	0.16	895	33.3	7.6
Lick Creek	4	5.2	0.4	8.0	18.0	25.0	1.92	5.53	0.35	0.045	5.96	3.10	0.097	4.6	0.1	0.58	1.30	12.00	9.29	0.13	1286	47.9	11.0
Lick Creek	5	3.5	0.4	8.4	21.0	30.0	1.24	3.83	0.32	0.045	3.76	3.04	0.097	2.9	0.1	0.36	1.32	14.00	6.56	0.12	1347	50.1	11.5
Lost Creek	1	7.6	0.5	3.8	32.0	35.0	3.55	8.01	0.44	0.045	8.94	2.52	0.097	6.8	0.1	0.86	1.05	21.33	2.54	0.13	1135	42.2	9.7
Lost Creek	2	7.9	0.5	3.1	35.0	28.0	3.7	8.31	0.45	0.045	8.44	2.28	0.097	7.1	0.1	0.82	0.95	23.33	2.08	0.11	1145	42.6	9.8
Lost Creek	3	7.7	0.5	7.7	38.0	23.0	3.6	8.11	0.44	0.045	12.91	3.59	0.097	6.9	0.1	1.25	1.49	25.33	1.73	0.18	1214	45.2	10.3
Lost Creek	4	8.2	0.5	9.4	27.0	24.0	3.85	8.61	0.45	0.045	15.33	3.98	0.097	7.4	0.1	1.48	1.65	18.00	3.73	0.20	1139	42.4	9.7
Lost Creek	5	7.0	0.5	5.9	34.0	23.0	3.25	7.41	0.44	0.045	10.12	3.11	0.097	6.2	0.1	0.98	1.30	22.67	2.22	0.16	1174	43.7	10.0
Lost Creek	6	7.8	0.4	21.4	11.0	12.0	2.96	8.13	0.36	0.045	15.51	5.24	0.097	7.2	0.1	1.50	2.15	7.33	28.15	0.21	1203	44.8	10.3
Lost Creek	8	7.0	0.5	9.9	32.0	17.0	3.25	7.41	0.44	0.045	13.11	4.03	0.097	6.2	0.1	1.27	1.69	21.33	2.54	0.20	1186	44.1	10.1
Salt Creek	1	8.3	0.7	1.5	37.0	17.0	5.32	8.88	0.60	0.045	10.29	1.93	0.097	7.2	0.2	0.99	0.82	24.67	1.83	0.14	822	30.6	7.0
Salt Creek	2	7.5	0.7	2.7	26.0	12.0	4.76	8.08	0.59	0.045	12.21	2.57	0.097	6.4	0.2	1.18	1.09	17.33	4.06	0.18	786	29.2	6.7
Salt Creek	3	6.4	0.6	4.8	23.0	17.0	3.48	6.90	0.50	0.045	10.74	3.09	0.097	5.5	0.1	1.04	1.31	15.33	5.35	0.19	908	33.8	7.7
Salt Creek	4	6.4	0.6	7.3	22.0	24.0	3.48	6.90	0.50	0.045	13.24	3.81	0.097	5.5	0.1	1.28	1.62	14.67	5.91	0.23	917	34.1	7.8
Salt Creek	5	3.5	0.4	10.2	43.0	26.0	1.24	3.83	0.32	0.045	4.15	3.35	0.097	2.9	0.1	0.40	1.45	28.67	1.31	0.14	1580	58.8	13.5
Salt Creek	6	4.3	0.3	12.3	32.0	28.0	1.2	4.55	0.26	0.045	3.85	3.21	0.097	3.8	0.1	0.37	1.34	21.33	2.54	0.10	1936	72.0	16.5
Soda Creek	1	6.9	0.5	8.2	30.0	20.0	3.2	7.31	0.44	0.045	11.74	3.67	0.097	6.1	0.1	1.13	1.53	20.00	2.94	0.18	1161	43.2	9.9
Soda Creek	2	4.5	0.4	12.2	36.0	15.0	1.64	4.83	0.34	0.045	6.19	3.78	0.097	3.9	0.1	0.60	1.60	24.00	1.95	0.15	1522	56.6	13.0
Soda Creek	3	5.0	0.5	4.0	67.0	19.0	2.25	5.41	0.42	0.045	5.57	2.48	0.097	4.2	0.1	0.54	1.06	44.67	0.48	0.13	1342	49.9	11.4
S.Fk. Little Butte Creek	1	23.0	0.9	1.3	20.0	42.0	19.89	23.75	0.84	0.045	44.78	2.25	0.097	21.6	0.2	4.33	0.91	13.33	7.32	0.20	560	20.8	4.8
S.Fk. Little Butte Creek	2	17.9	0.9	1.8	19.0	36.0	15.3	18.65	0.82	0.045	39.98	2.61	0.097	16.5	0.2	3.87	1.07	12.67	8.22	0.23	563	21.0	4.8
S.Fk. Little Butte Creek	3	18.4	0.8	1.5	22.0	39.0	14.08	19.06	0.74	0.045	31.31	2.22	0.097	17.2	0.2	3.03	0.91	14.67	5.91	0.18	643	23.9	5.5
S.Fk. Little Butte Creek	4	18.4	0.7	1.3	19.0	37.0	12.39	18.98	0.65	0.045	23.62	1.91	0.097	17.3	0.2	2.28	0.77	12.67	8.22	0.13	701	26.1	6.0
S.Fk. Little Butte Creek	5	16.5	0.7	1.3	22.0	31.0	11.06	17.08	0.65	0.045	20.97	1.90	0.097	15.4	0.2	2.03	0.77	14.67	5.91	0.13	724	26.9	6.2
S.Fk. Little Butte Creek	6	17.2	0.8	1.9	28.0	36.0	13.12	17.86	0.73	0.045	32.72	2.49	0.097	16.0	0.2	3.16	1.02	18.67	3.43	0.20	684	25.4	5.8
S.Fk. Little Butte Creek	7	16.7	0.7	2.6	20.0	34.0	11.2	17.28	0.65	0.045	30.06	2.68	0.097	15.6	0.2	2.91	1.09	13.33	7.32	0.19	732	27.2	6.2
S.Fk. Little Butte Creek	8	12.0	0.6	2.9	30.0	26.0	6.84	12.50	0.55	0.045	17.32	2.53	0.097	11.1	0.1	1.67	1.04	20.00	2.94	0.15	928	34.5	7.9
S.Fk. Little Butte Creek	9	13.9	0.6	4.4	27.0	29.0	7.98	14.40	0.55	0.045	25.10	3.15	0.097	13.0	0.1	2.43	1.28	18.00	3.73	0.19	923	34.3	7.9
S.Fk. Little Butte Creek	10	12.6	0.5	6.3	23.0	22.0	6.05	13.01	0.46	0.045	20.25	3.35	0.097	11.8	0.1	1.96	1.36	15.33	5.35	0.17	1075	40.0	9.2
S.Fk. Little Butte Creek	11	10.5	1.0	3.8	14.0	16.0	9.5	11.33	0.84	0.045	36.60	3.85	0.097	9.0	0.2	3.53	1.64	9.33	16.35	0.39	501	18.7	4.3

Values (Reported or Derived) and Assumptions Used to Estimate Total Suspended Solids Generated by Pipeline Construction

Subbasin Fifth Field Watershed Stream Name	Aquatic Inventories Project Habitat and Reach Data from ODFW (2014) [1]						Estimates for Bankfull Flow Using Manning's Formula [2]						Estimates for Average Low Flow [3]					Mean TSS, All Activities (Reid et al., 2004) [4]					
	Reach	Active or Bankfull Width-(m)	Active or Bankfull Channel Height (m)	Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate	Percent Gravel in Substrate	BFW Stream Cross Section Area (meter^2)	BFW Wetted Perimeter (meter)	BFW Hydraulic Radius (meter)	Estimate of Manning's Roughness (n)	BFW Estimate of Q (meter^3 per sec)	BFW Stream Velocity (meter per second)	Ratio of Average Low Flow to BFW Flow	Average Low Flow Width (meter)	Average Low Flow Depth (meter)	Ave. Low Flow Estimate of Q (Stream Flow, meter^3)	Ave. Low Flow Stream Velocity (meter/second)	Pf = Percent fines (silt,clay)	d50 = median sediment size of the excavated material by weight (mm);	Width Adjusted Stream Flow (q = Q / Width)	Wet Open-Cut All Activities Mean TSS (mg/L) 50 meters downstream	Mean TSS (mg/L) Adjusted for Flume 50 meters downstream	Mean TSS (mg/L) Adjusted for Dam & Pump 50 meters downstream
Wasson Creek	1	6.4	0.7	7.3	17.0	21.0	3.99	6.98	0.57	0.045	16.50	4.14	0.097	5.3	0.2	1.59	1.78	11.33	10.56	0.30	755	28.1	6.4
Wasson Creek	2	5.6	0.5	10.6	12.0	25.0	2.55	6.01	0.42	0.045	10.41	4.08	0.097	4.8	0.1	1.00	1.73	8.00	23.14	0.21	973	36.2	8.3
Wasson Creek	3	3.8	0.4	9.6	24.0	27.0	1.36	4.13	0.33	0.045	4.46	3.28	0.097	3.2	0.1	0.43	1.41	16.00	4.86	0.13	1389	51.7	11.8
Yew Creek	1	4.2	0.4	11.3	43.0	23.0	1.52	4.53	0.34	0.045	5.48	3.61	0.097	3.6	0.1	0.53	1.54	28.67	1.31	0.15	1577	58.7	13.4
North Fork Little Butte Creek	1	13.0	0.8	2.5	24.0	32.0	9.76	13.66	0.71	0.045	27.40	2.81	0.097	11.8	0.2	2.65	1.16	16.00	4.86	0.22	673	25.0	5.7
Little Butte Creek	1	33.7	1.0	2.5	23.0	35.0	32.7	34.53	0.95	0.045	110.80	3.39	0.097	32.2	0.2	10.70	1.36	15.33	5.35	0.33	536	20.0	4.6
Little Butte Creek	2	23.6	1.0	1.0	17.0	36.0	22.6	24.43	0.93	0.045	47.68	2.11	0.097	22.1	0.2	4.61	0.86	11.33	10.56	0.21	484	18.0	4.1

[1] Stream names, reach and stream-specific data in these columns are from ODFW 2014: Aquatic Inventories Project – Habitat and Reach Data.

[2] Manning's Formula: $Q = A (k/n) (R^{2/3}) (S^{1/2})$ where Q= discharge rate (m^3/second),: k = 1 with metric units, k = 1.486 with English units; A = cross-sectional area of stream (m^2), assumed to be trapezoidal if bankfull width >2 x predominant depth, V-shaped otherwise; R = the hydraulic radius (m, where R = A/P, and P is the wetted perimeter, m), S = the slope of channel (vertical feet per horizontal feet), and n is Manning's roughness coefficient (estimated, see text). Q and velocity (V, m/sec) are assumed to be bankfull flows, observed during winter months.

[3] Ratio of average Low Flows (during ODFW instream construction window) to Bankfull Flows in a Sub-basin is used to reduce bankfull flow depths (reducing width, A, and R concomitantly) so that the ratio of average low flow to estimated bankfull flow is the average for the sub-basin (see Table 3.2-23 in the text).

[4] The formulas for mean TSS generated (C_{av}) by all activities during wet open-cut pipeline construction : $C_{av} = 1.5 \times 10^6\ U^{1.09}\ d_{50}^{0.95}\ P_f^{0.35}\ q^{-1}$ and for peak TSS (C_p) during wet open-cut: $C_p = 5.7 \times 10^5\ U^{1.86}\ d_{50}^{0.57}\ P_f^{1.2}\ q^{-1}$ (Reid et al., 2004). For both models U = mean flow velocity (m per second) at the crossing location during the construction period), d_{50} = the median sediment size (mm) of the excavated material by weight, P_f = percentage of fines (silt and clay) in the excavated material (%);and q = the width adjusted stream flow rate ($q = Q/B$, (m^2 per second) with B = the watercourse width (m); Q = stream flow rate (m^3 per second) with the assumptions that d_{50} = 0.00025 m (250 µm) since particles that size or less adversely affect fish. Reid et al., (2004) reported that mean TSS concentrations generated during dry open-cut construction for fluming were 3.7 percent of the wet open-cut concentrations and 0.85 percent of the wet open-cut concentrations for dam-and-pump construction and peak TSS concentrations generated during dry open-cut construction for fluming were 30.3 percent of the wet open-cut concentrations and 5.0 percent of the wet open-cut concentrations for dam-and-pump construction.

APPENDIX Z

NSO/MAMU Impact Categorization Documents

CONFIDENTIAL AND PRIVILEGED FILING

APPENDIX AA

Summaries of Pathways and Indicators for Aquatic Habitat Conditions from Available Watershed Analyses of Some 5th Field Watersheds Crossed by the Proposed Route

Table AA-1
Catching-Beaver Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: Summer water temperatures on BLM land in the analysis area have not been measured. However, they are likely below the state temperature criterion based on observed temperature in similarly shaded small streams in the Coos and Umpqua watersheds. Past harvest of entire upslope stream basins on federal and private land, with little or no buffer protection, undoubtedly led to elevated temperatures.	**Watershed Summary:** There are no streams in the analysis area listed by Oregon Department of Environmental Quality for sedimentation.	**Watershed Summary:** The 2004/2006 303(d) list includes 142 streams in the Coos and Coquille watersheds for which water quality is limited primarily for dissolved oxygen, fecal coliform, and temperature. Isthmus Slough is the only water body listed for manganese in the Coos and Coquille watersheds. The main stem Coquille River is the only water body listed for chlorophyll a (nuisance phytoplankton growth) in the Coos and Coquille watersheds.
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: Tide gates reduced access to aquatic habitat along the tidally influenced rivers and slough. This not only reduced the ability for juvenile salmonids to get out of the main stem rivers during high flows, reduced access to spawning habitat for returning adult salmon and restricted the movement of juvenile salmonids out of streams and into estuaries.	**Watershed Summary:** The constituent materials delivered to streams by mass movement, and by other erosion processes, range in size from clay particles to boulders. Silt and clay particles are almost entirely swept out of the stream system as suspended sediment during high winter flows.	**Watershed Summary:** Large wood and other potential obstructions were removed from main river channels for to improve navigation, and log transport and storage. Removal of large woody debris from streams has resulted in a loss of structural complexity and subsequent loss of ability to retain sediments. Loss of large riparian trees along many streams will delay attainment of new large wood that can be recruited to the channels and floodplains.
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: Many first and second order headwater tributaries exhibit extremely low base flows (gallons per minute). They have discontinuous pools or are dry entirely during the summer.	**Watershed Summary:** Waterways in the tidally influenced lowlands remain highly altered. Most of the lands that were diked and drained remain so. The quality of fish habitat in these areas remains poor with silt and sand bottomed pools comprising most of the available aquatic habitat. Within these pools, fish remain exposed to predation and at risks from high water temperatures during the summer months	**Watershed Summary:** 90% of the estuarine marshes have been lost to diking, draining and filling. In a study published in 1974, approximately 86% of the salt marsh in Coalbank Slough, Catching Slough and Isthmus Slough was lost between 1892 and 1972..
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: The removal of large wood from river and slough channels simplified aquatic habitats used by smolting juvenile salmonids. One potential change would have been the loss of flow velocity refugia, formerly provided by the instream wood, which juvenile salmonids would have used during flood events	**Watershed Summary:** Dikes have increased the potential for catastrophic flooding and they have exacerbated the effects of smaller seasonal peak flows. Sediment deposition between dikes can raise the base elevation of a channel relative to the surrounding land and it can reduce the cross sectional area of the channel and its ability to contain high flows..	**Watershed Summary:** Meanders and roughness elements such as in-stream wood and riparian vegetation have largely been eliminated and this has increased the flow velocity and erosive energy in stream channels above heads of tide.

Table AA-1
Catching-Beaver Watershed (continued)

Pathway: Habitat Elements	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: Lowland portions of the analysis area that are tidally-influenced can experience flooding during high tides and high runoff events in the winter. Catching Slough, for example, can have standing water on portions of the road and flooded pastures during a typical winter. Tidal influence extends several miles up the sloughs and rivers of the analysis area The head of tide is often at the fall line or area where exposed gravel bars begin as you move upstream. Downstream from the fall line, streams are sinuous and extensive floodplains and marshes develop.	**Watershed Summary:** Because rain is infrequent in the summer, many first and second order12 headwater tributaries in the analysis area exhibit extremely low base flows (gallons per minute), discontinuous pools or they dry entirely. During the summer low flow period, higher order streams behind tide gates can pool until their depth is sufficient to overcome the downstream water pressure on the gate, the weight of the gate, and the friction on the gate"s hinges. The installation of tide gates has also altered depositional processes and hydrology.	**Watershed Summary:** In the analysis area, low order streams account for approximately 77% of the channel network across all ownerships and 90% of the streams crossing on BLM-administered land.
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: A total of 115.9 km (72 miles) of road were surveyed in the Catching Slough sub-basin area . The average number of drainage sites per mile was 7.3. Within the Catching road sediment survey, there were 188 stream crossings, 227 ditch relief culverts, 103 ditch outs, three potential landslides and seven road surface sites.	**Watershed Summary:** Major disturbance processes affecting the analysis area and the scale of their effects on the landscape include disturbances caused by fire, wind, snow, landslides, floods, insects and disease. Records indicate a portion of the analysis area burned in 1868, and possibly in 1846 or 1850. Data from other watersheds on the Umpqua Resource Area indicate major fires plausibly burning in the analysis area during the 1500s and mid-1700s.	**Watershed Summary:** The oldest and tallest stands in the analysis area are in the Coos River and Catching Slough Subwatersheds. These stands are 130 years old with 196 feet tall dominant trees. Before the 1970s, clearcutting down to the stream edge was a common practice on all streams. Over 98% of the Riparian Reserve acres in Catching Slough Subwatershed support stands older than 15 years. Full recovery of the remaining 25 acres in Catching Slough Subwatershed is expected between 2006 and 2011. Over 95% of the Riparian Reserve acres in Coos River Subwatershed support stands older than 15 years. Full recovery of the remaining 12 acres in Coos River Subwatershed is expected between 2008 and 2013.
Source: U.S. Department of the Interior, Bureau of Land Management (BLM). 2010. Catching-Beaver Watershed Analysis. USDI-Bureau of Land Management, Coos Bay District, North Bend, OR.		

Table AA-2
Upper Middle Fork Coquille River Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: Middle Fork Coquille River, from the mouth to the headwaters on Oregon's Final 1998 Water Quality Limited Streams 303(d) list for temperature. Roseburg BLM District collected stream temperature data on Twelvemile, Boulder, and Dice Creeks in 1998. All three creeks had temperatures above 64^{o}F part of the summer. Timber harvesting and road building in and adjacent to riparian areas have led to higher stream temperatures within the watershed. Water withdrawals for irrigation and domestic uses in the Camas Valley can lead to higher stream temperatures, which can impact aquatic habitat.	**Watershed Summary:** High road densities, high stream crossing densities, and cumulative effects of harvesting in the past 40 years have probably increased peak flows and increased sediment in the streams. Many roads within the watershed have not been regularly maintained. The lack of routine road maintenance may lead to increased sedimentation from the road surface, increased risk of culvert problems, and landslides from road failures. BLM has identified roads that are located in RMAs (formerly Riparian Reserve) and are causing sedimentation problems. BLM indicated that there may be other roads within RMAs causing sedimentation problems that have not been identified and could be considered for decommissioning.	**Watershed Summary:** Each drainage in the watershed has different limiting factors including an increase in sedimentation, decrease in the water quantity or quality, or the improper placement of drainage and erosion control features associated with the forest road network. Water quality samples did not exceed the drinking water standards set by the EPA. Trace metals are not a large concern in the watershed though sedimentary rocks in the watershed contain low amounts of metals.
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: Natural waterfalls, log or debris jams, beaver dams, and road crossings are potential barriers to fish movement and migration. Road surveys examined 343 road segments affecting the fisheries resource. The road surveys identified 26 (7.5 percent) segments were interacting with fish-bearing streams, with seven fish passage barriers. Four pump-chances block upstream migration of	**Watershed Summary:** The Riparian Reserve age class distribution and the PFC surveys indicate the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed.	**Watershed Summary:** In-stream structure (LWD) and channel complexity are lacking throughout the Middle Fork of the Coquille River Basin. The PFC Survey notes mentioned problems associated with a lack of LWD, lack of future LWD recruitment potential because the riparian areas had been harvested, and roads encroaching on the stream channel.
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: The Riparian Reserve age class distribution and the PFC surveys indicate the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed.	**Watershed Summary:** The Riparian Reserve age class distribution and the PFC surveys indicate the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed.	**Watershed Summary:** The Riparian Reserve age class distribution and the PFC Survey surveys indicate the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed.
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: The Riparian Reserve age class distribution and the PFC surveys indicate the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed.	**Watershed Summary:** Several areas in the Upper Middle Fork Coquille watershed are at higher elevations and have exposed bedrock due to erosion and other geological processes.	**Watershed Summary:** The main water quality problems observed in the watershed were erosion and sedimentation, culverts restricting the stream or causing excessive downcutting in the stream, and roads restricting the natural meandering of streams.

Table AA-2
Upper Middle Fork Coquille River Watershed (continued)

Pathway: Channel Condition and Dynamics	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: The main water quality problems observed in the watershed were erosion and sedimentation, culverts restricting the stream or causing excessive downcutting in the stream, and roads restricting the natural meandering of streams. Many tributaries of the Middle Fork Coquille River in the Camas Valley area have been straightened and/or have had their flow patterns altered.	**Watershed Summary:** A number of drainages in the watershed have high road densities, as well as high stream crossing densities. Increased peak flows may occur in drainages with high road and stream crossing densities and a large amount of land in the TSZ (i.e., between 2,000 and 5,000 feet in elevation) and a large percentage harvested within the last 30 years may be susceptible to increased peak flows. The intercepted water is routed to the streams faster because snow accumulation is greater in recently harvested units. Management activities, such as regeneration harvests and road building, may magnify the effects of increased peak flows in drainages with these conditions	**Watershed Summary:** A number of drainages in the watershed have high road densities, as well as high stream crossing densities. Roads can increase the stream drainage network by routing water into culverts, which if not properly located can cause gullying, effectively acting as another stream channel.
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: Road densities range from 4.03 miles per square mile in the Wildcat Drainage to 6.86 miles per square mile in the Lower Twelve Mile Drainage. Average road density of 5.42 miles per square mile. Approximately 1,148 stream crossings (1.97 crossings per stream mile in the watershed) in the watershed. These conditions may increase sediment in streams that is outside the range of natural variability.	**Watershed Summary:** Stream cleaning practices conducted in the 1960s and 1970s and salvage logging, which still occurs. Stream cleaning activities were conducted to facilitate passage of logs from the splash dams to the estuary. The stream cleaning included cutting streambank vegetation and removing boulders and LWD from the stream channel. Splash dams limited access above the dams to fish and had destructive impacts to fish during operational flows and affected stream channel characteristics by reducing habitat complexity, destabilizing stream banks, incising and scouring channels, removing LWD, and changing stream meandering. Many tributaries of the Middle Fork Coquille River in the Camas Valley area have been straightened and/or have had their flow patterns altered.	**Watershed Summary:** Over 82 miles of roads are located within Riparian Reserves and almost 32 miles of road are within 100 feet of a stream in the watershed (Note: BLM portion of watershed is no longer has Riparian Reserve, so miles of road from combined Riparian Reserve and RMAs would be less than 82 miles, but likely not substantially). Roads within 100 feet of the stream are more likely to add sediment to the stream. Sediment from roads is probably impacting water quality in these areas. Each drainage in the watershed contains different limiting factors. Limiting factors for the fishery resource included the absence of a functional riparian area.
Source: U.S. Department of the Interior, Bureau of Land Management. 1999. Upper Middle Fork Coquille Watershed Analysis. USDI-Bureau of Land Management, Roseburg District, Roseburg, OR.		

Table AA-3
Olalla Creek-Lookingglass Creek Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: The BLM has monitored stream temperature on Olalla Creek since 1994. The 7-day maximum water temperature exceeded Oregon' (ODEQ) standards in each year monitored. Current water quality concerns are high temperatures, low flows, low DO levels, and sedimentation levels that do not meet state water quality standards. Domestic water withdrawal, irrigation, agriculture, and livestock watering have all contributed to lower volumes of water in the stream channels during the summer months. Volumes withdrawn are unknown but water removal during the summer may decrease available habitat for aquatic life, increase summer water temperatures and pH due to less water is in the channel.	**Watershed Summary:** High road densities, high stream crossing densities, and cumulative effects of harvesting in the past 30 years have probably increased peak flows and increased sediment in the streams. Current water quality concerns include sedimentation levels that do not meet state water quality standards. Problems with turbidity were identified by ODEQ on Thompson Creek and with sediment on Olalla and Thompson Creeks. Sediment data have not been collected by the BLM in this watershed.	**Watershed Summary:** Summer baseflow water quality in Olalla Creek was very good for the sampled constituents. EPA's drinking water standards were not exceeded. Trace metals are of much concern in the Olalla-Lookingglass watershed. Heavy metal outcrops, generally, do not occur in the watershed. Portions of Lookingglass, Olalla, Tenmile, Byron, and Thompson Creeks were identified by ODEQ, in 1988, with low DO and decreased flows due to water withdrawal.
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: Fish distribution limits have been mapped, using GIS, for streams with documented barriers within the Olalla-Lookingglass watershed. Natural waterfalls, log or debris jams, beaver dams, and road crossings are potential barriers to fish movement and migration	**Watershed Summary:** Many stream channels in the Olalla-Lookingglass watershed have been eroded down to bedrock, probably due to increased peak flows associated with timber harvesting and high road densities.	**Watershed Summary:** Channel downcutting has occurred due to over grazing on streambanks and LWD is lacking in many stream channels because of previous stream cleaning practices on many streams in the watershed. The riparian areas in the Olalla-Lookingglass watershed can be improved in the long term by placing LWD in streams, planting conifers in riparian areas among other projects.
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: Many stream channels in the Olalla-Lookingglass watershed have been eroded down to bedrock, probably due to increased peak flows associated with timber harvesting and high road densities.	**Watershed Summary:** Sea-run cutthroat and coho salmon are limited to the upper portion of the mainstem South Umpqua River. Warm water temperatures, lack of over-summering pool habitats, and low flows have precluded their use of the lower stream reaches in the basin.	**Watershed Summary:** Many stream channels in the Olalla-Lookingglass watershed have been eroded down to bedrock, probably due to increased peak flows associated with timber harvesting and high road densities..
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: Not described	**Watershed Summary:** Results from USFS study document changes in low-flow channel widths within the South Umpqua River Basin since 1937. Stream widening could have resulted from increased peak flows Land management activities (road construction and timber harvesting) have contributed to the changes in channel characteristics. Changes in channel condition may have resulted in the observed decline of three of the four anadromous salmonid stocks occurring in the South Umpqua River Basin. The watershed plans recommends placing LWD in streams to lower width/depth ratio, heighten belt width, lower radius of curvature, and shorten meander length. ..	**Watershed Summary:** PFC surveys were conducted on select reaches of the Olalla-Lookingglass watershed. Representative reaches, totaling about three miles were surveyed for three subwatersheds. The surveys generally found that stream channels are downcutting causing accelerated bank erosion, floodplain abandonment, and narrowing of riparian areas.

Table AA-3
Olalla Creek-Lookingglass Creek Watershed (continued)

Pathway: Channel Condition and Dynamics	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: Surveys generally found that stream channels are downcutting causing accelerated bank erosion, floodplain abandonment, and narrowing of riparian areas. The causes include road encroachment (the most damaging), increased peak flows, lack of LWD, lack of riparian vegetation, over grazing on streambanks and placer mining.	**Watershed Summary:** The Olalla-Lookingglass watershed has a rain dominated precipitation regime because most of the watershed is below 2,000 feet in elevation. The area above 2,000 feet totals about 14 percent of the watershed Many stream channels in the Olalla-Lookingglass watershed have been eroded down to bedrock, probably due to increased peak flows associated with timber harvesting and high road densities. Drainage from roads may be a major cause of increased winter peak flows in streams in the watershed. The watershed analysis recommends reducing road densities in subwatersheds where peak flows have negatively altered stream channel condition and have had negative impacts on the fisheries resource.	**Watershed Summary:** The majority of roads within the Olalla-Lookingglass watershed were constructed with ditches and/or insloped road surfaces designed to carry water flow off of the road surface. Once it is in the ditch, much of the water reaches stream channels faster than in an unroaded area. In fact, some ditchlines effectively function as stream channels extending the actual length of flowing streams during rain storms. Increased drainage densities, due to road construction, may increase peak flows and mean annual floods. Peak flow increases due to channel extension may be estimated using the number of stream crossings. The highest crossing densities would be assumed to have the greatest potential for peak flow increases from road related run-off.
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: Road density in the Olalla-Lookingglass watershed ranges from 2.4 miles per square mile in the Flournoy Creek Drainage to 7.3 miles per square mile in the Shields Creek Drainage with an average of 4.43 miles per square mile. However, not all roads are on GIS and the actual road densities may be higher.	**Watershed Summary:** Many stream channels have eroded down to bedrock due to increased peak flows associated with timber harvesting and high road densities. Channel downcutting has occurred due to over grazing on streambanks and LWD is lacking in many stream channels because of previous stream cleaning practices. Past heavy equipment use in stream channels compacted soils. Road encroachment is the most damaging because once a stream channel has been straightened it would begin to down cut and widen trying to reach a new equilibrium. 20 of 35 stream reaches identified in aquatic habitat inventories were in fair condition, 0 stream reaches were excellent; 8 stream reaches in higher elevations were in good condition. 7 reaches were in poor condition.	**Watershed Summary:** Surveys generally found that stream channels are down cutting causing accelerated bank erosion, floodplain abandonment, and narrowing of riparian areas. The causes include road encroachment (the most damaging), lack of LWD, lack of riparian vegetation, and placer mining. Timber harvesting occurred within riparian areas and l vegetation has not reestablished. Riparian functioning condition in the Olalla-Lookingglass watershed is much less than other watersheds in the Roseburg BLM District. Riparian Reserves within the watershed are composed of 40 percent functional late seral habitat. (Note: BLM portion of watershed is no longer Riparian Reserve, so portion of functional late seral habitat from combined Riparian Reserve and RMA habitat may differ from 40 percent, but likely not substantially).Private riparian areas within the watershed have 14 percent in functional late seral habitat. Taken together, the percentage of functional riparian habitat in the Olalla-Lookingglass watershed is approximately 20 percent. Limiting factors for the fishery resource included the absence of a functional riparian area. The riparian areas in the Olalla-Lookingglass watershed can be improved in the long term by decommissioning roads, placing LWD in streams, planting conifers in riparian areas, and modifying placer mining techniques.
Source: U.S. Department of the Interior, Bureau of Land Management. 1999. Olalla-Lookingglass Watershed Analysis. USDI-Bureau of Land Management, Roseburg District, Roseburg, OR.		

Table AA-4
Middle South Umpqua Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: ODEQ identified the South Umpqua River as water quality limited for stream temperature.Timber harvesting and road building in and adjacent to riparian areas led to higher stream temperatures within the watershed. Water quality concerns: high stream temperatures and low DO levels in Rice Creek that don't meet state water quality standards. Warm water temperatures, lack of over-summering pool habitats, and low flows prevent sea-run cutthroat trout from using stream reaches in the lower part of the basin. Water withdrawn during the summer may decrease available habitat for aquatic life, increase summer water temperatures and pH due to less water volume. Timber harvests and roads in and adjacent to riparian areas have lead to higher stream temperatures.	**Watershed Summary:** The main water quality problems in the watershed were erosion and sedimentation, culverts restricting the stream causing excessive downcutting in the channel. Lack of routine road maintenance may lead to increased sedimentation from road surfaces, landslides from road failures, and an increased risk of culvert problems. About 14 miles of roads are located within Riparian Reserves or RMAs and almost seven miles of road are within 100 feet of a stream. Roads within 100 feet of a stream are more likely to add sediment to the stream. (Note: Distance may differ slightly from 14 miles as values based on Riparian Reserve data.)	**Watershed Summary:** Water quality concerns include high stream temperatures and low DO levels in Rice Creek that do not meet state water quality standards. Kent, Lane, and Rice Creeks were listed as water quality limited in 1998 due to habitat modifications. The habitat modifications included the lack of LWD and pool frequency. The South Umpqua River was listed as water quality limited due to DO by ODEQ.
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: Natural waterfalls, log or debris jams, beaver dams, and road crossings are potential barriers to fish movement and migration. An 8-foot dam limits anadromous fish access on 5 miles of Clark Branch. A 10- foot dam blocks anadromous fish access to ≈ 6.5 miles on the East Fork of Willis Creek. Stream temperatures, DO, sediment, fish passage, and peak flows are could be improved by reducing road densities, replacing culverts, improving roads, and stream restoration projects.	**Watershed Summary:** The Riparian Reserve age class distribution indicates the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed.	**Watershed Summary:** Removing LWD from the stream channels and harvesting vegetation along many streams reduced the amount of LWD recruitment. Most anadromous fish-bearing stream reaches in the watershed are deficient in LWD. Lack of in-stream large wood has, in most instances, negatively altered stream channel dynamics, such as bedload transport and stream substrate distribution. Other channel characteristics impacted by the lack of LWD include stream channel sinuosity, streambank stability, and floodplain interaction.
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: Kent, Lane, and Rice Creeks were listed as water quality limited in 1998 due to habitat modifications. The habitat modifications included the lack of LWD and pool frequency.	**Watershed Summary:** Lack of LWD and pool frequency. Warm water temperatures, lack of over-summering pool habitats, and low flows prevent sea-run cutthroat trout from using stream reaches in the lower basin.	**Watershed Summary:** The lack of in-stream large wood has, in most instances, negatively altered stream channel dynamics, include stream channel sinuosity, streambank stability, and floodplain interaction..
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: Most of the anadromous fish-bearing stream reaches surveyed by ODFW in the watershed are deficient in LWD. The lack of in-stream LWD has, negatively altered stream channel dynamics, such as bedload transport and stream substrate distribution. Other stream channel characteristics impacted by the lack of LWD include stream channel sinuosity, streambank stability, and floodplain interaction.	**Watershed Summary:** Results of a study on Umpqua National Forest during summer from 1989 through 1993 on same stream reaches as surveyed in 1937 showed 22 of the 31 surveyed stream reaches were significantly different from the 1937 survey. 19 stream reaches were significantly wider while the remaining 3 stream reaches were significantly narrower. Of the 8 streams surveyed within designated wilderness areas, only one stream channel increased in width since 1937. But 13 of 14 stream segments located in areas where timber harvesting occurred were significantly wider than in 1937. Stream widening could have resulted from increased peak flows.	**Watershed Summary:** Many low-gradient stream channels in the watershed have been eroded down to bedrock, probably due to increased peak flows as a result of timber harvesting and road construction, channel downcutting due to overgrazing on streambanks, and the lack of LWD due to stream cleaning practices. The lack of in-stream large wood has, in most instances, negatively altered stream channel dynamics, include stream channel sinuosity, streambank stability, and floodplain interaction.

Table AA-4
Middle South Umpqua Watershed (continued)

Pathway: Channel Condition and Dynamics	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: One of the main water quality problems observed in the watershed included roads restricting the natural meandering of streams. The lack of in-stream large wood has, in most instances, negatively altered stream channel dynamics, include stream channel sinuosity, streambank stability, and floodplain interaction. Bureau of Land Management stream survey crews observed many of the streams on BLM-administered land in the South Umpqua watershed are incised and disconnected from their floodplain.	**Watershed Summary:** Many low-gradient stream channels in the watershed have been eroded down to bedrock, probably due to increased peak flows as a result of timber harvesting and road construction, channel downcutting due to overgrazing on streambanks, and the lack of LWD due to stream cleaning practices. The TSZ is defined as land between 2,000 and 5,000 feet in elevation. Only about ten percent of the watershed is area above 2,000 feet in elevation. The Middle South Umpqua watershed is characterized as having a rain dominated precipitation regime. Roads may increase winter peak stream flows in the watershed. Many roads in the watershed are in need of some maintenance. Maintenance is needed to reduce the amount of runoff entering the stream channels. Installing cross drains would disperse the water flowing in the ditchline keeping it from flowing into the stream. This would decrease the potential for larger peak flows.	**Watershed Summary:** The majority of roads within the watershed are constructed with ditches and/or insloped road surfaces designed to carry water off of the road surface. Once it is in the ditch, much of the water reaches the local stream channel faster than in an unroaded area. In fact, some ditchlines effectively function as stream channels extending the actual length of flowing streams during rain storms. Many roads in the watershed are in need of some maintenance. Maintenance is needed to reduce the amount of runoff entering the stream channels. Installing cross drains would disperse the water flowing in the ditchline keeping it from flowing into the stream. This would decrease the potential for larger peak flows.
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: Road densities range from 3.86 to 5.74 miles per square mile. The road density for the watershed is 4.67 miles per square mile. However, road densities may be higher because all roads are may not be on GIS. There are approximately 1,198 stream crossings in the watershed. The average number of stream crossings per stream mile in the watershed is 2.06.	**Watershed Summary:** Many low-gradient stream channels have eroded down to bedrock, probably due to increased peak flows as a result of timber harvesting and road construction, channel downcutting due to overgrazing on streambanks, and the lack of LWD due to stream cleaning practices. Timber harvesting and road building in and adjacent to riparian areas have lead to higher stream temperatures within the watershed. Domestic water withdrawal, irrigation, agriculture, and livestock water use contribute to the lower summer flows. Water withdrawn during summer decreases available aquatic habitat, increase summer water temperatures and pH with less water volume.	**Watershed Summary:** The Riparian Reserve age class distribution indicates the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed. About 14 miles of roads are located within Riparian Reserves and almost seven miles of road are within 100 feet of a stream. Roads within 100 feet of a stream are more likely to add sediment to the stream, because the limited amount of vegetation between the road and stream cannot capture the sediment before it reaches the stream. Timber harvesting and road building in and adjacent to riparian areas have led to higher stream temperatures within the watershed. Approximately half of the roads in the Riparian Reserves are within 100 feet of a stream. The majority of these roads are considered main access routes and not likely to be fully decommissioned. These roads could be renovated or upgraded to minimize the impacts on water quality and the aquatic habitat.
Source: U.S. Department of the Interior, Bureau of Land Management. 1999. Middle South Umpqua Watershed Analysis. USDI-Bureau of Land Management, Roseburg District, Roseburg, OR.		

Table AA-5
Myrtle Creek Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: Timber harvesting and road construction in and adjacent to riparian areas have led to higher stream temperatures within the watershed. South Myrtle Creek and Riser Creek are on the water quality limited list for temperature. Data collected by the BLM show Buck Fork, Letitia, Louis (lower), North Myrtle (lower), Slide, and Weaver (lower) Creeks have also exceeded the water temperature standard. However, they are not on the water quality limited list for temperature, at this time.	**Watershed Summary:** Timber harvesting and road construction in and adjacent to riparian areas have led to higher stream temperatures within the watershed. South Myrtle Creek and Riser Creek are on the water quality limited list for temperature. Data collected by the BLM show Buck Fork, Letitia, Louis (lower), North Myrtle (lower), Slide, and Weaver (lower) Creeks have also exceeded the water temperature standard. However, they are not on the water quality limited list for temperature, at this time.	**Watershed Summary:** Water quality is impacted during the summer low flows. North Myrtle Creek, Riser Creek, and South Myrtle Creek are included in the 1998 303(d) list. South Myrtle Creek is listed for flow modification from the mouth to Weaver Creek. Trace metal data have not been collected in the watershed and no streams have been listed as water quality limited due to trace metal toxicity. ODEQ Biotic Index (BI) data indicated 8 sites have slight impairment and 4 sites have moderate impairment. The 4 moderately impaired streams include lower Weaver Creek, lower Louis Creek, lower North Myrtle Creek, and Slide Creek (near the mouth) had the lowest BI and habitat scores with most days above the standard (17.8^{o}C).
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: Anadromous fish distribution limits and documented stream barriers in the Myrtle Creek watershed have been mapped, using GIS. Natural waterfalls, log or debris jams, beaver dams, and road crossings (culverts) are potential barriers to fish migration. Other barriers to fish migration may be due to water quality impairment, such as high or low pH, or high water temperatures.	**Watershed Summary:** ODFW inventories indicate sediment in spawning habitat was a limiting factor in some stream reaches. The lack of in-stream large wood has, in most instances, negatively altered stream channel dynamics, such as bedload transport and stream substrate distribution. The Riparian Reserve age class distribution indicates the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed.	**Watershed Summary:** ODFW AHI surveys indicated many of the second through fifth order streams in the watershed do not meet the LWD Frequency (4 or more functional key pieces of wood/ 100 meters for 50 percent of the stream length). Five of the eight surveyed reaches on North Myrtle Creek do not meet the Oregon Coast Salmon Restoration Initiative (CSRI) key LWD criteria used by ODEQ.Past management practices, such as stream cleaning, road construction, and salvaging activities in riparian areas, left many streams lacking LWD.
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: Low pool frequency was identified by ODEQ as one of the causes for including North Myrtle Creek on the water quality limited list for habitat modification. ODFW inventories indicate low percent pool area was a limiting factor in some stream reaches. The low frequency and volume of in-stream wood has resulted in fewer pool habitats for fish.	**Watershed Summary:** The Riparian Reserve age class distribution indicates the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed.	**Watershed Summary:** The Riparian Reserve age class distribution indicates the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed..
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: Not described, except in terms of restoration. For example, improved pool frequency conditions would help restore the groundwater and floodplain connection and increase the groundwater and stream interaction with an expected increase in cool water refugia.	**Watershed Summary:** The ODFW habitat survey data shows that most stream reaches surveyed in the Myrtle Creek Watershed had riffle width to depth ratios ranging from excellent to poor, with an average rating of fair. About one-half of all reaches were rated as fair or poor. The data indicates channel widening may have occurred in some stream reaches in the Myrtle Creek Watershed. These changes in channel condition may have contributed to the decline of anadromous salmonid stocks in the Myrtle Creek Watershed.	**Watershed Summary:** Historic stream conditions indicate riparian areas were dominated by old growth forests and banks were armored by massive root systems. Surveys conducted in the watershed noted downcutting and bank erosion on some stream reaches. Stream channel characteristics impacted by the lack of LWD include streambank stability.

Table AA-5
Myrtle Creek Watershed (continued)

Pathway: Channel Condition and Dynamics	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: Stream channel characteristics impacted by the lack of LWD include stream channel sinuosity, and floodplain interaction. Bureau of Land Management survey crews observed many streams on BLM-administered land in the Myrtle Creek Watershed are incised and disconnected from their floodplain.	**Watershed Summary:** Many roads need maintenance to reduce the amount of runoff entering streams. Installing cross drains would disperse the water flowing in the ditchline keeping it from flowing into streams. This would decrease the potential for larger peak flows, increase the amount of subsurface flow, and provide more sediment filtration. Many low-gradient stream reaches have eroded to bedrock, probably due to increased peak flows as a result of timber harvesting, road construction, Himalayan blackberry noxious weeds dominating some riparian areas, channel down cutting due to overgrazing on streambanks, and the lack of LWD due to stream cleaning practices.	**Watershed Summary:** 15 drainages have road densities >4 miles/mi^2 , affecting watershed hydrology. Drainages with road densities >4 miles/mi^2, numerous stream crossings, and intensive timber harvesting activities probably have led to peak flows greater than in undisturbed drainages.
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: Road densities in the watershed range from 3.03 to 5.94 miles/mi^2 averaging 4.36 miles/mi^2. Road densities on BLM-administered land range from 0 to 6.82 miles/mi^2 averaging 3.85 miles/mi^2. NMFS considers properly functioning condition when road density <2miles/mi^2. No drainages in the watershed have <2 miles/mi^2 of roads. There are approximately 1,823 stream crossings in the watershed with stream crossing ranging from 1.22 to 3.06 crossings/stream mile, averaging 2.08 crossings/stream mile.	**Watershed Summary:** Many streams have been impacted from agriculture, timber harvesting, and urbanization and development. Much land along South and North Myrtle Creeks has been converted to agriculture. Tributaries have been straightened for agricultural use. Riparian are as may have a thin buffer of deciduous trees along the streambanks. Domestic water withdrawal, irrigation, industrial, and livestock watering use contribute to lower summer flows. Water withdrawn during the summer may decrease aquatic, increase summer water temperatures and pH, and decreased DO with less water volume. Shade along portions of North and South Myrtle Creek has been reduced by agriculture and human settlement. The greatest loss of shade on federal lands from tree harvest in riparian zones.	**Watershed Summary:** ODFW inventories indicate hardwood dominated riparian areas, the lack of large conifers available for future recruitment of LWD and lack of shade (contributing to higher stream temperatures) were limiting factors in some stream reaches. Past management practices, such as stream cleaning, road construction, and salvaging activities in riparian areas, left many streams lacking in LWD. The ODFW aquatic habitat inventory data classified riparian vegetation size as shrubs or medium sized trees on about 40 percent of the stream reaches surveyed. The Riparian Reserve age class distribution indicates the stream channels are less complex, the substrate has been degraded, and fish habitat is poor in many areas of the watershed.
Source: U.S. Department of the Interior, Bureau of Land Management. 2002. Myrtle Creek Watershed Analysis and Water Quality Restoration Plan. USDI-Bureau of Land Management, Roseburg District, Roseburg, OR.		

Table AA-6
South Umpqua River Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: Based on BLM monitoring data 10 out of the 17 monitored sites in the watershed exceeded the water quality standards for rearing temperature regardless of yearly climate differences. Water temperatures in lower Coffee Creek, lower Days Creek, Lavadoure Creek, the East Fork of Stouts Creek, Stouts Creek, and the West Fork of Canyon Creek exceeded water quality standards most of the summers.	**Watershed Summary:** Sediment data have not been collected by the BLM in this watershed. However, the ODEQ listed part of the South Umpqua River as water quality limited due to sediment.	**Watershed Summary:** Beals Creek, Days Creek, and Shively Creek were on the water quality limited list for habitat modification. Fate Creek, Stouts Creek, and the East Fork of Stouts Creek were on the water quality limited list for temperature. The South Umpqua River through portions of the watershed was on the water quality limited list due to toxics, flow modification, aquatic weeds or algae, bacteria, biological criteria, DO, sediment, pH, and temperature.
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: All of the barriers to fish migration in the Watershed have not been identified or mapped.	**Watershed Summary:** BLM macroinvertebrate and stream substrate embeddedness surveys assessed sedimentation and aquatic life use in major tributaries. Surveys on BLM-administered lands in the watershed exhibited three of the ten sites sampled indicated the streams were moderately impaired from sedimentation. Sites in Stouts Creek, Coffee Creek, and St. John Creek had both high levels of embeddedness, Most anadromous fish-bearing stream reaches surveyed by ODFW are deficient in LWD. Lack of in-stream LWD has negatively altered stream channel dynamics, bedload transport and stream substrate distribution.	**Watershed Summary:** Stream cleaning, road construction, and salvaging activities in riparian areas removed LWD. Early seral vegetation along many streams prohibits LWD recruitment. Removal of large wood from the stream and potential woody debris from riparian area had considerable direct impact on stream channel morphology. ODFW habitat survey shows 61 percent of stream reaches with no mature trees (≥20 inches or 50 cm DBH) within 100 feet (30 meters) of either side of the stream channel. Most reaches were deficient in LWD. Low frequency and volume of in-stream LWD led to fewer pool habitats. Lack of in-stream LWD has negatively altered stream channel dynamics, bedload transport and stream substrate distribution. Also impacted by the lack of LWD include stream channel sinuosity, streambank stability, and floodplain interaction.
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: Pool frequencies in the South Umpqua River and its tributaries have been impacted by channel simplification, loss of LWD, sedimentation, and increased width/depth ratios.	**Watershed Summary:** Channel simplification has increased channel width, decreased channel depth, and reduced pool size and frequency in the upper South Umpqua River	**Watershed Summary:** Problems associated with channelization, road encroachment on the stream channel, and upstream channel conditions were noted on the PFC surveys..
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: Restoration activities would lead to channel recovery by decreasing the amount of sediment entering streams. Improved pool frequency conditions would help restore the groundwater and floodplain connection and increase the groundwater and stream interaction with an expected increase in cool water refugia.	**Watershed Summary:** Stream surveys showed most stream reaches had riffle width to depth ratios which averaged as fair. 46 percent of all reaches were rated as fair to poor and channel widening may have occurred in some stream reaches. Much of the land along the South Umpqua is used for agriculture purposes. In the agricultural areas many tributaries have been straightened or there flow patterns altered. Main problems observed in the watershed were culverts restricting the stream causing excessive downcutting in the channel, and roads restricting the natural meandering of streams..	**Watershed Summary:** Stream channel characteristics impacted by the lack of LWD include stream channel sinuosity, streambank stability, and floodplain interaction.

Table AA-6
South Umpqua River Watershed (continued)

Pathway: Channel Condition and Dynamics	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: In agricultural areas many tributaries have been straightened or there flow patterns altered. The higher elevations are a combination of federal and private timber land. Many streams on BLM lands are incised and disconnected from their floodplain. A main problem observed in the watershed was, culverts restricting the stream causing excessive downcutting in the channel, and roads restricting the natural meandering of streams.	**Watershed Summary:** The South Umpqua watershed is characterized as having a rain dominated precipitation regime, because 52 percent of the watershed is below 2,000 feet in elevation. Roads may increase winter peak flows in streams in the watershed. Thirty-two drainages in the watershed have road densities greater than four miles per square mile, which can affect the hydrology. Drainages with road densities greater than four miles per square mile, numerous stream crossings, and intensive timber harvesting activities probably have experienced peak flows greater than what would have occurred in an undisturbed drainage. Many roads in the watershed are in need of some maintenance to reduce the amount of runoff entering streams. This maintenance would decrease the potential for large peak flows.	**Watershed Summary:** Roads may increase winter peak flows in streams in the watershed. Thirty-two drainages in the watershed have road densities greater than four miles per square mile, which can affect the hydrology. Drainages with road densities >4 miles/mi^2, numerous stream crossings, and intensive timber harvesting activities probably have experienced peak flows greater than what would have occurred in an undisturbed drainage.
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: Road densities in the watershed range from 1.86 to 9.76 mi/mi^2 with an average of 4.56 mi/mi^2. There are approximately 2,985 stream crossings in the watershed. Stream crossing densities in the watershed range from 0.26 to 6.42 crossings per stream mile. The average number of stream crossings per stream mile in the watershed is 2.12. NMFS considers an area to be in a properly functioning condition when the road density is less than two miles per square mile. Two drainages in the watershed have less than two miles per square mile of roads.	**Watershed Summary:** Domestic water withdrawal, irrigation, livestock watering use contribute to lower summertime streamflows. Water withdrawn during summer may decrease available habitat for aquatic life, increase summer water temperatures and pH, and decrease DO because less water is in the stream. Removing LWD from the stream channels in the past and harvesting vegetation along many streams has reduced the amount of LWD available for in-stream structures. Timber harvesting and road construction in and adjacent to riparian areas have lead to higher stream temperatures within the watershed. Many streams have been impacted from agriculture, timber harvesting, and urban settlement and development.	**Watershed Summary:** Much of the land along the South Umpqua is used for agriculture purposes. Most of the native vegetation has been replaced with low growing vegetation, generally grasses. Riparian areas may have deciduous trees along the stream banks. About 109 miles of roads are located within Riparian Reserves and about 60 miles of roads are within 100 feet of a stream. Roads within 100 feet of a stream are more likely to add sediment to the stream, because the limited amount of vegetation between the road and stream cannot capture the sediment before it reaches the stream.
Source: U.S. Department of the Interior, Bureau of Land Management. 2001. South Umpqua Watershed Analysis and Water Quality Restoration Plan. USDI-Bureau of Land Management, Roseburg District, Roseburg, OR.		

Table AA-7
Cow Creek Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: Stream temperatures are cool throughout most of the watershed; they begin to rise in the wide, shallow part of the mainstem of Cow Creek. Cow Creek has no large tributaries that affect its temperature. The maximum temperature was 75 degrees F in the summer of 1995. Canopy cover was above 80 percent of the lower order reaches (1^{st}, 2^{nd}, and 3^{rd}) averaged 88 percent for 4^{th} order reaches and 52 percent for 5^{th} order reaches of Cow Creek. Water temperature and canopy suggest good stream shading in the watershed.	**Watershed Summary:** Sediment is likely the most limiting factor to aquatic health throughout the basin. Approximately 69.4 percent of the watershed is in the high or very high soil erosion and mass wasting risk potential. Landslides and surface erosion put sediment into streams, filling pools and riffles. 76 percent of the landslides and debris torrents are caused by harvest activities, 21 percent by road and only 3 percent are natural	**Watershed Summary:** Sediment is likely the most limiting factor to aquatic health throughout the basin. pH measured between 7.0 and 8.0. Several sites had pH measurements greater than 8.0, including Cow Creek. Algae which can raise pH of water was often observed in the wide, unconstrained, shallow, bedrock/sand dominated lower reaches of Cow Creek.
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: The Upper Cow Creek watershed no longer supports anadromous fisheries due to the construction of the Galesville Dam in 1995.	**Watershed Summary:** Changes in sediment composition due to road construction, timber harvest, mining, debris torrents and livestock grazing all have an impact on salmonid reproduction.	**Watershed Summary:** Surveys identified large variability in coarse woody debris materials. Although 35 percent of these transects were located in areas where the stream buffer did not have harvest units, these transects did not have higher amounts of wood. Management practices used in the Cow Creek drainage may explain absence of wood in some locations including burning in-channel debris dams during low flow, loss of wood during 1964 and 1974 floods. Also, several smaller flood events in recent decades may have removed marginal sized wood.
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: The streams within the basin are primarily storage systems; fine sediments are stored in pools and behind large woody material, reducing spawning substrate and pool habitat.	**Watershed Summary:** Fine sediment simplifies the stream substrate composition, which reduces macro-invertebrate habitat values.	**Watershed Summary:** The lack of large wood in riparian areas has simplified channel structure..
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: Not described	**Watershed Summary:** Past timber harvesting and road construction may be altering the magnitude and timing of peak flow events, thereby impacting stream channel conditions.	**Watershed Summary:** Loss of trees from streambanks made the banks more susceptible to erosional processes.

Table AA-7
Cow Creek Watershed (continued)

Pathway: Channel Condition and Dynamics	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: In some locations floodplains have been restricted.	**Watershed Summary:** Past timber harvesting and road construction may be altering the magnitude and timing of peak flow events. Increased size of peak flows appears to be related to cumulative effects of timber harvesting, primarily clearcut logging in the TSZ. The majority (76.8 percent) of the watershed occurs above the TSZ - 2,500 feet.	**Watershed Summary:** Average channel extension was 27.2 percent for the watershed from roads on NFS lands in the watershed. Higher road densities/increased channel extensions are expected in the watershed on private lands where roads are not constructed to same standards.
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: Road densities range from 0.69 to 5.49 mi/mi^2 with an average of 3.02 mi/mi^2, although 11 of the 18 WAA exceed this average. The total miles of roads in the watershed on all landowners are unknown.	**Watershed Summary:** Roads, timber harvest, mining and grazing have increased landslide and general sedimentation rates over high - natural levels, adversely impacting water quality and aquatic habitat. Roads contribute to the disruption of floodplain connectivity, large wood and nutrient storage regimes, peak flow routing, aquatic habitat, habitat complexity, temperature regimes and channel morphology.	**Watershed Summary:** 31 percent of federal lands in Riparian Reserves are in late-seral condition, historical conditions were 40-60 percent. Riparian area modifications, road construction; removal of riparian vegetation, large woody material, and complex channel structure; and physical alterations of the channels have adversely impacted fisheries and water quality. Many riparian areas are deficient in large conifers, which are future sources of large woody material. 9.5 percent of the riparian acreage in Cow Creek is roaded.
Source: U.S. Department of Agriculture, Forest Service (Forest Service). 1995. Cow Creek Watershed Analysis. Umpqua National Forest, Roseburg, OR		

Table AA-8
Trail Creek Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: Most streams in watershed are below 3,400 feet with water temperatures >64°F.	**Watershed Summary:** Relatively high input of fine sediment from roads in several sub-watersheds may have contributed to high fines in riffle substrates and in spawning gravel.	**Watershed Summary:** Nutrient deficiency possible. West Fork Trail Creek on 2002 ODEQ 303d list for DO, June 1 to September 30.
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: Passage barriers (cascades, high-gradient stream reaches, waterfalls, log jams, improperly sized culverts) present.	**Watershed Summary:** Gravel and cobble substrates are uncommon - washed out during flood events and/or removed to facilitate log transport. Bedrock, boulder substrates are common.	**Watershed Summary:** 33 percent of all fish-bearing streams have moderate/high LWD recruitment potential. LWD density is relatively low for western Cascade streams.
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: Past LWD removal from channels to facilitate log transport and flooding reduced pool frequency.	**Watershed Summary:** High levels of fines, low levels of gravel/cobble	**Watershed Summary:** Very little channel meandering an alluvial bank cutting - Trail Creek channel is entrenched, disconnected from its floodplain with unusually low sinuosity..
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: Unknown	**Watershed Summary:** Recommends reducing width to depth ratios - channels became wider during recurrent flood events..	**Watershed Summary:** Riparian areas typically narrow with canopy density variable, averaging 64 percent.
Pathway: Channel Condition and Dynamics	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: Very little channel meandering an alluvial bank cutting - Trail Creek channel is entrenched, disconnected from its floodplain with unusually low sinuosity.	**Watershed Summary:** Changes in forest stand structure and road densities with discharge directly into stream networks have directly affected peak flows.	**Watershed Summary:** Road networks within riparian areas are extensive on federal and nonfederal lands.
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: Road networks within riparian areas are extensive on federal and nonfederal lands.	**Watershed Summary:** Extensive land clearing, bottomland reclamation for pasture, road building on floodplain, riparian logging, use of Trail Creek for log transport.	**Watershed Summary:** Severe degraded conditions in main fish-bearing channels related to direct channel disturbance and management practices within riparian areas that have lead to depletion of LWD followed by loss of gravel and habitat diversity.
Source: Western Watershed Analysts and Maxim Technologies, Inc. 1999. Trail Creek Watershed Analysis. USDI-Bureau of Land Management, Medford District, Medford, OR.		

Table AA-9
Lower Big Butte Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: Several sites in the watershed exceeded ODEQ water quality standards >64°F.	**Watershed Summary:** Sediment delivered to stream channels from roads a result of surface erosion, stream crossing failure, construction in erodible areas.	**Watershed Summary:** 3 streams in watershed on 303d list in 1996 due to temperature, sedimentation, and flow.
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: Numerous natural barriers (falls, bedrock chutes, log jams, gradient) and manmade (water diversions, diversion canals, irrigation pumps, culverts, diversion dams).	**Watershed Summary:** Spawning gravels range from fair to excellent in 1972, fair or unknown in 1996.	**Watershed Summary:** Lack of LWD in watershed is the single most deficient component.
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: Not described.	**Watershed Summary:** Pool quality range from fair to good in 1972, poor, fair or unknown in 1996.	**Watershed Summary:** Some floodplains generally narrow, restricted by high terraces, hillslopes and V-shaped valleys.
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: Springs within creeks provide cool temperatures for fish refuge.	**Watershed Summary:** Streams in valley bottoms most likely had lower width/depth ratios. .	**Watershed Summary:** High flows in burned areas had most influence on stream channel stability and streambank erosion.
Pathway: Channel Condition and Dynamics	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: Propose restoring development of side channels and meanders by reconnecting channelized streams with from floodplain.	**Watershed Summary:** Rain-on-snow storm events in Transient Snow zone chain increase flooding.	**Watershed Summary:** Not described
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: 62 miles of road in Riparian Reserves on federal lands.	**Watershed Summary:** Major cause for degradation of aquatic habitat were rural development, logging, roads, livestock grazing.	**Watershed Summary:** 62 percent of federal lands in Riparian Reserves/RMAs in late and mature seral stage but only 11 percent in late/mature seral stage within watershed.(Note: Percent may change slightly as values based on Riparian Reserve areas).
Source: U.S. Department of the Interior, Bureau of Land Management (BLM). 1999. Lower Big Butte Watershed Analysis. USDI-Bureau of Land Management, Medford District, Medford, OR.		

Table AA-10
Little Butte Creek Watershed

Pathway: Water Quality	**Pathway:** Water Quality	**Pathway:** Water Quality
Indicator: Temperature	**Indicator:** Sediment/Turbidity	**Indicator**: Chemical Contamination/ Nutrients
Description: Water temperature during spawning, migration and rearing	**Description:** Percentage and sizes of fines in gravel; relative turbidity rating	**Description:** Relative contaminant (from various sources) rating; 303(d) listed
Watershed Summary: Water temperatures in 1996 (7-day average) exceeded 64°F in five streams in watershed.	**Watershed Summary:** ODFW 1994 measured high percentage of fine sediment in major drainages (Little Butte, S.F. Little Butte, Deer, Lake, Lost and Soda Creeks).	**Watershed Summary:** Nutrient deficiency possible. Lick Creek on 2002 ODEQ 303d list for DO, Jun 1-Sep 30. Salt Creek, Lick Creek for *E.coli* June 1 to September 30.
Pathway: Habitat Access	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Physical Barriers	**Indicator**: Substrate	**Indicator**: LWD
Description: Presence of man-made barriers affecting fish passage	**Description:** Measured substrate category: cobble, gravel, bedrock, sand, silt and degree of embeddedness	**Description:** Measured pieces/mile with specific size dimensions
Watershed Summary: Natural (falls, steep gradients, dry channels in summer) and man-made barriers (reservoirs, culverts, in-stream water diversion structures, screened/unscreened irrigation pumps).	**Watershed Summary:** Portions of major drainages with high percentage of fine sediment (no update following 1997 New Year's Day flood). Fish Lake dam traps larger particles (cobble, gravel).	**Watershed Summary:** Most stream reaches survey in 1991, 1994 had very low amounts of LWD (changed after 1997 New Year's Day flood).
Pathway: Habitat Elements	**Pathway:** Habitat Elements	**Pathway:** Habitat Elements
Indicator: Pool Frequency	**Indicator**: Pool Quality	**Indicator**: Off-Channel Habitat
Description: Measured pools/mile for stream channel width categories	**Description:** Evaluation of pool depth, vegetative cover, water temperature, degree of fine sediment fill	**Description:** Evaluation of backwaters, vegetative cover, off-channel features
Watershed Summary: Low pool to riffle ratios. Removal of pools a result of stream cleanout for flood control, timber and firewood harvest.	**Watershed Summary:** Low pool quality (limited depth and cover) due to LWD removal from system.	**Watershed Summary:** Loss and/or reduction of wetlands and floodplains from forestry and agricultural practices on federal/nonfederal lands..
Pathway: Habitat Elements	**Pathway:** Channel Condition and Dynamics	**Pathway:** Channel Condition and Dynamics
Indicator: Refugia	**Indicator**: Width/Depth Ratio	**Indicator**: Streambank Condition
Description: Evaluation of important remnant habitat for sensitive aquatic species.	**Description:** Measured stream width/depth ratio category	**Description:** Evaluation of streambank stability category
Watershed Summary: Macroinvertebrate presence indicative of high temperatures, high sediment loads (poor refugia conditions).	**Watershed Summary:** Removal of LWD results in reduced sinuosity, closing side channels, increased width-to-depth ratio, loss of riparian vegetation. .	**Watershed Summary:** Some streambanks with over 50 percent actively eroding in 1991, 1994.
Pathway: Habitat Elements	**Pathway:** Flow/Hydrology	**Pathway:** Flow/Hydrology
Indicator: Floodplain Connectivity	**Indicator**: Change in Peak/ Base Flows	**Indicator**: Increase in Drainage Network
Description: Evaluation of hydrologic linkage off-channel and main channel, overbank flows, wetland function, riparian succession	**Description:** Evaluation of hydrograph flows relative to undisturbed watershed	**Description:** Evaluate roads relative to drainage network
Watershed Summary: LWD has been placed on floodplains to provide microsites for riparian vegetation and/or vegetation protection during flood events.	**Watershed Summary:** Streams without high enough flows in winter to flush out accumulated sediments – result of Fish Lake Dam on N.F. Little Butte Creek.	**Watershed Summary:** High road densities >4.0 mi/sq.mi.in some areas of the watershed with nearly 2,500 stream crossings by roads.
Pathway: Watershed Conditions	**Pathway:** Watershed Conditions	**Pathway:** Watershed Conditions
Indicator: Road Density and Location	**Indicator**: Disturbance History	**Indicator**: Riparian Reserves/RMAs
Description: Evaluate road density (mi/mi^2) and valley bottom roads	**Description:** Evaluate disturbance in unstable areas, refugia, riparian areas, relative to NWFP and retention of late successional/ old growth in watershed	**Description:** Evaluate functional components of riparian system, grazing impact, riparian vegetation relative to potential natural vegetation
Watershed Summary: High road densities >4.0 mi/sq.mi.in some areas of the watershed with nearly 2,500 stream crossings by roads.	**Watershed Summary:** Stream channelization, in-stream wood removal, stream-adjacent roads, logging in riparian and sensitive (unstable) upland areas, poor farming/grazing practices, residential development.	**Watershed Summary:** Riparian habitat improvements to overcome degraded conditions include 1) fence an/or alter agricultural and livestock management, 2) plant conifers and hardwoods for LWD recruitment and shade, 3) placing LWD on floodplains to reestablish connectivity.
Source: U.S. Department of Agriculture, Forest Service. 1997. Little Butte Creek Watershed Analysis. Version 1.2. Rogue River National Forest, Ashland Ranger District, Ashland, OR.		

APPENDIX BB

Jordan Cove Noise Assessments

Appendix BB.1 **Baseline Ambient Sound Level Survey Report**

Appendix BB.2 **Computer Noise Modeling and Mitigation Report**

Appendix BB.3 **Marine Mammal Airborne Noise Impact Assessment**

Appendix BB.4 **Underwater Noise Impact Assessment**

APPENDIX BB.1

Baseline Ambient Sound Level Survey Report

global environmental solutions

Jordan Cove Energy Project, L.P.

JCEP LNG Terminal

Baseline Environmental Noise Survey

SLR Ref: 108.01593.00004

September 18, 2017

Draft Rev. 2

JCEP LNG Terminal

Baseline Environmental Noise Survey

Prepared for:

Jordan Cove LNG LLC
5615 Kirby Drive, Suite 500
Houston, Texas 77005

This document has been prepared by SLR International Corporation. The material and data in this report were prepared under the supervision and direction of the undersigned.

Jessica Stark, P.E.
Principal Engineer

Laurie Morrill
Associate Scientist

CONTENTS

CONTENTS (CONTINUED)

TABLES

ATTACHMENTS

APPENDICES

ACRONYMS AND ABBREVIATIONS

dB	Decibel
dB(A)	A-weighted Decibel
L_{eq}	Equivalent Continuous Sound Level
L_{dn}	Day-Night Average Sound Level
m/s	meters-per-second
mph	miles-per-hour
NSA	Noise Sensitive Area

REFERENCE STANARDS

ANSI S12.9, "Quantities and Procedures for Description and Measurement of Environmental Sound."

ANSI S12,18, "Procedures for Outdoor Measurement of Sound Pressure Level."

ANSI S12.100, "Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas."

ISO 1996-1, "Acoustics – Description, measurement and assessment of environmental noise, Part 1: Basic quantities and assessment procedures."

ISO 1996-2, "Acoustics – Description, measurement and assessment of environmental noise, Part 2: Determination of environmental noise levels."

SUMMARY

At the request of Jordan Cove Energy Project, L.P. (JCEP), SLR International Corporation (SLR) has conducted baseline ambient sound level monitoring for the proposed natural gas liquefaction and liquefied natural gas (LNG) export facility (LNG Terminal).

This report presents the results of the sound level measurements for the JCEP Project area. The measurement results are summarized in the table below.

Summary of Long-Term Baseline Sound Level Measurement Data

Receptor	Distance to Receptor, Miles	Direction	Measurement Duration[1] HH:MM	Daytime[2] L_{eq}, dBA	Nighttime[3] L_{eq}, dBA	Ambient L_{dn}, dBA
NSA 1	1.3	South	29:48	51.7	43.9	**52.7**
NSA 2	2.2	East	32:39	62.7	57.5	**65.2**
NSA 3	1.3	Northeast	32:03	57.9	40.3	**56.3**
REC 1	0.7	West	31:50	51.1	48.3	**55.2**

(1) The Measurement Duration represents the total duration of valid data, when the wind speed was less than 6.6 m/s.

(2) Daytime is 7:00 a.m. until 10:00 p.m.

(3) Nighttime is 10:00 p.m. until 7:00 a.m. the next day.

1. INTRODUCTION

At the request of Jordan Cove Energy Project, L.P. (JCEP), SLR International Corporation (SLR) has conducted baseline ambient sound level monitoring for the proposed natural gas liquefaction and liquefied natural gas (LNG) export facility (LNG Terminal). The facility site is located on the bay side of the North Spit of Coos Bay, Oregon. This report presents the results of the sound level measurements for the JCEP Project area.

2. ENVIRONMENTAL SOUND LEVEL CRITERIA

2.1 FEDERAL

The environmental sound level contributions from the proposed equipment at this facility are subject to the FERC noise regulation governing interstate gas transmission compressor stations and LNG facilities. The FERC noise regulation is receptor based, and limits LNG facility noise contributions to no more than 55 dB(A) day-night average (L_{dn}) or, equivalently, no more than a continuous 48.6 dB(A) at the surrounding noise sensitive areas (NSAs) such as schools, hospitals, or residences.

2.2 STATE AND LOCAL

The ODEQ noise standards are contained in OAR, Chapter 340, Division 35 – Noise Control Regulations. The OAR noise regulations are not directly applicable to the operational noise from the LNG Terminal site.

The City of North Bend has a noise ordinance that prohibits the "making of unnecessary noise," but the ordinance has no specific numerical limits (North Bend City Code, Section 9.04.030). Daytime construction noise between the hours of 7 a.m. to 6 p.m. is exempt under the North Bend ordinance. The project is located in Coos County, but Coos County does not have a noise ordinance.

3. SOUND LEVEL SURVEY AND SITE ASSESSMENT

3.1 METHODOLOGY

A baseline ambient environmental sound level survey was conducted near the JCEP project area by Jessica Stark and Kellye Larsen of SLR on May 23 – 26, 2017. Sound level monitors were positioned near each receptor, as shown on the attached Figure 1 in order to measure environmental sound levels during daytime and nighttime hours. Over 72 hours' worth of continuous sound measurement data were collected at each location. An averaging period with 1-hour samples was used. Sound levels were also simultaneously collected in terms of 60-second averages to capture shorter-term variations in sound levels. The sound meters were time synchronized with each other. Microphones were located approximately 5 feet above the ground and a windscreen was used.

3.2 NOISE SENSITIVE AREAS

A drawing showing the approximate distance and direction from the facility to the receptors is shown in the attached Figure 1 and summarized in Table 1. Distances are referenced from the center of the proposed liquefaction area. There were three NSAs identified. NSAs 1 and 2 represent residential communities consisting primarily of single family houses. NSA 3 was a campground and recreation area. A fourth recreational area was monitored and is referred to as REC 1.

Table 1: Summary of Pre-existing Noise Sensitive Areas

Receptor	Description	Direction to Receptor	Distance, miles
NSA 1	Residential	South	1.3
NSA 2	Residential	East	2.2
NSA 3	Campground	Northeast	1.2
REC 1	Recreational	West	0.7

3.3 MEASUREMENT EQUIPMENT

Sound level equipment used during the site survey included the following instruments:

- Larson Davis Model 831 SLM; Type 1; s/n 0001736, 0001737, and 0002443
- Brüel & Kjær Model 4231 Pure Tone Calibrator; Class 1; s/n 2240964

Equipment was field calibrated before and after measurement intervals. All instrumentation has current laboratory certification. Calibration certificates are attached.

3.4 WEATHER CONDITIONS

Weather station data (wunderground.com) for the North Bend Municipal Airport, North Bend, Oregon (KOTH) were used to determine ranges of environmental parameters during the monitoring period, as summarized in Table 2.

Table 2: Weather Data During the Monitoring Period

Date	May 23 – 26, 2017
Temperature	48 – 61° F
Relative Humidity	59 – 100%
Wind Direction	North & NNE
Wind Speed	0 – 33 mph
Sky Condition	Clear
Ground Condition	Damp

The wind was generally from the north (59% of the time) and north-northeast (12%) during the survey. The wind speed was 10 mph or less 36% of the time. There was no precipitation during the survey period.

3.5 DATA REDUCTION

ANSI S12.18 does not allow for sound level measurements during wind speeds greater than 5 m/s (11.2 mph). To account for the fact that data were collected at a height of 5 feet (1.5 m) above ground, and a typical weather station anemometer is located at a height of 10 m above ground, the wind speed threshold was adjusted for height using wind profile power law. Based on this equation, which corrects between wind speeds at different heights, a speed of 6.6 m/s (14.8 mph) at a height of 10 m was found to correspond to a speed of 5 m/s at a height of 1.5. Therefore, measurement data that were collected during periods with wind speed exceeding 6.6 m/s were excluded from analysis.

The wind speed exceeded this for 44 percent of the measurement duration. The monitored sound level data were processed to eliminate data from periods when wind speeds exceeded 6.6 m/s. The following tables show, for the respective receptors measuring locations, the data reduction including the total cumulative amount of measurement time used to determine the L_{dn} for each location.

Table 3: Data Reduction to Exclude High Wind Speeds at NSA 1.

	Minutes	23-May	24-May	25-May	26-May	Total Minutes	Hours	Minute s	%
Day	Used	37	156	341	163	**697**	11	37	25.6
	Total	761	900	900	163	**2724**	45	24	
Night	Used	224	404	500	0	**1128**	18	48	69.6
	Total	540	540	540	0	**1620**	27	0	
Day + Night	Used	261	560	841	163	**1825**	30	25	42.0
	Total	1301	1440	1440	163	**4344**	72	24	

Table 4: Data Reduction to Exclude High Wind Speeds at NSA 2.

	Minutes	23-May	24-May	25-May	26-May	Total Minutes	Hours	Minutes	%
Day	Used	0	156	341	334	**831**	13	51	30.4
	Total	601	900	900	334	**2735**	45	35	
Night	Used	224	404	500	0	**1128**	18	48	69.6
	Total	540	540	540	0	**1620**	27	0	
Day + Night	Used	224	560	841	334	**1959**	32	39	45.0
	Total	1141	1440	1440	334	**4355**	72	35	

Table 5: Data Reduction to Exclude High Wind Speeds at NSA 3.

	Minutes	23-May	24-May	25-May	26-May	Total Minutes	Hours	Minutes	%
Day	**Used**	0	156	341	285	**782**	13	2	28.8
	Total	627	900	900	285	**2712**	45	12	
Night	**Used**	224	404	500	0	**1128**	18	48	69.6
	Total	540	540	540	0	**1620**	27	0	
Day + Night	**Used**	224	560	841	285	**1910**	31	50	44.1
	Total	1167	1440	1440	285	**4332**	72	12	

Table 6: Data Reduction to Exclude High Wind Speeds at REC 1.

	Minutes	23-May	24-May	25-May	26-May	Total Minutes	Hours	Minutes	%
Day	**Used**	0	156	341	298	**795**	13	15	29.3
	Total	617	900	900	298	**2715**	45	15	
Night	**Used**	224	404	500	0	**1128**	18	48	69.6
	Total	540	540	540	0	**1620**	27	0	
Day + Night	**Used**	224	560	841	298	**1923**	32	3	44.4
	Total	1157	1440	1440	298	**4335**	72	15	

3.6 MEASUREMENT RESULTS AND AMBIENT SOUND ENVIRONMENT

The 24-hour day-night average (L_{dn}) sound levels have been determined based on the data-reduced daytime and nighttime sound levels measured at the four monitoring positions. The results are shown in Table 7. Level versus time graphs are included in Appendix A.

Table 7: Summary of Long-Term Baseline Sound Level Measurement Data

Receptor	Distance to Receptor, Miles	Direction	Duration[(1)] HH:MM	Daytime[(2)] L_{eq}, dBA	Nighttime[(3)] L_{eq}, dBA	Ambient L_{dn}, dBA
NSA 1	1.3	South	29:48	51.7	43.9	**52.7**
NSA 2	2.2	East	32:39	62.7	57.5	**65.2**
NSA 3	1.3	Northeast	32:03	57.9	40.3	**56.3**
REC 1	0.7	West	31:50	51.1	48.3	**55.2**

(1) The Measurement Duration represents the total duration of valid data, when the wind speed was less than 6.6 m/s.

(2) Daytime is 7:00 a.m. until 10:00 p.m.

(3) Nighttime is 10:00 p.m. until 7:00 a.m. the next day.

Existing environmental noise sources present at NSA 1 included industrial noise from the nearby water treatment plant, airplane traffic at the nearby airport, and intermittent traffic noise on the neighborhood streets. Wind noise and frog vocalizations were also audible.

Environmental noise sources present at NSA 2 included vehicular traffic on the Highway 101 bridge and on nearby local roads. A helicopter in flight was also observed. Wind noise was also audible.

Environmental noise sources present at NSA 3 included a recreational vehicle power generator, all-terrain vehicles, and human activities including speech and shouts. Wind noise and frog vocalizations were also audible.

Environmental noise sources present at REC 1 included general traffic noise, an all-terrain vehicle, forest sounds, and high wind noise. Waves and frog noise were generally the dominant sound sources.

In addition to the reduced data, Table 8 show what the sound level was at each receptor without the wind speed data reduction. These data are just slightly higher than the wind speed corrected data. The wind speed corrected data will be used for any further analysis to be conservative.

Table 8: Summary of Baseline Sound Level Measurement Data Without Data Reduction

Receptor	Distance to Receptor, Miles	Direction	Duration HH:MM	Daytime[1] L_{eq}, dBA	Nighttime[2] L_{eq}, dBA	Ambient L_{dn}, dBA
NSA 1	1.3	South	72:24	52.8	46.0	**54.3**
NSA 2	2.2	East	72:35	63.3	57.3	**65.3**
NSA 3	1.3	Northeast	72:15	57.1	44.5	**56.3**
REC 1	0.7	West	72:12	52.3	49.4	**56.4**

(1) Daytime is 7:00 a.m. until 10:00 p.m.

(2) Nighttime is 10:00 p.m. until 7:00 a.m. the next day.

4. SUMMARY AND CONCLUSION

Sound level measurements were taken at the receptors around the proposed LNG Facility. The measurements show that the current ambient sound levels range from 53 to 65 dB(A) L_{dn}. High wind speeds were present during the survey and are typical for the coastal area. However, the data were processed so that only sound level data taken during periods when the wind speed was below 6.6 m/s were used to determine the day night average sound level at each site.

ATTACHMENTS

SLR
6001 Savoy Drive, Suite 215
Houston, Texas 77036-3322
713-789-9400 Tel 713-789-5493 Fax

Project Number:	108.01593.00004	**Scale:**	AS SHOWN	**Date:**	06/16/2017
Description:	NSA DISTANCES AND DIRECTIONS			**By:**	TGS / JWS
Project Name:	JORDAN COVER ENERGY PROJECT			**Figure:**	FIGURE 1

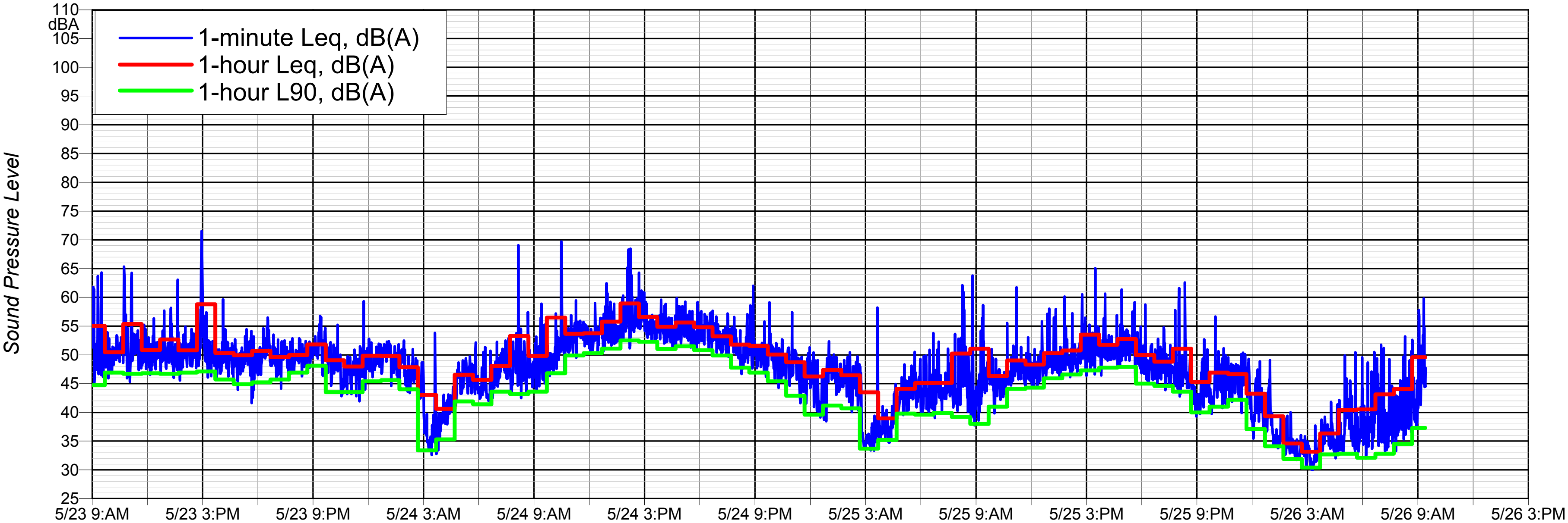
APPENDIX A

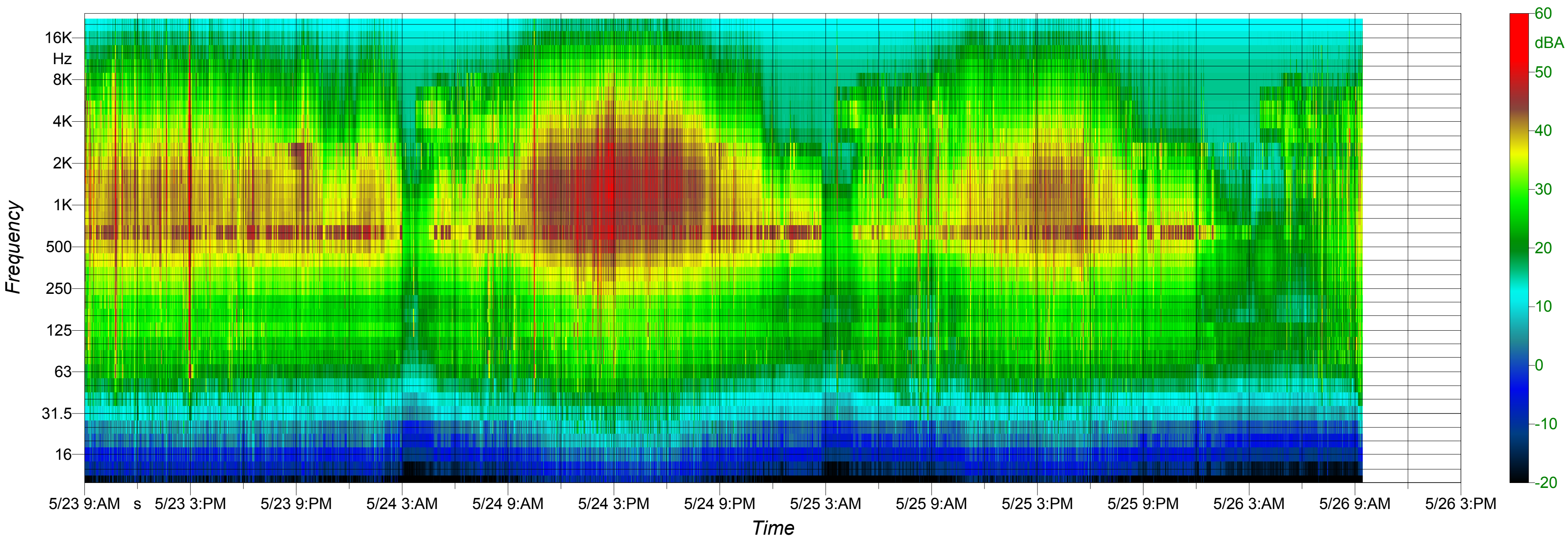
LEVEL VERSUS TIME GRAPHS FOR OVERNIGHT MONITORING

A graphical presentation of all of the monitoring data is included in this appendix. Each measurement position has four pages of graphs, the first is the full data set from May 23 to May 26, 2017 followed by individual daily graphs. The top section of each graph shows the 1-minute L_{eq}, represented by a solid blue line; the 1-hour L_{eq}, a stepped red line; and the 1-hour L_{90}, a stepped green line.

The bottom section of the graphs shows the frequency-based data. Sound frequency is plotted on the vertical axis and time on the horizontal axis. The color indicates the A-weighted sound pressure level at each frequency. The frequency data are useful for determining the presence of any tonal frequencies and helps to characterize the presence of specific noise emissions.

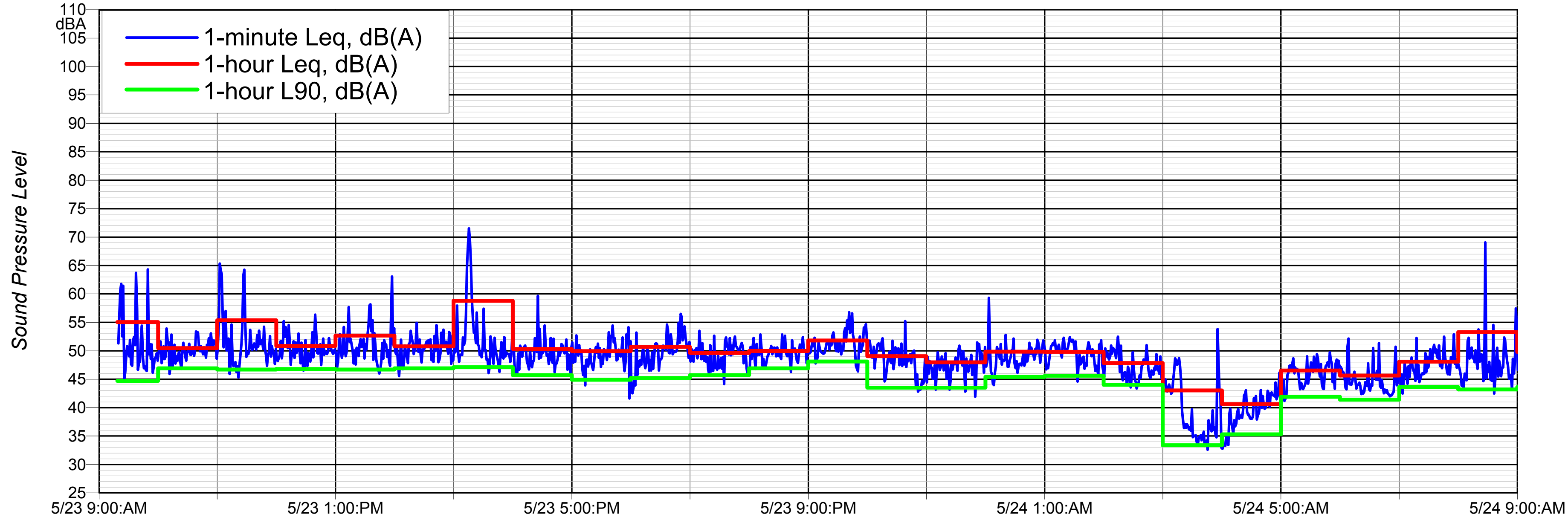
Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 26, 2017
NSA 1 - South of Site

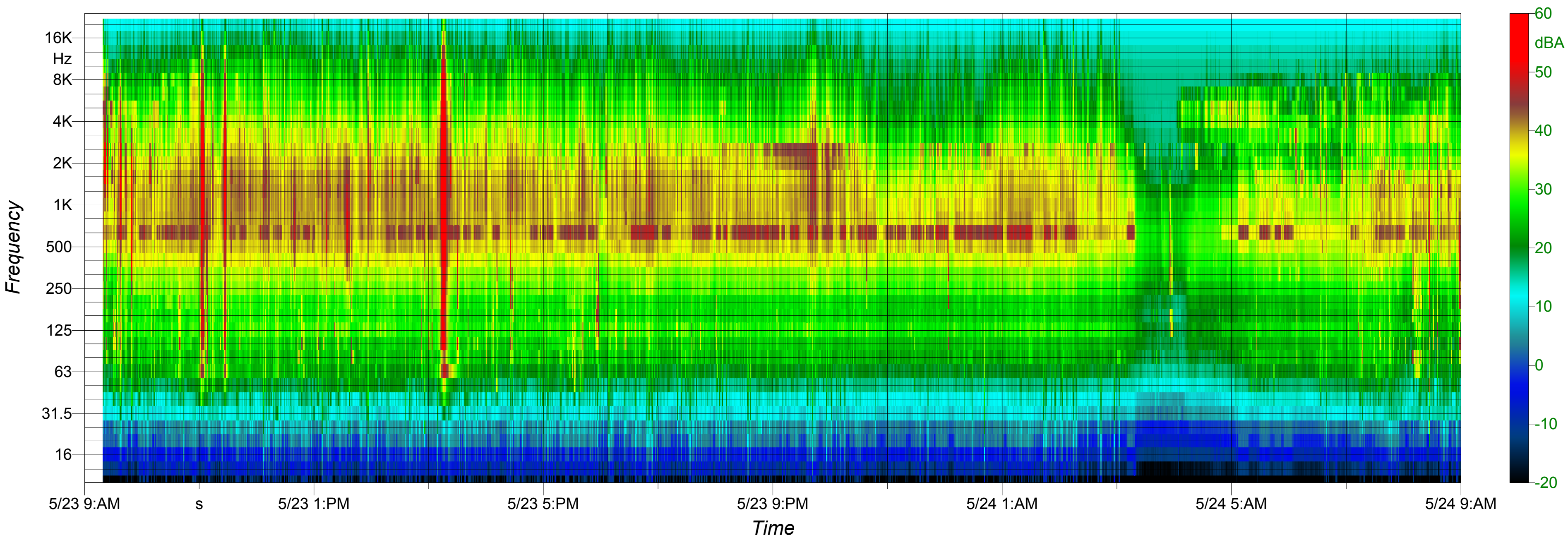




Prepared for Veresen - Jordan Cove LNG

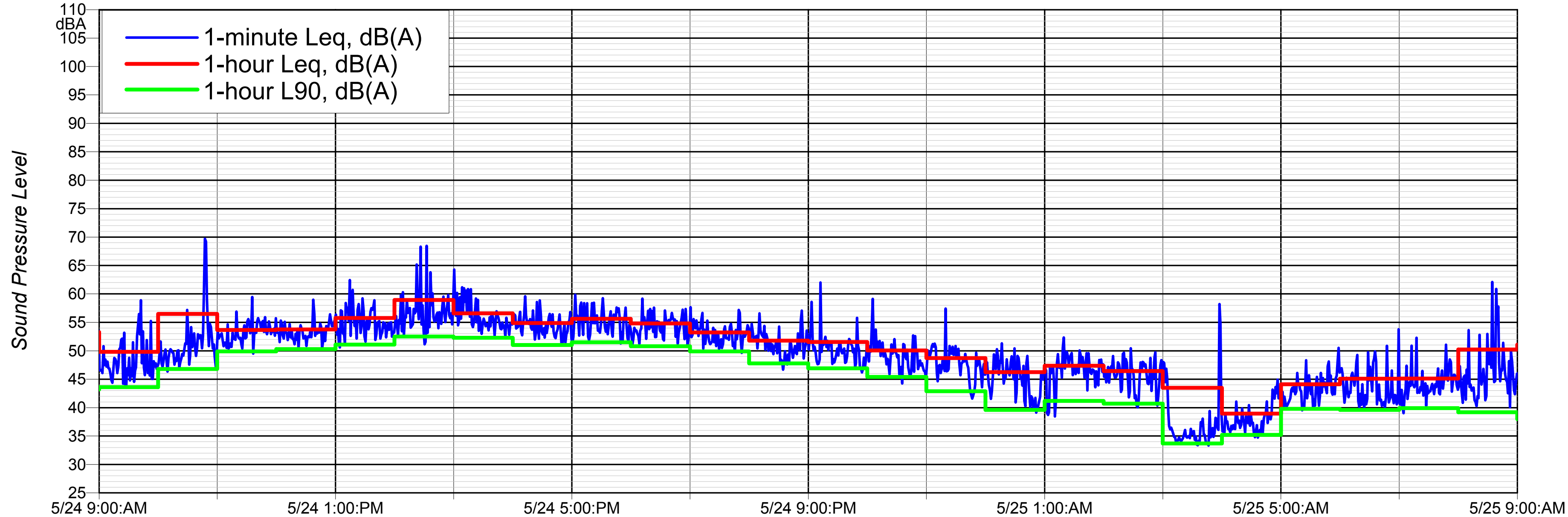
Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 24, 2017
NSA 1 - South of Site

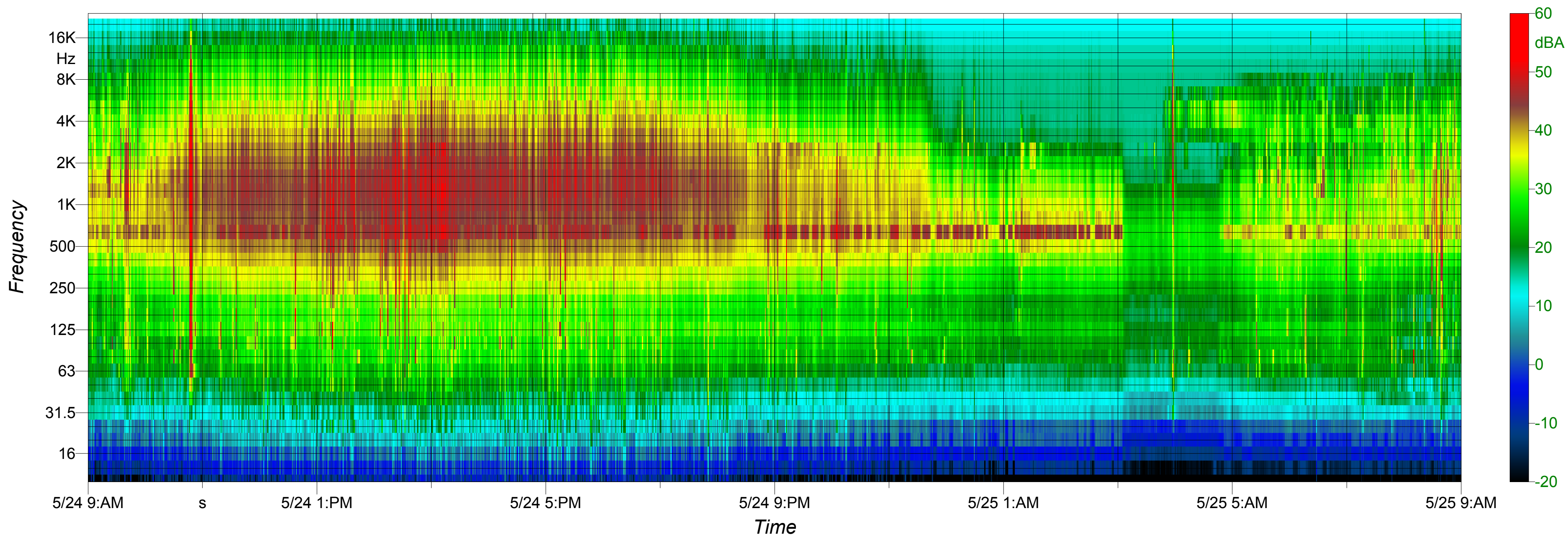




Prepared for Veresen - Jordan Cove LNG

Sound Level Measurements Near Jordan Cove LNG Site, May 24 - 25, 2017
NSA 1 - South of Site

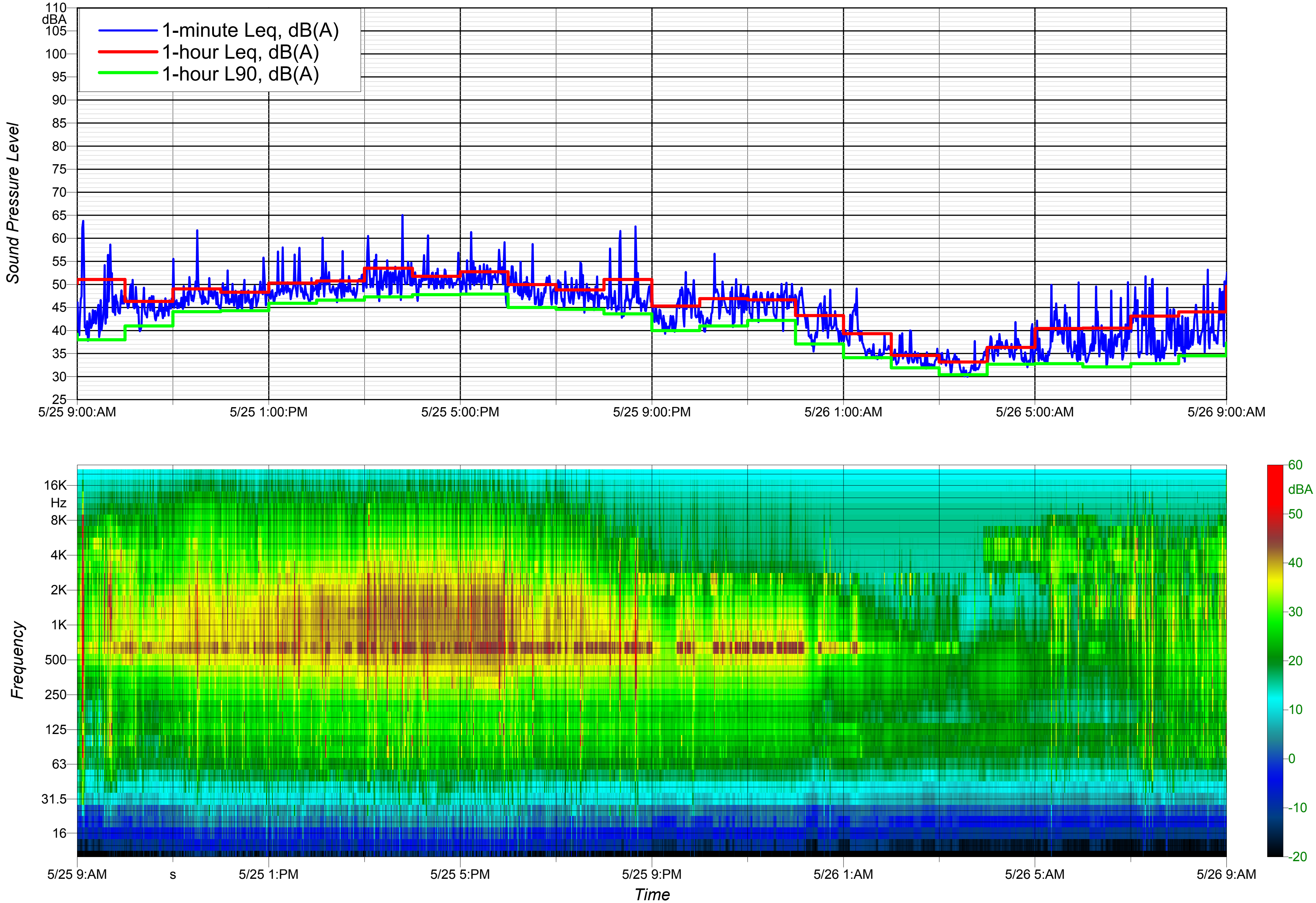




Prepared for Veresen - Jordan Cove LNG

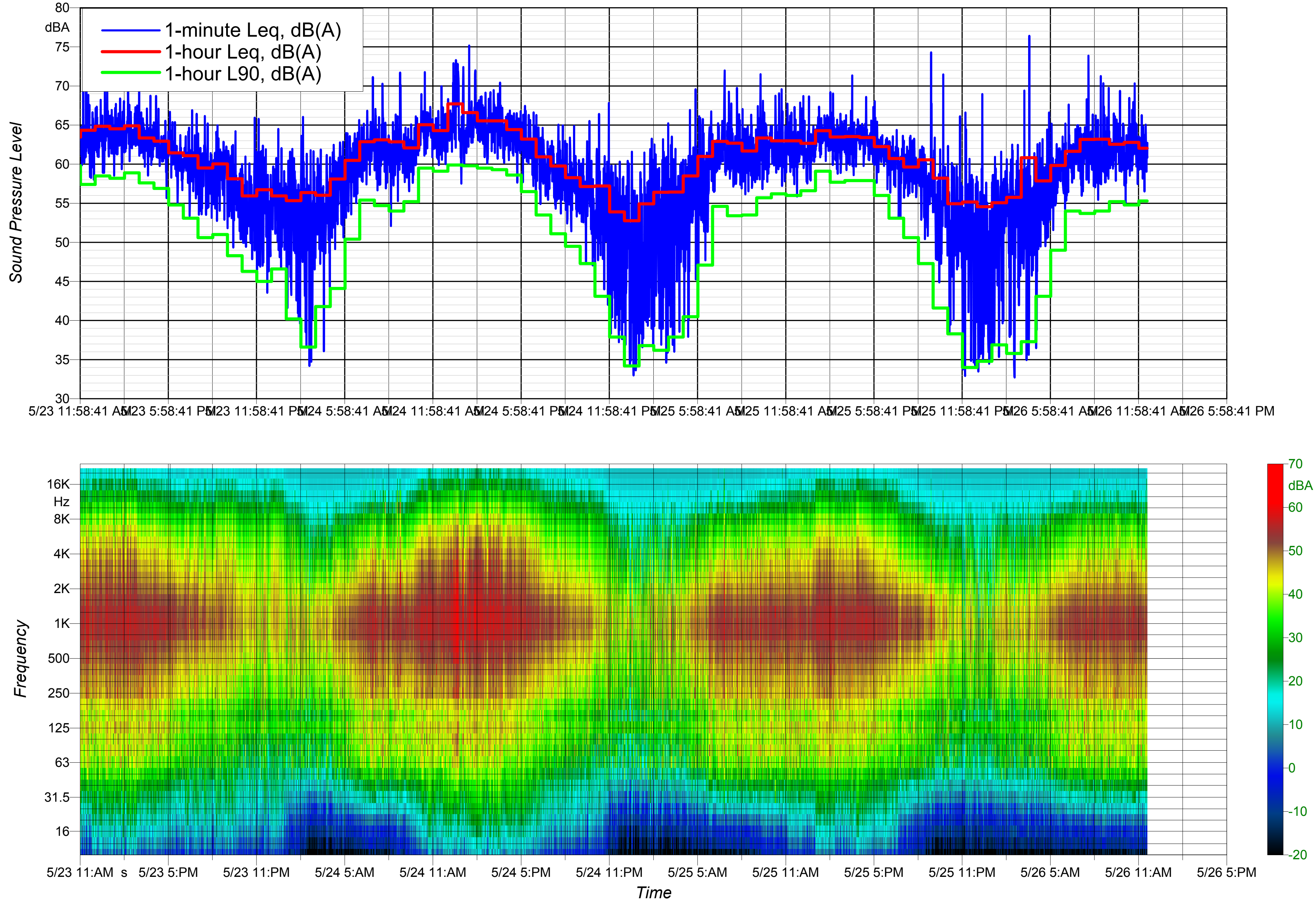
SLR

Sound Level Measurements Near Jordan Cove LNG Site, May 25 - 26, 2017
NSA 1 - South of Site



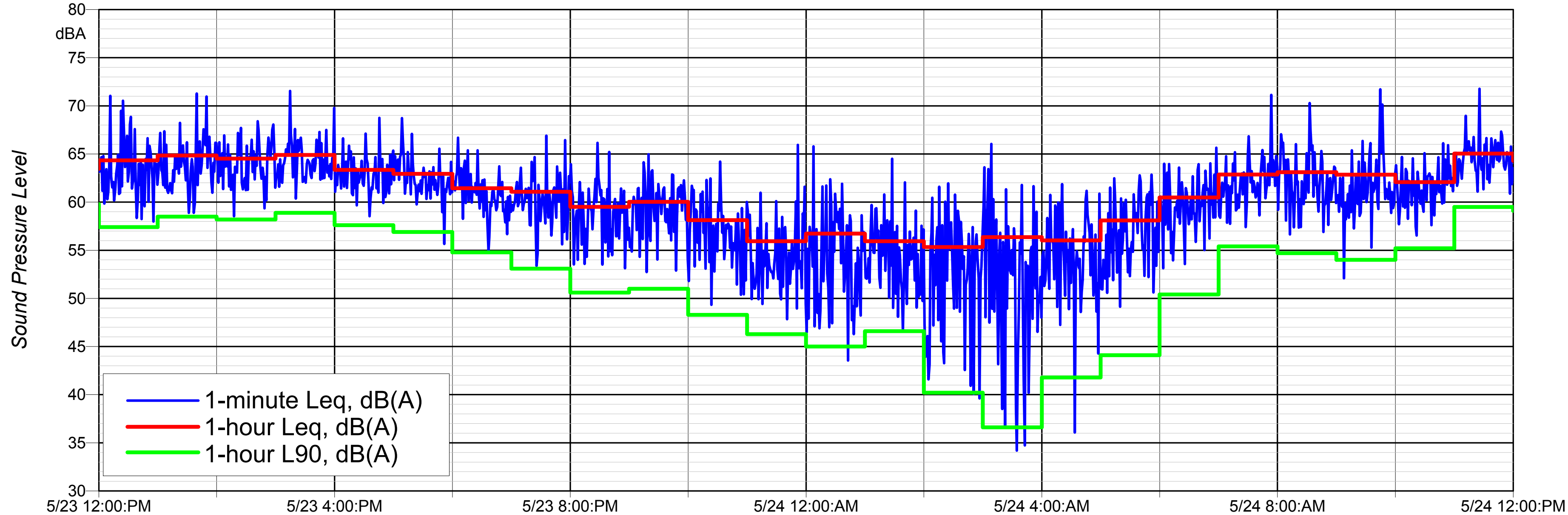
Prepared for Veresen - Jordan Cove LNG

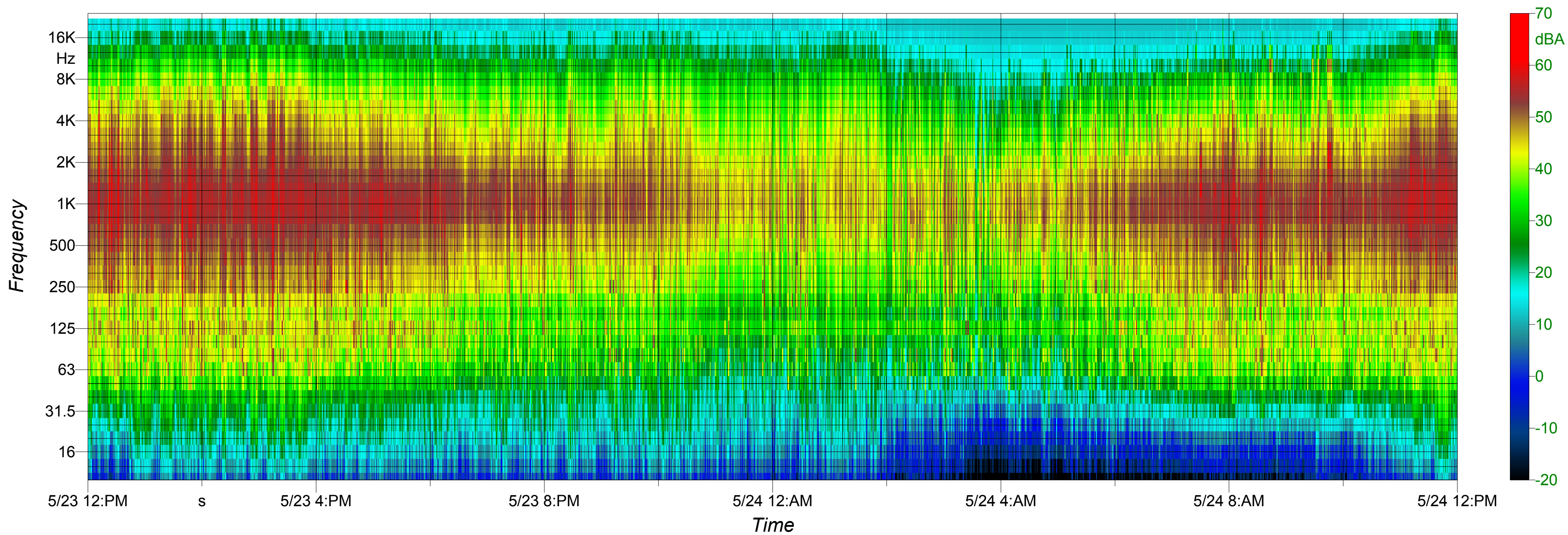
Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 26, 2017
NSA 2 - East of Site



Prepared for Veresen - Jordan Cove LNG

Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 24, 2017
NSA 2 - East of Site

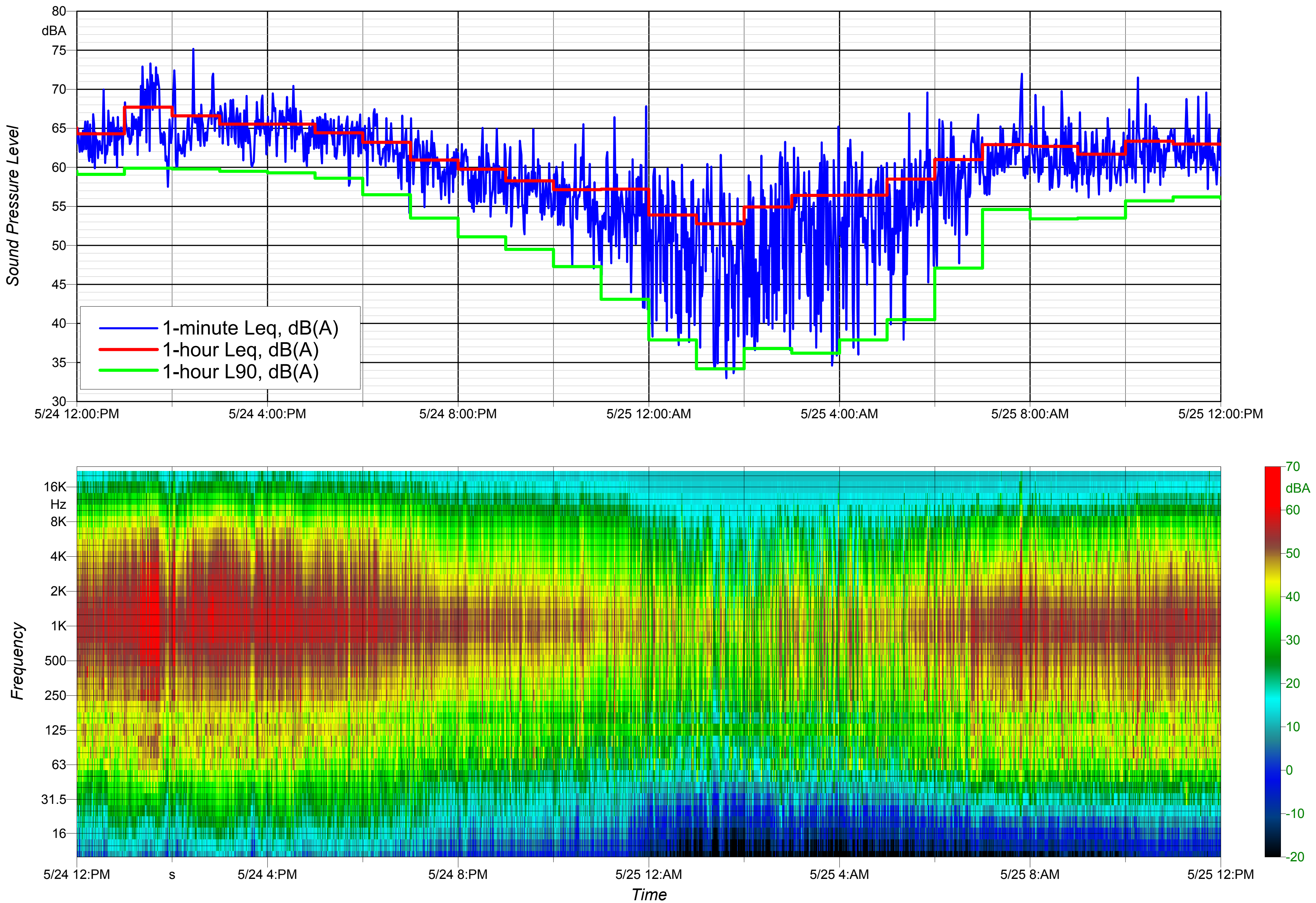




Prepared for Veresen - Jordan Cove LNG

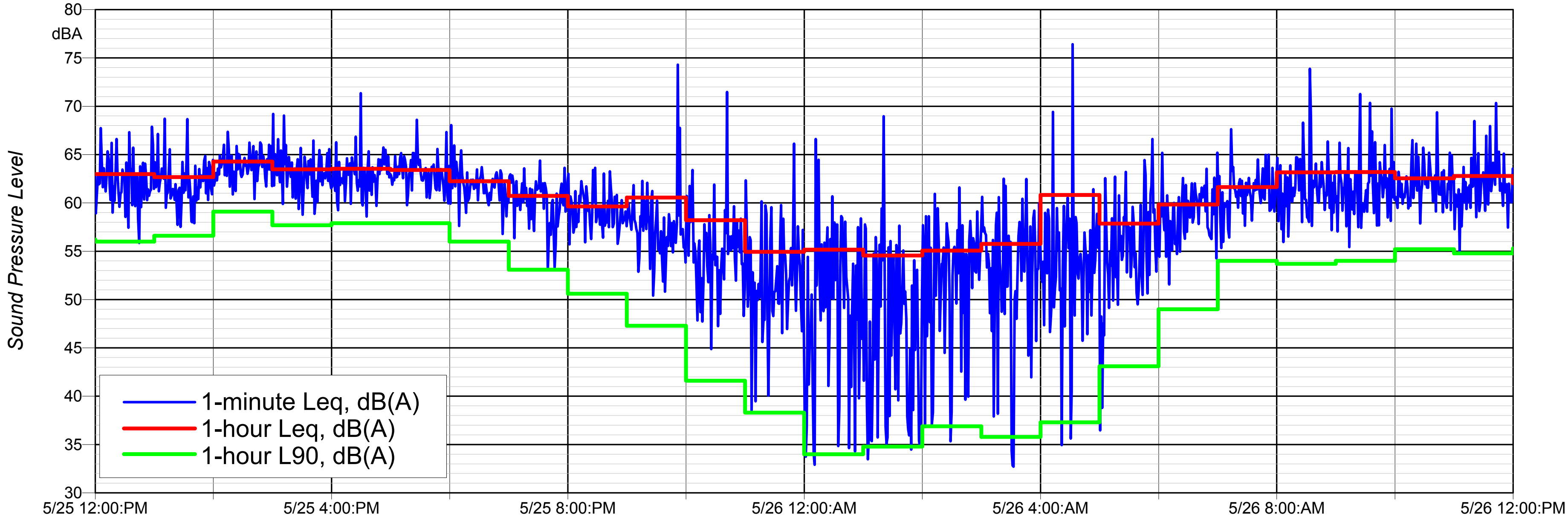
SLR

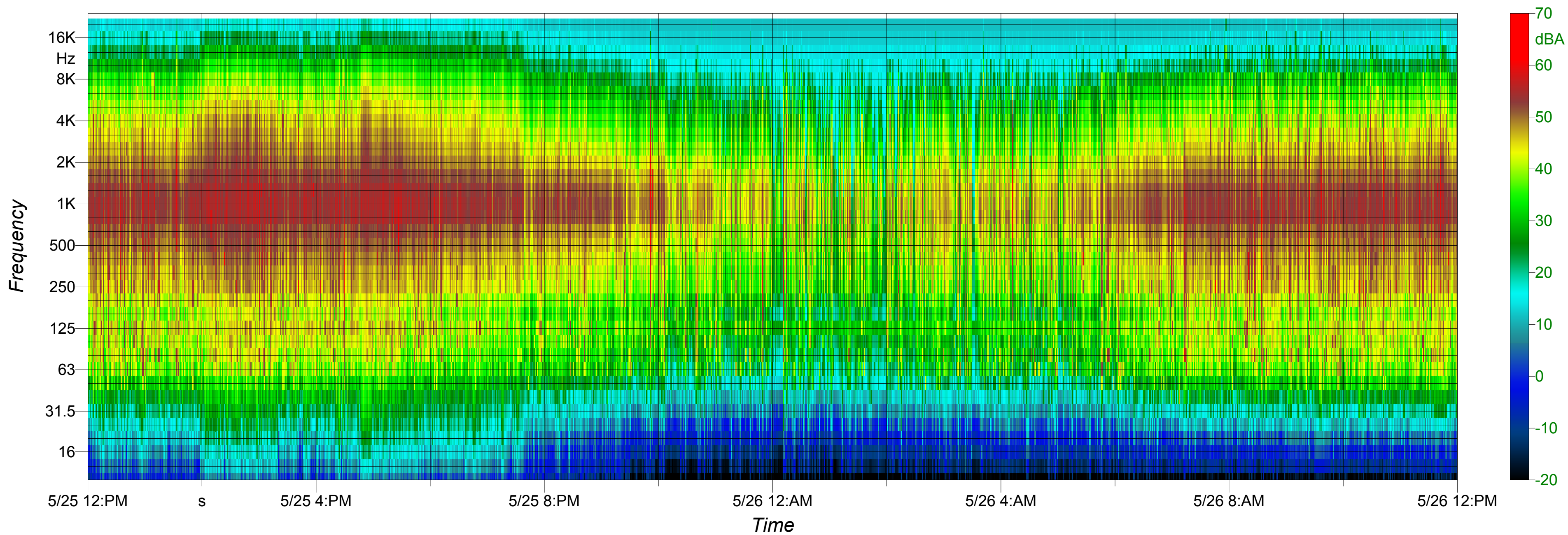
Sound Level Measurements Near Jordan Cove LNG Site, May 24 - 25, 2017
NSA 2 - East of Site



Prepared for Veresen - Jordan Cove LNG

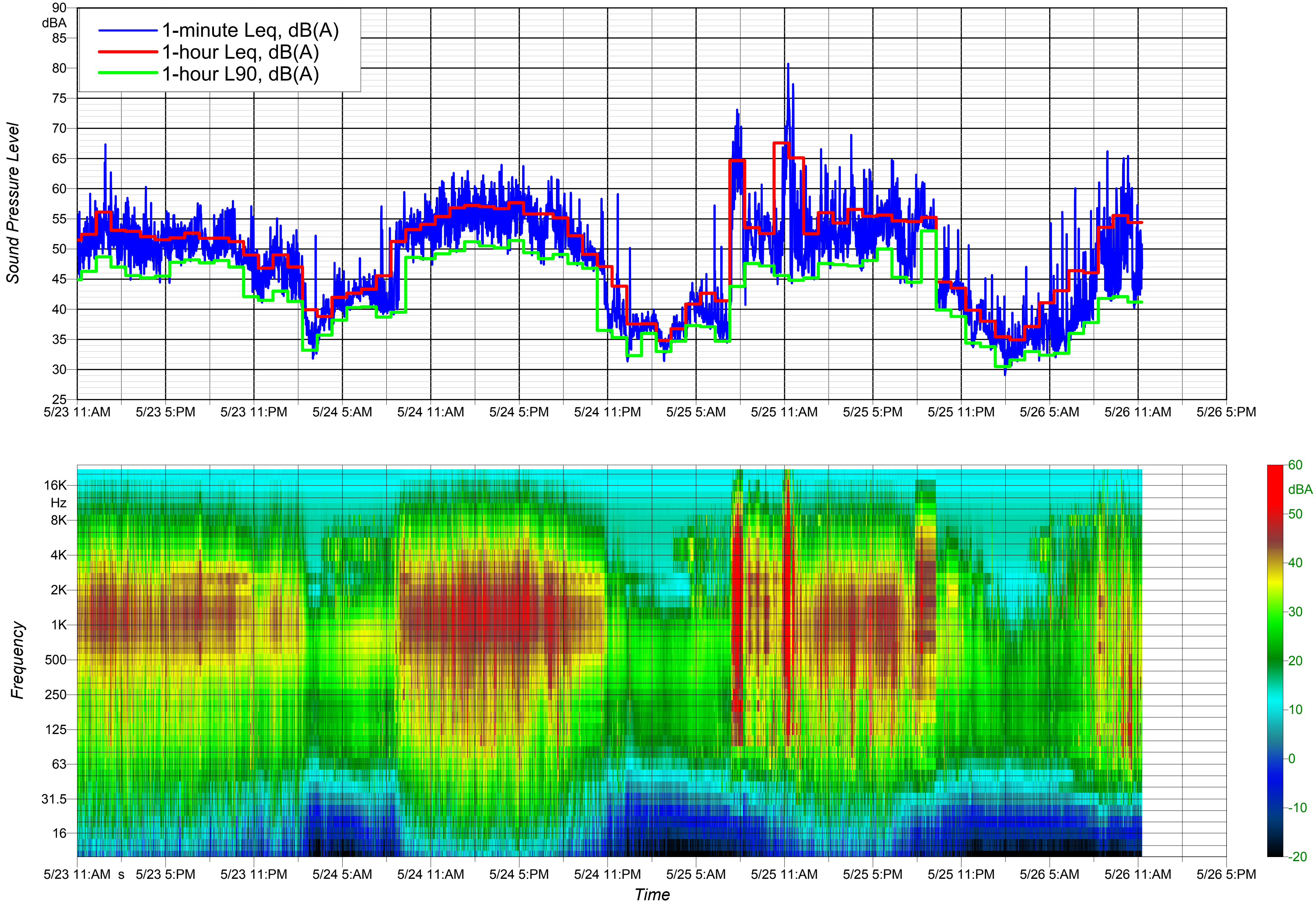
Sound Level Measurements Near Jordan Cove LNG Site, May 25 - 26, 2017
NSA 2 - East of Site





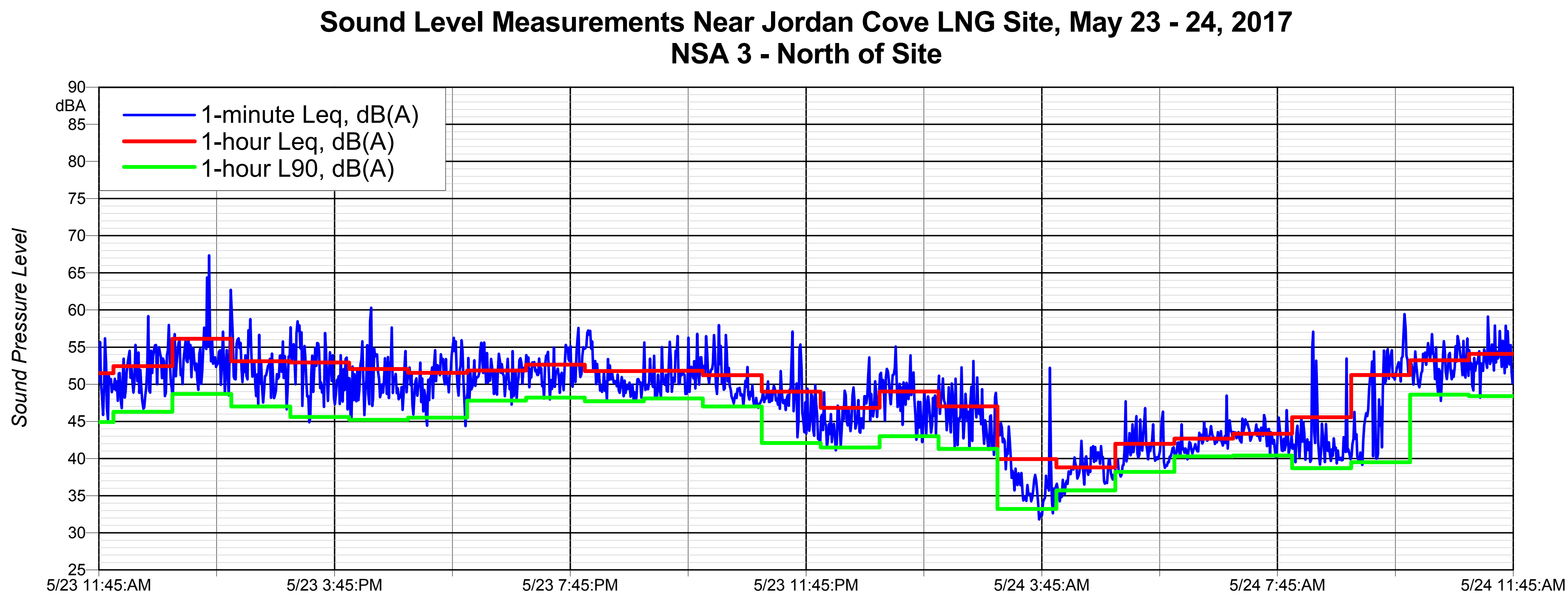
Prepared for Veresen - Jordan Cove LNG

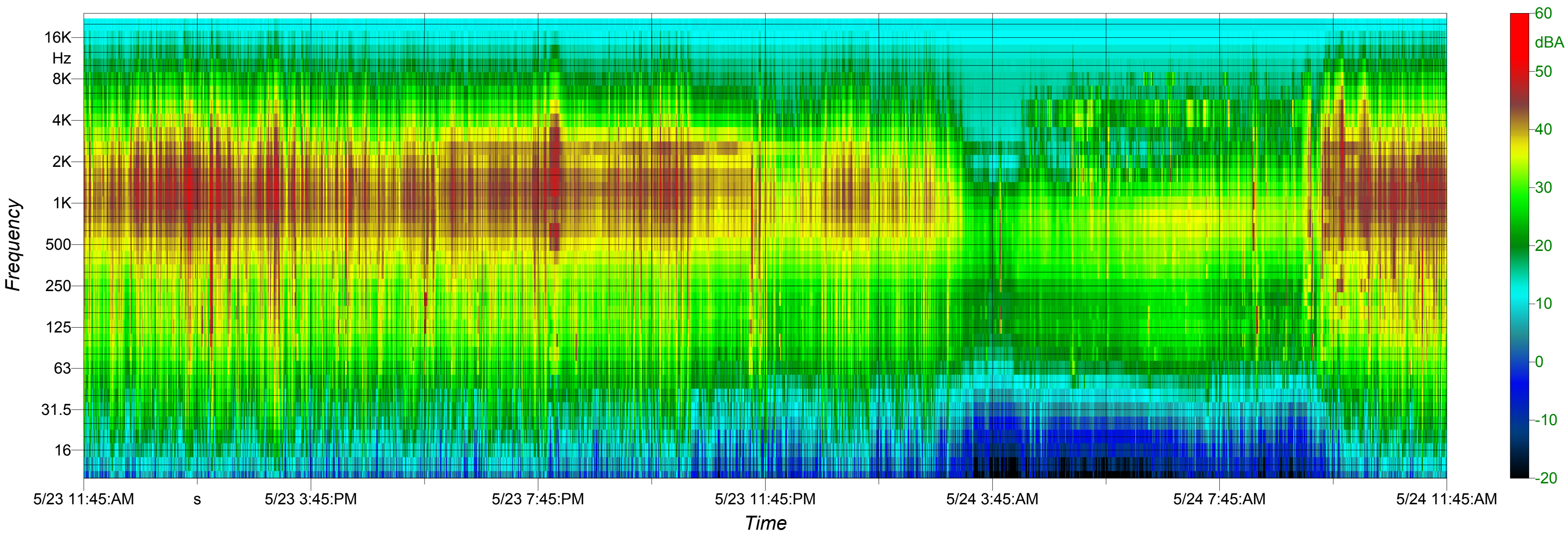
Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 26, 2017
NSA 3 - North of Site



Prepared for Veresen - Jordan Cove LNG

SLR

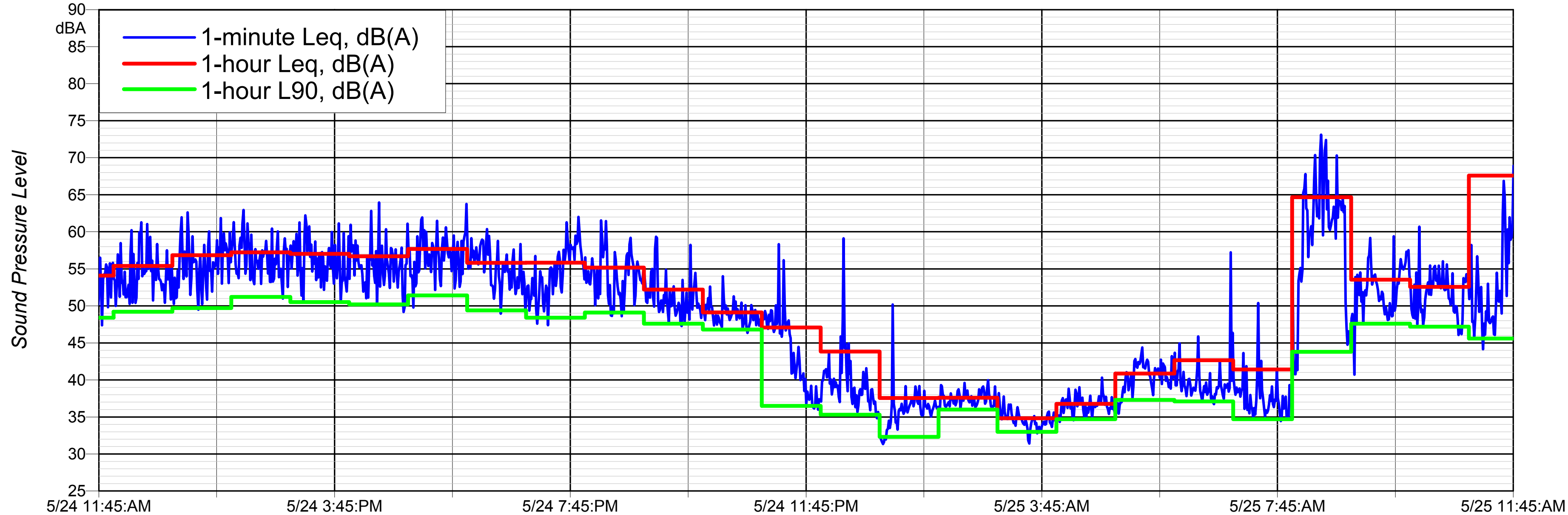


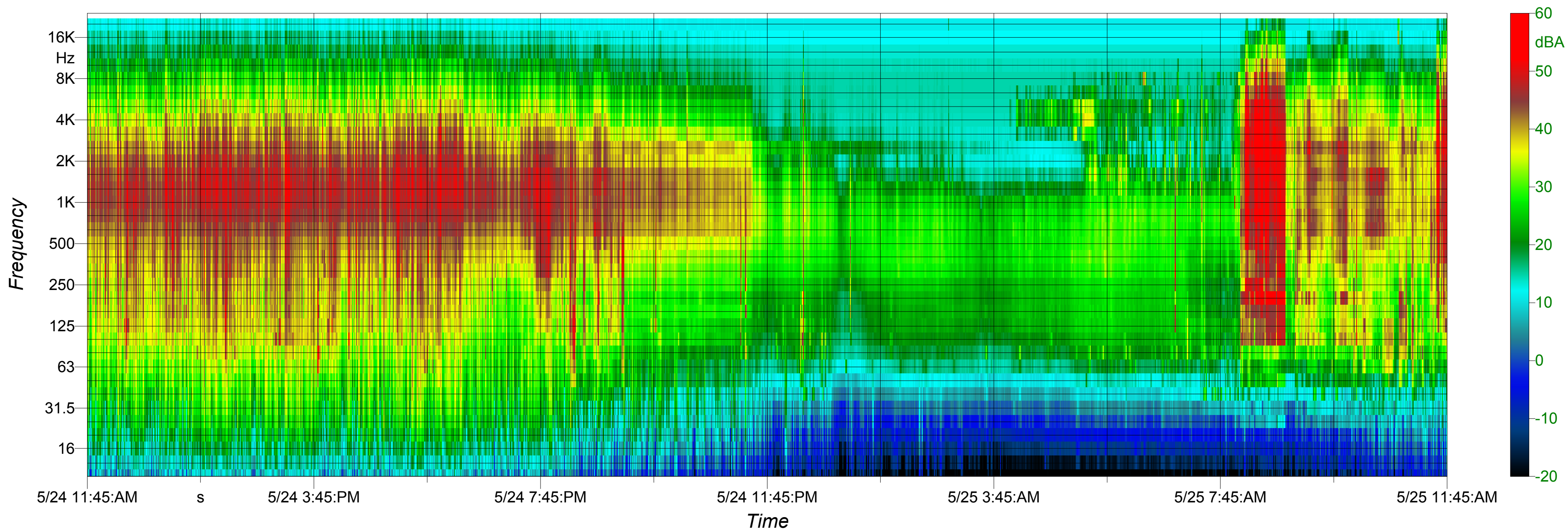


Prepared for Veresen - Jordan Cove LNG

SLR

Sound Level Measurements Near Jordan Cove LNG Site, May 24 - 25, 2017
NSA 3 - North of Site

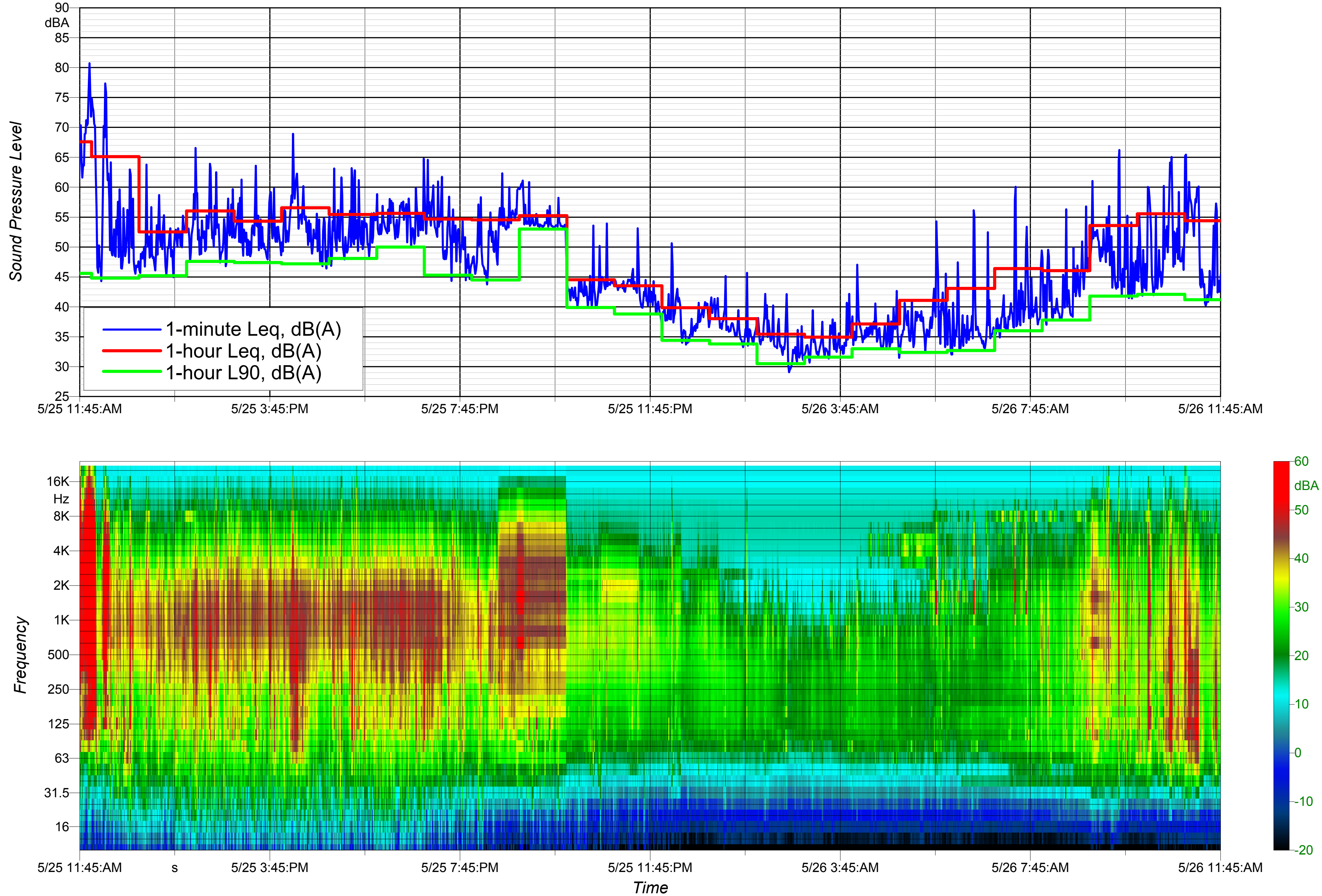




Prepared for Veresen - Jordan Cove LNG

SLR

Sound Level Measurements Near Jordan Cove LNG Site, May 25 - 26, 2017
NSA 3 - North of Site



Prepared for Veresen - Jordan Cove LNG

SLR

APPENDIX B

SOUND LEVEL EQUIPMENT CALIBRATION CERTIFICATIONS

Calibration Certificate

Certificate Number 2015007196

Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	831	***Procedure Number***	D0001.8378
Serial Number	0001736	***Technician***	Ron Harris
Test Results	**Pass**	***Calibration Date***	30 Jul 2015
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	30 Jul 2016
Description	Larson Davis Model 831	***Temperature***	23.27 °C ± 0.01 °C
		Humidity	49.1 %RH ± 0.5 %RH
		Static Pressure	86.98 kPa ± 0.03 kPa

Evaluation Method Tested electrically using PRM831 S/N 029412 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Hart Scientific 2626-H Temperature Probe	06/17/2015	06/17/2016	006798
SRS DS360 Ultra Low Distortion Generator	03/26/2015	03/26/2016	007174

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED
Cert #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Calibration Certificate

Certificate Number 2015009141

Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	831	***Procedure Number***	D0001.8378		
Serial Number	0002443	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	21 Sep 2015		
Initial Condition	Inoperable	***Calibration Due***	21 Sep 2017		
		Temperature	22.75	°C	± 0.01 °C
Description	Larson Davis Model 831	***Humidity***	51.7	%RH	± 0.5 %RH
		Static Pressure	86.36	kPa	± 0.03 kPa

Evaluation Method Tested electrically using PRM831 S/N 029411 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)

Larson Davis, a division of PCB Piezotronics, Inc. certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances will be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
SRS DS360 Ultra Low Distortion Generator	02/06/2015	02/06/2016	006239
Hart Scientific 2626-H Temperature Probe	06/17/2015	06/17/2016	006798

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

PRECISION INTEGRATING SLM

Manufactured by:	**LARSON DAVIS**
Model No:	**831**
Serial No:	**0001737**
Calibration Recall No:	**26438**

Submitted By:

Customer:	**Eve MacPherson**	
Company:	**SLR INTERNATIONAL CORPORATION**	
Address:	**6001 SAVOY DRIVE**	
	HOUSTON	**TX 77036-332**

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. 831 LARS

Upon receipt for Calibration, the instrument was found to be:

Within (X)

tolerance of the indicated specification. See attached Report of Calibration.

West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Approved by:

Calibration Date: **29-Apr-16**

FC

Certificate No: **26438 - 1**

Felix Christopher (QA Mgr.)

QA Doc. #1051 Rev. 2.0 10/1/01

Certificate Page 1 of 1

ISO/IEC 17025:2005

West Caldwell Calibration Laboratories, Inc.

uncompromised calibration

1575 State Route 96, Victor, NY 14564, U.S.A.

ACCREDITED

Calibration Lab. Cert. # 1533.01

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®

NVLAP Lab Code: 200625-0

Calibration Certificate No.36571

Instrument:	**Acoustical Calibrator**	*Date Calibrated:* **7/7/2016**	*Cal Due:* **7/7/2017**
Model:	**4231**	*Status:*	**Received** / **Sent**
Manufacturer:	**Brüel and Kjær**	*In tolerance:*	X / X
Serial number:	**2240964**	*Out of tolerance:*	
Class (IEC 60942):	**1**	*See comments:*	
Barometer type:		*Contains non-accredited tests:*	__Yes _X_ No
Barometer s/n:			
Customer:	**SLR International Corporation**	*Address:*	**1800 Blankenship Road, Suite 440, West Linn, OR 97068**
Tel/Fax:	**503-723-4423 / 503-723-4436**		

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 1/16/2015

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 23, 2015	Scantek, Inc./ NVLAP	Oct 23, 2016
DS-360-SRS	Function Generator	33584	Oct 20, 2015	ACR Env./ A2LA	Oct 20, 2017
34401A-Agilent Technologies	Digital Voltmeter	US36120731	Oct 6, 2015	ACR Env. / A2LA	Oct 6, 2016
HM30-Thommen	Meteo Station	1040170/39633	Oct 23, 2015	ACR Env./ A2LA	Oct 23, 2016
140-Norsonic	Real Time Analyzer	1406424	Oct 26, 2015	Scantek / NVLAP	Oct 26, 2016
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	173368	Nov 10, 2015	Scantek, Inc. / NVLAP	Nov 10, 2016
1203-Norsonic	Preamplifier	14052	Aug 24, 2015	Scantek, Inc./ NVLAP	Aug 24, 2016

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	Valentin Buzduga
Signature	Lydon Dawkins	Signature	[signature]
Date	7/7/2016	Date	7/07/2016

Document stored as: Z:\Calibration Lab\Cal 2016\BNK4231_2240964_M1.doc

APPENDIX BB.2

Computer Noise Modeling and Mitigation Report

Acoustical Modeling Report

REV	DATE	DESCRIPTION	BY	CHKD	APPVD	COMPANY APPROVAL
			JDS	KJL	SPH	
1	29-Aug-17	Issue for FERC Filing	JDS	KJL	SPH	

IP SECURITY	☐ Confidential		Total amount of pages including coversheet:				10
FOR CONTRACTOR DOCUMENTS	Contract No.		Contractor Document No.				Contractor Rev.
	KBJ-029		J1-000-RGL-RPT-KBJ-51300-00				1
JCL DOCUMENT NUMBER	Proj. Code	Unit / Location	Discipline	Doc. Type	Orig. Code	Sequence No.	Sheet No.
	J1	000	RGL	RPT	KBJ	51300	00

Revision Modification Log

Document Title :	Acoustical Modeling Report	**Rev. :**	1
Document No. :	J1-000-RGL-RPT-KBJ-51300-00	**Rev. Date :**	29-Aug-2017

Page No.	Section	Change Description

Table of Contents

LIST OF TABLES

LIST OF FIGURES

1 Scope

This document describes the basis, methodology, and results of acoustical modeling for the JCLNG project. It includes updated acoustical design and performance information that is consistent with the Acoustical BOD, along with acoustical calculation results in accordance with design standards.

2 Applicable Documents

2.1 SUPPORTING AND SUPPLEMENTAL DOCUMENTS

2.1.1 Supporting Documents

Supporting documents are those documents that are used in conjunction with this document.

Document Title	Document Number
1. Acoustical BOD	J1-000-MEC-BOD-KBJ-50002

2.1.2 Drawings

JCLNG Project Drawing Title	JCLNG Document Number
1. Overall Plot Plan	J1-000-TEC-PLT-KBJ-51000-01 (Proj. Dwg. No. 189980-0000-FG2000)
2. Liquefaction Plot Plan	J1-000-TEC-PLT-KBJ-51001-01 (Proj. Dwg. No. 189980-0000-FG2001)
3. Equipment Layout Liquefaction – Train #1	J1-000-PIP-PLT-KBJ-50002-01 (Proj. Dwg. No. 189980-0000-FM0011)

3 Codes and Standards

Codes and Standards to be used on the JCLNG Project are the latest version of the codes and standards identified in 189980-0000-FU0200 Applicable Code and Standards, including ISO 9613 for calculation of outdoor sound levels, unless otherwise noted therein.

4 Calculation Methodology

Calculations were completed in accordance with ISO 9613 methodology using DataKustik Cadna/A™ software (version 2017). Modeling configuration was as follows:

- Source-to-receiver search radius: 6 km
- Temperature: 10 °C
- Relative humidity: 70 percent
- Default ground absorption value, G: 0.50 ("mixed" ground)

ISO 9613 calculations inherently assume a downwind condition from all sources to all receivers, and a moderate temperature inversion akin to a clear, calm, nighttime condition. Effects of local topography were included via project site grading information and GIS terrain data. Water surfaces—i.e., Coos Bay—were included with G=0.0 ("hard" ground). Shielding from major project equipment and structures, including impermeable vapor barrier walls, was included. Shielding from off-site structures was not included. All other calculation parameters were default ISO 9613 values.

5 Model Input (Sources)

Equipment packages considered in the acoustical model are detailed in Table 5-1. Information is consistent with the referenced Acoustical BOD. Items not originally included in the Acoustical BOD, but considered for this updated analysis are as indicated in Table 5-1. Octave-band sound levels for equipment were included in the model, as shown in Table 5-2. The basis for octave-band sound levels was in-house data sources for similar equipment, or empirically calculated data adjusted to conform to project specifications and requirements. For reference, a 3-D view of the acoustical model is provided in Figure 5-1. Note that some sources that will not operate continuously, such as ground flares and tanker hoteling, were conservatively included in the model. No supplemental noise mitigation measures have been included in the model.

Table 5-1 JCLNG Project Equipment Broadband Sound Levels

Equipment Package	Qty	Sound Level Specification (L_p re 20 µPa)	Associated Sound Power Level (L_w re 1 pW)
Refrigerant compressor	5	95dBA @ 3 ft	112 dBA
Combustion turbine	5	85 dBA @ 3 ft 62 dBA @ 400 ft	CT enclosure: 103 dBA CT air inlet: 90 dBA
Heat recovery steam generator	5	85 dBA @ 3 ft 58 dBA @ 400 ft	Boiler: 110 dBA Stack exit: 112 dBA
Compressor suction piping	NA	95 dBA @ 3 ft	≤ 114 dBA
Compressor discharge piping	NA	100 dBA @ 3 ft	≤ 118 dBA
JT valve	40	85 dBA @ 3 ft	100 dBA
Interstage aftercooler (42 cells)	5	85 dBA @ 3 ft	96 dBA per fan
Discharge and LO cooler (42 cells)	5	85 dBA @ 3 ft	96 dBA per fan
Amine cooler (12 cells)	1	85 dBA @ 3 ft	97 dBA per fan
Stripper reflux condenser (3 cells)	1	85 dBA @ 3 ft	97 dBA per fan
Regen gas cooler (6 cells)	1	85 dBA @ 3 ft	97 dBA per fan
BOG compressor interstage cooler (6 cells)	1	85 dBA @ 3 ft	97 dBA per fan
BOG compressor discharge cooler (6 cells)	1	85 dBA @ 3 ft	97 dBA per fan
Steam turbine	3	85 dBA @ 3 ft	HP/IP Turbine: 98 dBA LP Turbine: 94 dBA
Air-cooled condenser (4 cells)	3	85 dBA @ 3 ft	96 dBA per fan
BOG compressor	2	85 dBA @ 3 ft	105 dBA
Boiler feedwater pump	4	87 dBA @ 3 ft	107 dBA
Instrument air compressor	3	85 dBA @ 3 ft	100 dBA
Ground flares	2	85 to 100 dBA @ 3 ft	111 to 126 dBA
Tanker (hoteling) – idling engine noise	1	85 dBA @ 3 ft (interior)	90 dBA (idling exhaust)
Gas metering valve	1	85 dBA @ 3 ft	100 dBA

Table 5-2 JCLNG Project Equipment Octave-band Sound Level (dB) Modeling Input

Equipment Source	Sound Level Type	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Refrigerant compressor	L_w	100	92	89	87	88	95	83	78	73
CT air inlet	L_w	101	105	98	93	86	77	73	81	76
CT turbine enclosure	L_w	107	108	106	106	102	95	92	93	90
HRSG boiler casing	L_p @ 3 ft	88	93	89	81	71	70	58	38	8
HRSG stack exit	L_w	109	117	119	116	107	106	93	68	49
Refrigerant compressor suction piping	L_p @ 3 ft	101	94	90	88	91	93	86	79	75
Refrigerant compressor discharge piping	L_p @ 3 ft	106	99	95	93	96	98	91	84	80
Valve	L_w	82	82	81	81	86	99	85	85	90
Interstage aftercooler fan	L_w	103	102	98	94	94	91	87	83	75
Discharge & LO cooler fan	L_w	103	102	98	94	94	91	87	83	75
All other cooler fans (Amine, stripper reflux condenser, regen gas, BOG compressor interstage anddischarge)	L_w	100	102	102	98	95	92	84	80	76
HP/IP steam turbine	L_w	109	109	98	97	96	92	89	86	85
LP steam turbine	L_w	110	100	96	95	93	88	82	79	78
ACC fan	L_w	100	99	95	91	97	88	84	80	72
BOG compressor	L_p @ 3 ft	82	82	83	82	82	83	85	83	78
Boiler feedwater pump	L_w	100	106	104	103	102	101	100	99	95
Air compressor	L_w	93	99	97	96	95	94	93	92	88
Flare (max)	L_w	100	105	111	114	116	118	120	119	118
Engine noise	L_w	96	92	98	94	86	82	76	66	58

Note: L_w = sound power levels re 1 pW and L_p = sound pressure levels re 20 µPa. Sound levels are unweighted.

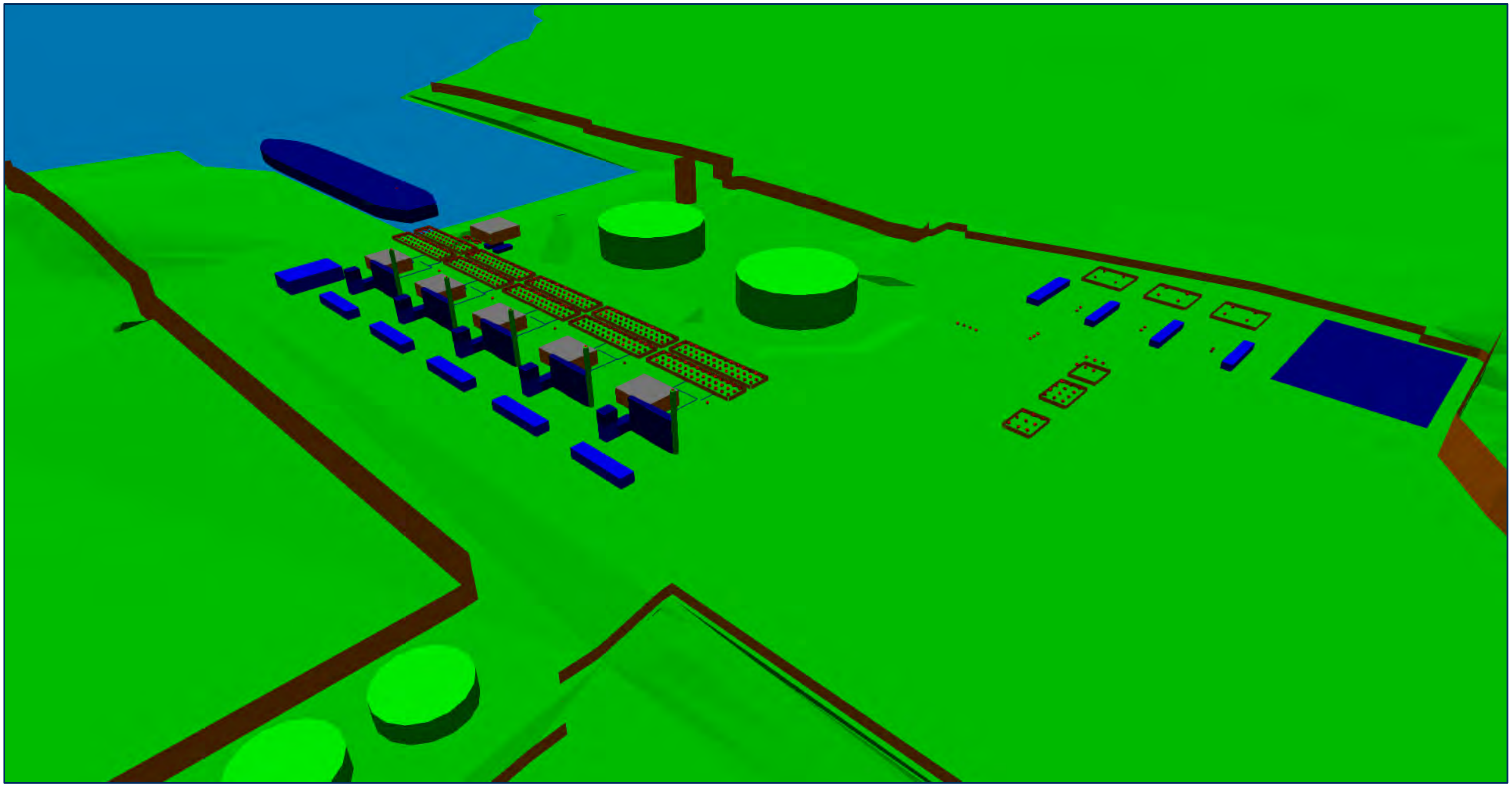


Figure 5-1 3D view of JCLNG acoustical model (from north).

6 Model Output (Results)

The results of the acoustical model were evaluated at three "noise-sensitive areas" (NSAs) that have been identified. Information regarding the location and predicted project sound levels at the NSAs is provided in Table 6-1. Figure 6-1 provides a sound level contour plot for the project and vicinity. Note that the sound levels include only project noise sources and do not include of any other sound sources, such as background noise.

Table 6-1 JCLNG Acoustical Modeling Results at NSAs

Location & Description	UTM Zone 10 Easting	UTM Zone 10 Northing	Elevation (AMSL)	Project L_{dn}	Project L_{eq}
NSA 1 – Residential	398481 m	4807460 m	29 m	51 dBA	45 dBA
NSA 2 – Residential	401292 m	4809791 m	34 m	43 dBA	37 dBA
NSA 3 – Horsfall Campground	399204 m	4810573 m	19 m	49 dBA	43 dBA

Note: L_{dn} = day-night average sound level (24-hour average sound level that includes a 10 dBA penalty for nighttime sound levels between 10 p.m. and 7 a.m.) and L_{eq} = equivalent-continuous ("steady-state" or "average") sound pressure level.

7 Mitigation

The modeling results include the effects of any standard noise control measures provided by equipment suppliers to meet the sound level specifications. Supplemental mitigation measures such as acoustical enclosures, acoustical barrier walls, and additional silencers, are not anticipated to be required for the project to achieve the sound levels noted above in Table 6-1.

Figure 7-1 **JCLNG normal operations L_{dn} sound level contour plot (aerial from Google™ Earth).**

APPENDIX BB.3

Marine Mammal Airborne Noise Impact Assessment

Memorandum

To: Bill Gorham, AECOM

From: Briony Croft

Date: 20 September 2017

Subject: Jordan Cove LNG – Marine Mammal Airborne Noise Impact Assessment

This technical memorandum provides information on the airborne noise impacts of construction and operation of the Jordan Cove Energy Project (JCEP) LNG Terminal on marine mammals (hauled out).

Noise predictions provided in this memo have been determined using the Project's Resource Report 9 (RR9) noise model, but with noise levels presented in an unweighted format appropriate for a review of impacts to marine mammals (noting that A-weighted levels described in RR9 are appropriate for human impact assessment purposes only).

1.0 INTRODUCTION

1.1 Project Description

The marine facilities associated with the Jordan Cove Energy Project (JCEP) LNG Terminal will be on the bay side of the North Spit of Coos Bay, Oregon. Construction of the marine facilities will include several activities with the potential to generate noise affecting marine mammals in air (hauled out):

- General construction activities
- Dredging of the marine slip, access channel and materials offloading facility (MOF);
- Piling

These activities with potential for airborne noise generation are described in detail in the documents submitted to The Federal Energy Regulatory Commission (FERC) for the purpose of review of the potential environmental impacts of a proposed project under the National Environmental Policy Act (NEPA).

The most prevalent sound source during general construction is anticipated to be the internal combustion engines used to provide mobility and operating power to construction equipment.

Dredging would occur in a staged approach, with as much material as possible removed by excavation in isolation from Coos Bay behind a temporary berm. The noise levels of this activity would be broadly similar to general construction noise. Some in water dredging would also be required.

Approximately 3600 pipe piles and over 11,800 sheet piles will be will be required for the project in total, including marine and upland piles.

During operation of the LNG facility, the primary airborne noise sources would be compressors, condensers, steam turbine generators, coolers, pumps, valves and piping. The noise impacts to marine mammals during operation would generally be less than during construction.

1.2 Marine Mammal Species Considered

This assessment considers the potential for construction noise from the JCEP LNG Terminal Project to impact on hauled out marine mammals (ie, the potential for airborne noise to affect marine mammals who are on land, above the surface of the water).

RR3 Section 3.1.3 lists non-endangered marine mammals potentially occurring in the region, and Table 3.4-1 lists threatened and endangered species. Non-endangered marine mammal species potentially occurring in haul outs in the Coos Bay estuary include the California sea lion, Steller sea lion, and harbor seal.

2.0 MARINE MAMMAL NOISE IMPACT THRESHOLDS

Guidance on in-air acoustic thresholds for marine mammal disturbance are provided by the National Oceanic and Atmospheric Administration (NOAA) and the National Marine Fisheries Service (NMFS)[1]. There are no established thresholds for injury (hearing damage) applicable to marine mammals in air. The NMFS interim in-air thresholds behavioral effects are shown in Table 1.

Table 1 Interim in-air marine mammal acoustic thresholds

Criterion Definition	Threshold
Behavioral disruption for harbor seals	90 dB_{rms}
Behavioral disruption for non harbor seal pinnipeds	100 dB_{rms}

Notes: dB referenced to 20 micro Pascal (re: 20µPa).
All thresholds are based off root mean square (rms) levels and are broadband (unweighted).

Of the construction noise sources considered in this assessment, the majority are considered approximately "continuous" for the purpose of this assessment. For continuous noise sources, the rms noise level is equivalent to L_{eq} parameter. The L_{eq} is defined as the energy equivalent sound level, or the sound energy average over a defined time period. For this assessment, the rms in-air marine mammal acoustic thresholds are directly compared with the L_{eq} noise levels from general construction, dredging and operations.

Noise from impact pile driving is impulsive, characterized by rapid noise pulses with each strike of the pile. For an impulsive noise source, the rms sound level is defined as the average sound level for a duration that contains 90 percent of the total sound energy of the impulsive event. For the purpose of this assessment, the short term maximum sound level during pile driving (L_{max}) is compared directly with the rms behavioral disruption threshold. This is a conservative assessment approach, since the rms noise level for an impulsive event will always be less than the maximum sound level.

3.0 NOISE LEVEL VERSUS DISTANCE

For the purpose of this impact assessment, the objective is to quantify the noise level for the various scenarios considered, across the areas in the vicinity of the project where marine mammals may be present in air. Examples of the extent of noise impacts are provided in the form of noise isopleths corresponding to the 90 decibel (dB) and 100 dB impact thresholds in the following figures. The noise modelling process, inputs and assumptions are as described in the documents submitted to The FERC for the purpose of review of the potential environmental impacts of the project. An example of the general construction noise impacts to marine mammals in air are shown in Figure 1. Corresponding figures for in-air noise impacts to marine mammals during dredging and piling are shown in Figure 2 and Figure 3 respectively. These figures are indicative – the location of construction noise sources will move around the site, and the noise impacts will shift accordingly.

---

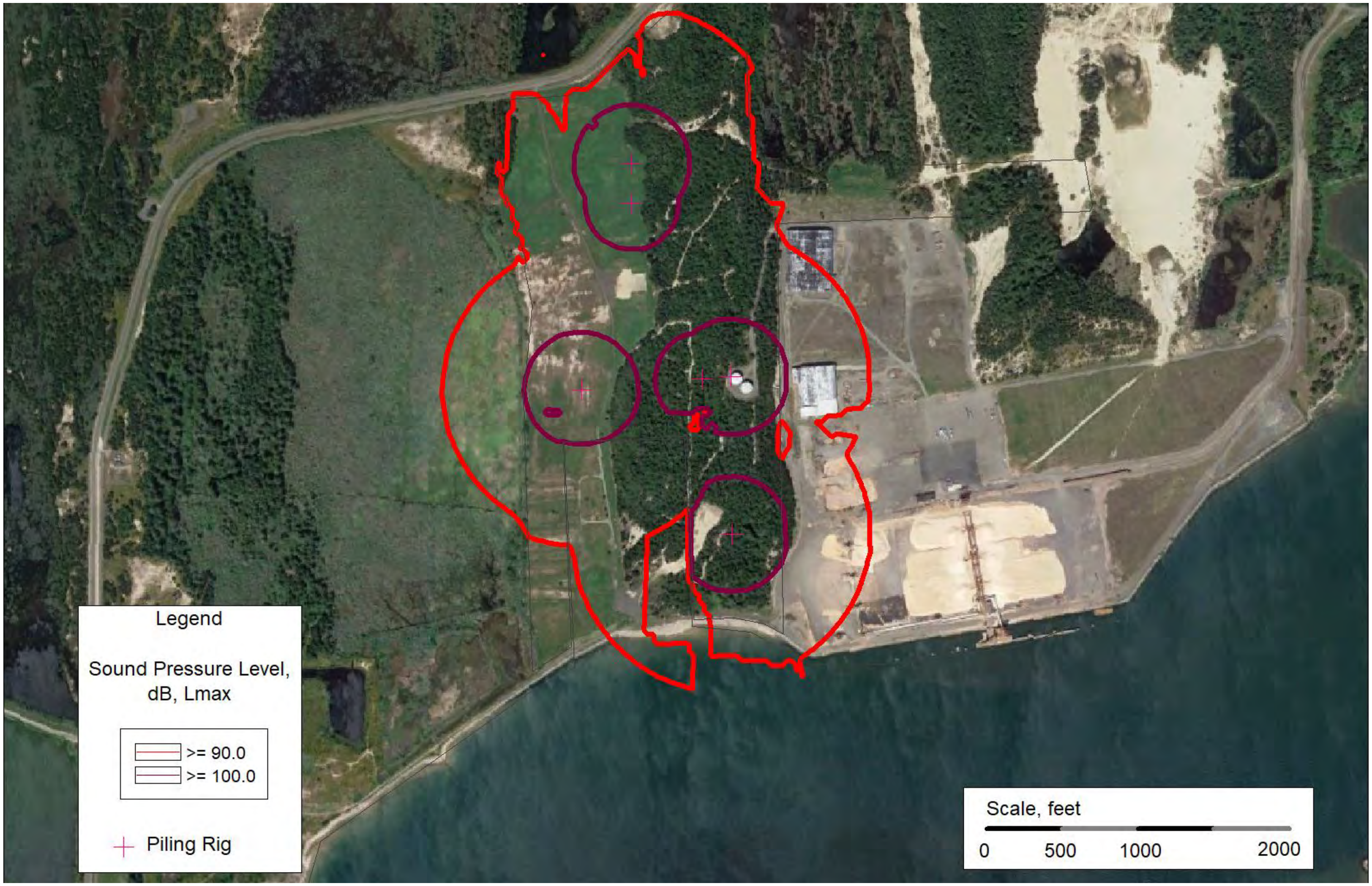
[1] http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html

Figure 1 Indicative general construction in air marine mammal noise impacts

Figure 2 Indicative dredging in air marine mammal noise impacts

Note that the 100 dB threshold is not exceeded by dredging, and the 90 dB contour is exceeded only within 40 feet of the dredge.

Figure 3 Indicative pile driving in air marine mammal noise impacts



Note: the active location of piling rigs will vary from day to day, with the location of noise isopleths shifting accordingly.

4.0 SUMMARY OF IN-AIR NOISE IMPACTS TO MARINE MAMMALS

The extent of noise in-air above the NMFS interim marine mammal behavioral disturbance thresholds is limited to areas in the immediate vicinity of the noise sources. The distances to the in air thresholds for each of the various noise prediction modelling scenarios considered are summarized as follows:

- During general construction, noise levels in air would decrease to below the most stringent threshold of 90 dB rms for harbor seals at distances of the order of 275 feet from the facility boundary.
- During dredging, noise levels in air would decrease to below the most stringent threshold of 90 dB rms for harbor seals at distances of the order of 40 feet from the noise source.
- During pile driving, noise levels in air would decrease to below the most stringent threshold of 90 dB rms for harbor seals at distances of the order of 920 feet from the nearest piling rig.

The noise impacts to marine mammals during operation would generally be less than during construction.

5.0 STATEMENT OF LIMITATIONS

The services described in this work product were performed in accordance with generally accepted professional consulting principles and practices. No other representations or warranties, expressed or implied, are made. These services were performed consistent with our agreement with our client. This work product is intended solely for the use and information of our client unless otherwise noted. Any reliance on this work product by a third party is at such party's sole risk.

Opinions and recommendations contained in this work product are based on conditions that existed at the time the services were performed and are intended only for the client, purposes, positions, time frames, and project parameters indicated. The data reported and the findings, observations, and conclusions expressed are limited by the scope of work. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this work product.

This work product presents professional opinions and findings of a scientific and technical nature. The work product shall not be construed to offer legal opinion or representations as to the requirements of, nor the compliance with, environmental laws rules, regulations, or policies of federal, state or local governmental agencies.

APPENDIX BB.4

Underwater Noise Impact Assessment

Memorandum

To: Drew Jackson

From: Briony Croft

Date: 15 September 2017

Subject: Jordan Cove LNG - Underwater Noise Impact Assessment

This technical memorandum provides a response to Items 8 and 11 from the FERC Environmental Information Request to the Jordan Cove and Pacific Connector Project (Docket No. PF17-4-000). These items request additional information to supplement the RR9 assessment of underwater noise impacts as follows:

8. *Include an evaluation and quantification of noise impacts from sound pressure waves generated within the water due to pile driving and dredging operations, as well as noise due to the operation of the tugs and LNG vessels. Quantify sound pressure levels in the aquatic environment (in dB re: 1μPa) to a distance of 1 mile and discuss impacts to all threatened and endangered aquatic species, marine mammals, and commercial and recreational fish species.*

11. *Estimate potential in-air and underwater noise impacts associated with the construction activities and equipment needed to widen and/or modify the Coos Bay Channel as part of the proposed Pilots Project.*

In addition to this memorandum, supporting documents are attached as follows:

Appendix A – NMFS spreadsheet calculations of potential for permanent threshold shift due to dredging and vessel operations.

Appendix B – JASCO Applied Sciences technical memorandum on vibratory pile driving

Appendix C - JASCO Applied Sciences technical memorandum on impact pile driving

1.0 INTRODUCTION

1.1 Project Description

The marine facilities associated with the Jordan Cove Energy Project (JCEP) LNG Terminal will be on the bay side of the North Spit of Coos Bay, Oregon. Construction of the marine facilities will include several activities with the potential to generate underwater noise:

- Dredging of the marine slip, access channel and materials offloading facility (MOF);
- Dredging in areas along the Coos Bay navigation channel as part of the proposed Pilots project;
- Placement of a sheet pile bulkhead; and
- Construction of platforms, fenders and mooring structures.

The construction activities with the most potential for underwater noise generation are dredging and pile driving. Dredging would occur in a staged approach, with as much material as possible removed through excavation in isolation from Coos Bay behind a temporary berm. In-water work including dredging and removal the temporary berm would be undertaken with a cutter suction dredge and a clamshell dredge. The equipment to dredge the Coos Bay navigation channel is yet to be confirmed, but on the basis of comparable projects use of a cutter suction dredge is likely and represents a reasonable worst case for indicative noise impact assessment.

Approximately 3600 pipe piles and over 11,800 sheet piles will be will be required for the project in total, including marine and upland piles. The average length of steel pipe piles will be around 93 feet in length. The largest steel pipe piles to be installed in water are the MOF bollards at 36-inches in diameter. These piles will be installed by hydraulic pile driving (impact hammer). The sheet pile bulkhead forming the MOF and berth walls would be installed by vibratory pile driving.

During operation of the LNG facility, the primary underwater noise sources would be vessels, including LNG ships and tugs. The JCEP LNG Terminal will add approximately 110-120 additional LNG carriers on an annual basis to the existing approximately 50 deep draft vessels per year operating in the area.

1.2 Aquatic Species Considered

Fisheries resources are described in JCEP LNG Terminal Project Resource Report 3 (RR3) Section 3.1. Fish habitat near the JCEP LNG Terminal supports a mix of marine and estuarine species, and both recreational and commercial fishing. Federally listed fish species spending a portion of their life cycle within the estuarine environment of Coos Bay are coho salmon; green sturgeon and eulachon.

RR3 Section 3.1.3 lists non-endangered marine mammals potentially occurring in the region, and Table 3.4-1 lists threatened and endangered species. Non-endangered marine mammal species potentially occurring in the Coos Bay estuary include the California sea lion, Steller sea lion, harbor porpoise, harbor seal, and northern elephant seal. Listed marine mammals occurring in the marine analysis area (which includes the JCEP project area and the LNG carrier transit route) are the blue whale; fin whale; gray whale; humpback whale; sei whale; sperm whale; killer whale and North Pacific right whale. Of these listed marine mammal species, humpbacks, gray whales and killer whales may occasionally enter Coos Bay within the JCEP project area.

Listed sea turtle species in the marine analysis area are loggerhead; leatherback; green; and olive ridley. These species are not expected to occur within the JCEP project area.

This assessment considers the potential for operational noise from vessel traffic in the marine analysis area to affect threatened and endangered aquatic species (fish, marine mammals and sea turtles). Noise from Facility construction activities including piling and dredging is assessed for potential to impact on fish and marine mammals.

1.3 Underwater Noise Sources and Scenarios

The project description has been used to develop a list of equipment with the potential to generate underwater noise. Overall broadband source noise levels at a 1m (3.3 feet) reference distance have been determined for each potential noise source from literature as shown in Table 1. Two different parameters are used to describe the source levels. The peak noise level is the short term maximum sound pressure level (SPL). It is used to describe the maximum noise level from an impulsive or short term event such as a hydraulic hammer striking a pile. The Root Mean Square (RMS) noise level is a type of average noise level over a time period of interest. RMS can be used to describe noise from a continuous source or the average noise during an impulsive event over a defined time period. All peak and RMS underwater sound levels in this report are described in decibels (dB) referenced to 1 micro Pascal (1 μPa).

A third parameter is used in this assessment as a descriptor of potential impacts, the Cumulative Sound Exposure Level (SEL_{cum}). This parameter describes the cumulative noise exposure from repeated or extended duration events such as piling hammer strikes or long term exposure to continuous noise. SEL_{cum} has units of dB re 1 $\mu Pa^2 s$.

Source levels for a range of sizes of support vessels have been estimated by scaling from frequency dependent reference vessel noise measurements, using the formulation described in Ross (1976) to adjust source levels on the basis of ship length, power and speed, as applied by Wales and Heitmeyer (2002).

Noise from large vessels (adjusted to a 1m reference distance) can range up to 188 dB re 1μPa (McKenna et al. 2012). In practice, noise from vessels will vary depending on vessel size and power, propulsion system loading and vessel speed. A typical transit speed for vessels within the Coos Bay navigation channel of 7 knots has been assumed for this assessment. At these speeds, transiting vessel noise emissions are reduced relative to noise at higher speeds. JASCO (2006) state that broadband noise from LNG vessels at half speed is expected to be around 175 dB re 1μPa at the 1m reference distance.

Noise from tugs under load is less speed dependent. Tugs under load can be noisier than larger vessels.

Noise from cutter suction dredges varies with the capacity of the dredger and the type of material being dredged. Reine et al (2014) measured source levels for a cutter suction dredger removing rock in New York Harbor of up to 175 dB re 1µPa at 1m. A smaller dredger with overall length approximately 100 ft., a total power of 1000 hp operating the main pumps, and with dredged material moving through a 16-in. pipeline undertaking maintenance dredging in a deep water shipping channel has been recorded with source levels up to 157 dB re 1µPa at 1m (Reine and Dickerson, 2014). Use of a similar dredge is anticipated for JCEP dredging. For this assessment, a dredging source noise level of 157 dB re 1µPa at 1m is assumed. The potential noise impacts of a larger dredger are also considered in this assessment as a worst case to assess the potential impact of dredging work in the Coos Bay navigation channel.

Underwater noise from piling is described in Caltrans (2015). This reference includes specific source levels for driving steel sheet piles and 36 inch diameter steel pipe piles.

Table 1 Broadband Source Noise Levels

Noise Source	Description	Peak dB re. 1µPa @ 1 m	RMS dB re. 1µPa @ 1 m	Reference
LNG vessel	Transiting 7 knots / half speed	n/a	175	McKenna et al 2012; JASCO, 2006.
Tugs and smaller support vessels	120' and up to 5400 HP	n/a	170	Warner et al, 2014
	150' and up to 6600 HP	n/a	175	Li et al, 2011
	220' and up to 10560 HP (LNG escort tug)	n/a	185	Jasco, 2006
Cutter Suction Dredging	Marine slip, access channel and MOF	n/a	157	Reine & Dickerson, 2014
	Coos Bay navigation channel	n/a	175	Reine et al, 2014
Sheet pile driving	Vibratory pile driving	195	180	Caltrans, 2015
	Impact hammer driving	225	210	Caltrans, 2015
36 inch steel pipe pile driving	Vibratory pile driving	200	190	Caltrans, 2015
	Impact hammer driving	230	213	Caltrans, 2015

Note 1: Source levels may vary over time with variations in propulsion system loading and vessel speed.

2.0 FISH AND SEA TURTLE NOISE IMPACT THRESHOLDS

Threshold levels for underwater noise impacts on fish and sea turtles have been the subject of research over many years. The majority of research has focused on the potential for physiological effects (injury or mortality) rather than on quantifying noise levels with behavioral effects. A review of the literature and guidance on appropriate thresholds for assessment of underwater noise impacts are provided in the 2014 Acoustical Society of America (ASA) Technical Report *Sound Exposure Guidelines for Fishes and Sea Turtles* (ASA, 2014).

The ASA Technical Report includes thresholds for mortality (or potentially mortal injury) as well as degrees of impairment such as temporary or permanent threshold shifts (TTS or PTS, indicators of hearing damage). Thresholds are defined for peak noise and cumulative impacts (due to continuous or repeated noise events) and for different noise sources (eg pile driving, and continuous noise from vessels or dredging). For continuous noise from vessels or dredging, there is a low risk of mortality or injury for any fish types or sea turtles. Piling noise results in higher noise levels and hence an increased potential for injury. The ASA guideline injury thresholds for piling noise for fish and sea turtles are summarized in Table 2.

Table 2 Underwater acoustic thresholds for fish and sea turtles during piling

Type of Animal	Mortality	Recoverable Injury	TTS
Fish: no swim bladder	> 219 dB SEL_{cum}; or > 213 dB Peak	>216 dB SEL_{cum}; or > 213 dB Peak	>> 186 dB SEL_{cum}
Fish: swim bladder not involved in hearing	210 dB SEL_{cum}; or > 207 dB Peak	203 dB SEL_{cum}; or > 207 dB Peak	> 186 dB SEL_{cum}
Fish: swim bladder involved in hearing	207 dB SEL_{cum}; or > 207 dB Peak	203 dB SEL_{cum}; or > 207 dB Peak	186 dB SEL_{cum}
Sea turtles	210 dB SEL_{cum}; or > 207 dB Peak	High risk near the source only (within tens of meters)	

Notes: Peak sound pressure has a reference value of 1 µPa and is "flat" or unweighted.
Cumulative sound exposure level (SEL_{cum}) has a reference value of 1µPa^2s.

Since soft start methods will be used as a mitigation measure for piling, and animals in the vicinity of noise sources will be free to move away, this assessment of impacts to fish focusses on the potential for peak noise levels during piling to cause mortality or injury. These effects are not anticipated at noise levels below about 207 dB re 1µPa, or at higher levels for species without swim bladders.

3.0 MARINE MAMMAL NOISE IMPACT THRESHOLDS

Guidance on acoustic thresholds for injury (hearing damage) in the form of permanent threshold shift (PTS) and disturbance are provided by the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS).

3.1 Acoustic Thresholds for Disturbance

The NMFS interim underwater thresholds for behavioral effects are shown in Table 3 (NMFS, 2012). Of the sources considered, the majority are "continuous" for the purpose of this assessment, with only the noise from impact pile driving treated as impulsive.

Table 3 Interim underwater acoustic thresholds for behavioral disruption

Criterion Definition	Threshold
Behavioral disruption for impulsive noise (e.g., impact pile driving)	160 dB_{rms}
Behavioral disruption for non-impulsive noise (e.g., vibratory pile driving, vessels)	120 dB_{rms}

Notes: dB referenced to 1 micro Pascal (re: 1μPa).
All thresholds are based off root mean square (rms) levels and are broadband (unweighted).
The 120 dB threshold may be slightly adjusted if background noise levels are at or above this level.

3.2 Acoustic Thresholds for Injury (Permanent Hearing Damage, PTS)

Acoustic thresholds related to PTS are provided by Technical Memorandum NMFS-OPR-55 *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts* (NMFS, 2016).

A dual metric approach is used for impulsive sounds, considering both cumulative sound exposure level and peak sound level. Different thresholds and auditory weighting functions are provided for different marine mammal hearing groups, which are defined in the Technical Guidance (NMFS, 2016). The generalized hearing range of each hearing group is reproduced in Table 4. The PTS thresholds are shown in Table 5. The non-endangered marine mammal species potentially occurring in the Coos Bay estuary include otariid pinnipeds (California sea lion, Steller sea lion), phocid pinnipeds (harbor seal, northern elephant seal) and the high frequency cetacean harbor porpoise. The listed marine mammal species which may occasionally enter Coos Bay within the JCEP project area are humpbacks and gray whales (low frequency cetaceans) and killer whales (mid frequency cetaceans).

Table 4 Cetacean hearing groups (from NMFS, 2016)

Hearing Group	Generalized Hearing Range
Low-frequency cetaceans	7 Hz to 35 kHz
Mid-frequency cetaceans	150 Hz to 160 kHz
High-frequency cetaceans	275 Hz to 160 kHz
Phocid pinnipeds	50 Hz to 86 kHz
Otariid pinnipeds	60 Hz to 39 kHz

Table 5 Underwater acoustic thresholds for PTS onset

Hearing Group	PTS Onset Acoustic Thresholds (Received Level)		
	Impulsive (Peak, L_{pk}, flat)	**Impulsive (SEL_{cum}, weighted, 24h)**	**Non-impulsive (SEL_{cum}, weighted, 24h)**
Low-frequency cetaceans	219 dB	183 dB	199 dB
Mid-frequency cetaceans	230 dB	185 dB	198 dB
High-frequency cetaceans	202 dB	155 dB	173 dB
Phocid pinnipeds	218 dB	185 dB	201 dB
Otariid pinnipeds	232 dB	203 dB	219 dB

Notes: Peak sound pressure (L_{pk}) has a reference value of 1 µPa and is "flat" or unweighted.
Cumulative sound exposure level (SEL_{cum}) has a reference value of 1µPa^{2}s.
SEL_{cum} received levels should be appropriately weighted for the hearing group for assessment.

4.0 NOISE LEVEL VS DISTANCE

For the purpose of this impact assessment, the objective is to quantify the noise level due to various sources at a range of distances out to 1 mile. These noise levels will then be discussed in relation to their potential to cause injury or disturbance to the species of interest, with reference to the identified thresholds.

4.1 Noise Level vs Distance

The magnitude of the noise level at a particular location depends strongly on the distance from the noise source. Underwater noise propagation models predict the sound transmission loss between the noise source and the receiver. When the source level (SL) of the noise source is known, the predicted transmission loss (TL) is then used to predict the received level (RL) at the receiver location as:

$$\mathrm{RL} = \mathrm{SL} - \mathrm{TL}$$

The transmission loss between two distances D1 and D2 may be described by a logarithmic relationship with an attenuation factor F:

$$\mathrm{TL} = \mathrm{F} \cdot \log(\mathrm{D}_1/\mathrm{D}_2)$$

If all losses due to factors other than geometric spreading are neglected, then the transmission loss would be wholly due to spherical spreading (in deep water) or cylindrical spreading (in shallow water, bounded above and below). Spherical spreading means underwater noise would attenuate by 6 dB with each doubling of distance, or F = 20. Cylindrical spreading means an attenuation of 3 dB with each doubling of distance, or F = 10.

In shallow water, noise propagation is highly dependent on the properties of the bottom and the surface as well as the properties of the fluid. Parameters such as depth and the bottom properties can vary with distance from the source. Sound energy at low frequencies may be transferred directly into the sea floor, rather than propagating through the water. Overall, the transmission loss in shallow water is a combination of cylindrical spreading effects, bottom interaction effects (absorption) at lower frequencies and scattering losses at high frequencies.

In practical cases the attenuation factor F can range from 5 up to 30. A “practical spreading loss model” based on an attenuation factor of 15 for sound transmission is commonly assumed for projects near shore (NMFS, 2012) and has been adopted for this study.

The noise attenuation vs distance is shown in Figure 1. The noise level from the various sources at a range of distances out to 1 mile is summarized in Table 6. Note that in situations with more than one noise source or several vessels operating in an area, the loudest or closest source may be assumed to dominate at any particular receiver location.

Figure 1 Noise Attenuation vs Distance – Practical Spreading Loss Model

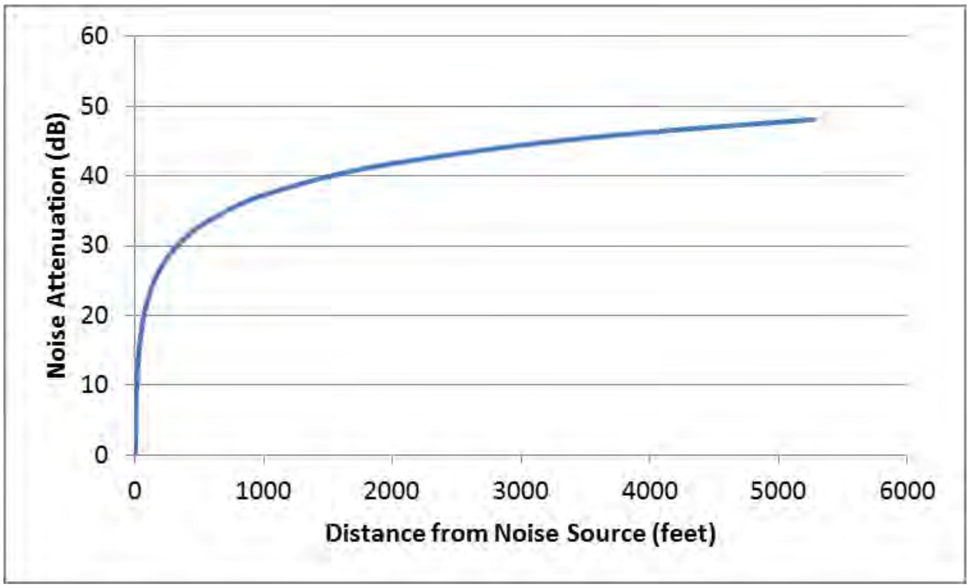


Table 6 Peak and RMS Noise Level vs Distance by Source

Parameter	Noise Source	3.3 ft	50 ft	100 ft	500 ft	1000 ft	1 mile
RMS dB re. 1µPa	LNG Vessel	175	157	153	142	138	127
	120’ Support Vessel	170	152	148	137	133	122
	150’ Support Vessel	175	157	153	142	138	127
	220’ LNG escort tug	185	167	163	152	148	137
	CSD – marine slip, access channel, MOF	157	139	135	124	120	109
	CSD – worst case Coos Bay nav. channel	175	157	153	142	138	127
	Vibratory sheet pile driving	180	162	158	147	143	132
	Impact sheet pile driving	210	192	188	177	173	162
	Vibratory steel pipe pile driving	190	172	168	157	153	142
	Impact hammer steel pipe pile driving	213	195	191	180	176	165
Peak dB re. 1µPa	Vibratory sheet pile driving	195	177	173	162	158	147
	Impact sheet pile driving	225	207	203	192	188	177
	Vibratory steel pipe pile driving	200	182	178	167	163	152
	Impact hammer steel pipe pile driving	230	212	208	197	193	182

5.0 DISCUSSION OF POTENTIAL PROJECT UNDERWATER NOISE IMPACTS TO FISH AND SEA TURTLES

As identified in Section 2.0, mortality or injury to fish or sea turtles of any species is not anticipated at peak noise levels below about 207 dB re 1μPa, or at higher levels for species without swim bladders.

Of the various activities with the potential to generate underwater noise, only piling using an impact hammer has source levels that are high enough to potentially cause injury or mortality to fish. Impact driving of steel pipe piles is noisier than impact driving of sheet piles. For sheet piles, the potential for injury to fish is limited to within 50 feet of the noise source, in a worst case situation. For steel pipe piles, this distances increases to about 100 feet, again under worst case assumptions. Soft start methods will be used as a mitigation measure for piling, with the initial strikes applied at lower power with reduced noise levels. The areas with potential piling noise physical impacts to fish would be within the excavated and dredged area required to construct the marine facility.

Fish behavioral responses to noise from piling activity may occur over greater distances. ASA (2014) indicates a high risk of behavioral effects to fish during piling in the near to intermediate field, ie within distances of tens to hundreds of meters. The risk of behavioral effects in the far field (of the order of thousands of meters or miles) reduces to moderate. In light of the Facility location in Coos Bay, the potential for adverse behavioral impacts to fish outside of the immediate project construction vicinity (within about 1 mile) is considered to be low.

With reference to ASA (2014), the risk of adverse fish behavioral responses to noise from dredging and vessel activity is also expected to be low except in the immediate vicinity of the noise source. The noise from project dredging and vessel movements will be similar to noise from existing dredging activity and vessel movements in the Coos Bay navigation channel. Similarly the risk of adverse sea turtle behavioral responses to noise from vessel activity is low, with the noise from project activity similar to noise from existing shipping activity.

6.0 DISCUSSION OF POTENTIAL PROJECT UNDERWATER NOISE IMPACTS TO MARINE MAMMALS

6.1 Marine Mammal Impulsive Peak Noise PTS Potential

As identified in Section 3.2, permanent hearing damage to marine mammals of any species is not anticipated at impulsive peak noise levels below 202 dB re 1μPa, with the lowest threshold applicable to high frequency cetaceans which include harbor porpoises. For low and mid frequency cetaceans and pinnipeds (ie for all other species potentially affected by the project), the impulsive peak noise injury threshold is higher, above 218 dB re 1μPa.

Marine mammals inside Coos Bay in the vicinity of the Facility may be affected by noise from piling during construction. Of the various piling scenarios, only the use of an impact hammer has impulsive peak source levels that are high enough to cause PTS in any species. The greatest distance at which PTS due to impulsive peak noise may possibly occur is around 250 feet for the harbor porpoise. Soft start methods will be used as a mitigation measure for piling, with the initial impacts applied at lower power with reduced noise levels and hence reduced potential for impacts. On this basis, injury in the form of PTS to any marine mammal species is not anticipated as a result of impulsive peak noise emissions during project piling.

6.2 Marine Mammal Cumulative Noise Exposure PTS Potential

The NMFS 2016 Technical Guidance provides a calculation method for determining the potential for cumulative noise to have adverse effects to marine mammal hearing. This method includes multiple conservative assumptions and is therefore expected to result in higher estimates of hearing impairment that would be the case in a practical situation. An assessment using the NMFS spreadsheet calculator has been undertaken for each of the vessel and dredging noise sources and scenarios. Calculation sheets detailing the various assumptions and the distance to the cumulative noise PTS threshold for each noise source are attached as Appendix A. More detailed site specific investigations of the potential for cumulative piling noise impacts have been investigated by JASCO (Deveau and MacGillvray 2017, O'Neill and MacGillivray 2017) and are attached as Appendices B and C. For most species, activities and scenarios, there is very low risk of cumulative PTS in practice since individual animals would need to remain in close proximity to the noise source for an extended period of time, without moving away. The results of these various cumulative noise impact calculations are summarized as follows:

- During dredging to construct the marine facility, individual harbor porpoises would need to remain within about 500 feet of the dredge for 24 hours for there to be a potential for PTS. Other marine mammals would need to remain effectively immediately adjacent to the dredge for the same duration.
- During dredging of the navigation channel, individual harbor porpoises would need to remain within about 1.6 miles of the dredge for 24 hours for there to be a potential for PTS. Killer whales would need to remain within about 180 feet of the dredge again for 24 hours for there to be potential for PTS. Other marine mammals would need to remain effectively immediately adjacent to the dredge for the same duration.
- When tugs are operating semi-stationary under full power near the Facility, individual harbor porpoises would need to remain within about 1 mile of the tug for 1 hour for there to be a potential for PTS. Killer whales would need to remain within about 100 feet of the tug for 1 hour for there to be potential for PTS.
- During 36" steel pipe pile installation using a vibratory driver, individual harbor porpoises would need to remain within about 1.3 miles of the noise source during the driving of approximately 3 individual piles (1000 strikes) for there to be potential for PTS. Harbor seals and killer whales would need to remain within 1.1 miles of the noise source for the same duration for PTS to potentially occur.
- The noise from transiting vessels and tugs does not represent a potential risk of PTS to any of the identified marine mammal species, at any realistically occurring distance.

There is potential for cumulative noise exposure to cause PTS in harbor porpoises (high frequency cetaceans) during in water piling, particularly when a hydraulic impact hammer is used. For PTS to occur, harbor porpoises would need to remain in the vicinity during extended periods of impact piling. The potential for PTS to occur in other marine mammals is less, due to the differing hearing sensitivities of other species. The use of a combination of engineered underwater noise mitigation measures (such as pile cushions, bubble curtains) and management techniques (including soft starts, protected species observers and exclusion zones) is expected to minimize the potential for acoustic injury to marine mammals.

6.3 Marine Mammal Behavioral Disturbance Potential

Away from the JCEP project area, the potential for effects to threatened and endangered marine mammals is limited to behavioral disturbance due to noise from piling, navigation channel dredging, LNG vessels, tugs and potentially other support vessels. Vibratory sheet pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 120 dB re 1 μPa at distances of up to 1.2 miles (Deveau and MacGillvray, 2017). Impact pipe pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 160 dB re 1 μPa at similar distances (O'Neill and MacGillvray, 2017).

The noise from project vessel movements and dredging will be similar to noise from existing vessel and dredging activity in the Coos Bay navigation channel.

7.0 SUMMARY

This assessment provides quantitative levels for underwater noise generated by the Jordan Cove LNG project and potential impacts to marine mammals, threatened and endangered aquatic species and to commercial and recreational fish species.

Of the various activities with the potential to generate underwater noise, only piling using an impact hammer has source levels that are high enough to cause potential injury or mortality to fish. In the noisiest scenario, potential physical impacts to fish would be restricted to areas within about 100 feet of the noise source, inside the excavated and dredged area required to construct the marine facility. The potential for adverse behavioral impacts to fish outside of the immediate project construction vicinity (at distances greater than about 1 mile) is considered to be low, for all construction scenarios.

The noise from project dredging and vessel movements will be similar to noise from existing dredging activity and vessel movements in the Coos Bay navigation channel, with a low risk of adverse fish behavioral responses to these noise sources.

Harbor porpoises (which are not endangered) are the only high frequency cetacean that may occur in the vicinity of the Facility. If present, this marine mammal species has the greatest potential to be affected by noise from piling or other marine facility construction noise sources. Permanent hearing impairment harbor porpoises is not anticipated as a result of impulsive peak noise emissions during project piling, provided they are not present with 250 feet of piling using an impact hammer. Individual harbor porpoises would need to remain with about 1.3 miles of the facility for the full duration of driving 3 of the largest marine pipe piles to risk permanent hearing impairment due to the cumulative noise effects of piling.

In relation to other marine mammals and the identified threatened and endangered species, there is a lower risk of permanent hearing impairment due to project noise. There is potential for behavioral disturbance due to noise from dredgers, LNG vessels, tugs and other support vessels. The noise disturbance from project vessel movements and dredges will be similar to noise from existing vessel and dredging activity in the Coos Bay navigation channel.

8.0 REFERENCES

Caltrans (2015). Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish, California Department of Transportation.

Deveau, T. J. and A. MacGillvray (2017). Jordan Cove Vibratory Pile Driving Underwater Noise Modeling: Technical Memorandum. Document 01324, Version 2.0. Technical report by JASCO Applied Sciences for AECOM Environment.

JASCO Research Ltd. (2006) Cacouna Energy LNG Terminal: Assessment of Underwater Noise Impacts.

Li, Z., MacGillivray, A., and Wladichuk, J. (2011) Underwater Acoustic Modelling of Tug and Barge Noise for Estimating Effects on Marine Animals. Version 1.0. Technical report prepared for AREVA Resources Canada by JASCO Applied Sciences.

McKenna, M.F., D. Ross, S.M. Wiggins, and J.A. Hildebrand (2012). Underwater radiated noise from modern commercial ships. Journal of the Acoustical Society of America 131(1): 92-103.

NMFS (2012). Guidance Document: Sound propagation modeling to characterize pile driving sounds relevant to marine mammals. U.S. Dept. of Commer., NOAA, NMFS Northwest Region and Northwest Fisheries Science Center. Memorandum.

NMFS (2016) Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

O'Neill, C., and A. MacGillivray (2017). Jordan Cove Impact Pile Driving Underwater Noise Modeling: Technical Memorandum. Document 01377, Version 1.0. Technical report by JASCO Applied Sciences for AECOM Environment.

Reine, K. J., D. Clarke, and C. Dickerson. (2014) Characterization of underwater sounds produced by hydraulic and mechanical dredging operations. The Journal of the Acoustical Society of America 135 (6), 3280 – 3294.

Reine, K. J., and C. Dickerson (2014). Characterization of underwater sound produced by a hydraulic cutterhead dredge during navigation dredging in the Stockton Deep-Water Channel, California. DOER Technical Notes Collection. ERDC TN-DOER-E38. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Ross, D. (1976) Mechanics of Underwater Noise, Pergamon, New York.

Wales, S. C., and Heitmeyer, R. M. (2002) An ensemble source spectra model for merchant ship-radiated noise. The Journal of the Acoustical Society of America 111(3), 1211-1231.

Warner, A. C. et al (2014) Underwater Acoustic Measurements in Haro Strait and Strait of Georgia: Transmission Loss, Vessel Source Levels, and Ambient Measurements. JASCO Document 00659, Version 3.0. Technical report by JASCO Applied Sciences for Hemmera.

9.0 STATEMENT OF LIMITATIONS

The services described in this work product were performed in accordance with generally accepted professional consulting principles and practices. No other representations or warranties, expressed or implied, are made. These services were performed consistent with our agreement with our client. This work product is intended solely for the use and information of our client unless otherwise noted. Any reliance on this work product by a third party is at such party's sole risk.

Opinions and recommendations contained in this work product are based on conditions that existed at the time the services were performed and are intended only for the client, purposes, positions, time frames, and project parameters indicated. The data reported and the findings, observations, and conclusions expressed are limited by the scope of work. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this work product.

This work product presents professional opinions and findings of a scientific and technical nature. The work product shall not be construed to offer legal opinion or representations as to the requirements of, nor the compliance with, environmental laws rules, regulations, or policies of federal, state or local governmental agencies.

APPENDIX A
NMFS spreadsheet calculations of potential for permanent threshold shift due to dredging and vessel operations

Jordan Cove LNG - Underwater Noise Impact Assessment

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	JCEP LNG - Dredging
PROJECT/SOURCE INFORMATION (Please include any assumptions)	As per information contained in Resource Reports 1,3,9
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	157
Activity Duration (hours) within 24-h period	24
Activity Duration (seconds)	86400
10 Log (duration)	49.37
Propagation (xLogR)	15
Distance of source level measurement (meters)[+]	1

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.3**	**3.5**	**167.6**	**0.6**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-15.27**	**-0.28**	**0.00**	**-8.68**	**-11.01**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Dredging Coos Bay navigation channel
PROJECT/SOURCE INFORMATION (Please include any assumptions)	As per information contained in Resource Reports 1,3,9
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	175
Activity Duration (hours) within 24-h period	24
Activity Duration (seconds)	86400
10 Log (duration)	49.37
Propagation (xLogR)	15
Distance of source level measurement (meters)[+]	1

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**4.7**	**54.8**	**2,655.9**	**9.5**	**0.4**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-15.27**	**-0.28**	**0.00**	**-8.68**	**-11.01**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	JCEP LNG - Stationary tug
PROJECT/SOURCE INFORMATION Please include any assumptions	As per information contained in Resource Reports 1,3,9. Stationary tug assumed working near facility 4 hours active in any one day.
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	185
Activity Duration (hours) within 24-h period	1
Activity Duration (seconds)	3600
10 Log (duration)	35.56
Propagation (xLogR)	15
Distance of source level measurement (meters)[+]	1

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**2.6**	**30.6**	**1,481.6**	**5.3**	**0.2**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-15.27**	**-0.28**	**0.00**	**-8.68**	**-11.01**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

C: MOBILE SOURCE: Non-Impulsive, Continuous (SAFE DISTANCE METHODOLOGY‡)

VERSION: 1.1 (Aug-16)

KEY

(green)	**Action Proponent Provided Information**
(pink)	**NMFS Provided Information (Acoustic Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	JCEP LNG -LNG Vessel in transit 7 knots
PROJECT/SOURCE INFORMATION Please include any assumptions	As per information contained in Resource Reports 1,3,9
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	175
Source Velocity (meters/second)	3.6
Duty cycle	1
Source Factor	3.16228E+17

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.0**	**0.0**	**1.4**	**0.0**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-15.27**	**-0.28**	**0.00**	**-8.68**	**-11.01**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

C: MOBILE SOURCE: Non-Impulsive, Continuous (SAFE DISTANCE METHODOLOGY‡)

VERSION: 1.1 (Aug-16)

KEY

(green)	**Action Proponent Provided Information**
(pink)	**NMFS Provided Information (Acoustic Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	JCEP LNG - Escort Tug in transit 7 knots
PROJECT/SOURCE INFORMATION Please include any assumptions	As per information contained in Resource Reports 1,3,9
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	185
Source Velocity (meters/second)	3.6
Duty cycle	1
Source Factor	3.16228E+18

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.0**	**0.0**	**13.8**	**0.0**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-15.27	-0.28	0.00	-8.68	-11.01

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

APPENDIX B
JASCO Applied Sciences
Technical memorandum on vibratory pile driving

Jordan Cove LNG - Underwater Noise Impact Assessment

Jordan Cove Vibratory Pile Driving Underwater Noise Modeling

Technical Memorandum

Submitted to: William Gorham, Ph.D.
AECOM Environment
Contract: 86019

Authors:
Terry J. Deveau
Alex MacGillvray

21 February 2017

P001353-001
Document 01324
Version 2.0

JASCO Applied Sciences (Canada) Ltd
Suite 202, 32 Troop Ave.
Dartmouth, NS B3B 1Z1 Canada
Tel: +1-902-405-3336
Fax: +1-902-405-3337
www.jasco.com

Suggested citation:

Deveau, Terry J. and Alex MacGillvray. 2017. Jordan *Cove Vibratory Pile Driving Underwater Noise Modeling: Technical Memorandum*. Document 01324, Version 2.0. Technical report by JASCO Applied Sciences for AECOM Environment.

Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

Figures

Tables

1. Introduction

This technical memorandum presents results from an underwater noise modeling study undertaken by JASCO on behalf of AECOM to support a Marine Mammal Protection Act Incidental Harassment Authorization application. The planned noise-generating activity is "in the dry" vibratory sheet pile installation that will be conducted as part of the construction of a Materials Off-loading Facility (MOF) at the proposed Jordon Cove LNG Terminal at Coos Bay, Oregon. The modeling presented in this technical memorandum is based on draft engineering plans for the Jordan Cove facility and is intended to provide a screening-level assessment of potential underwater noise from sheet-pile wall construction at the MOF.

The draft construction plans call for a 30-feet wide soil berm to be installed between the water and the location of the sheet piles. The sheet piles will be installed behind the berm prior to excavation of a marine slip at the proposed facility. The purpose of the present study is to model underwater noise that would be transmitted from the sheet piles to the water, through the soils, during vibratory driving. Noise from sheet pile driving may have the potential to negatively impact nearby marine mammals in Coos Bay. The impacts of underwater noise generated by vibratory pile driving at the MOF is expected to be mainly limited to harbor seals that may be foraging near or transiting past the construction site, though other species of marine mammals may occasionally be present.

A hydrographic chart of Coos Bay is shown in Figure 1, with the location of the proposed sheet pile wall and the two transects used for underwater noise modelling in this study.

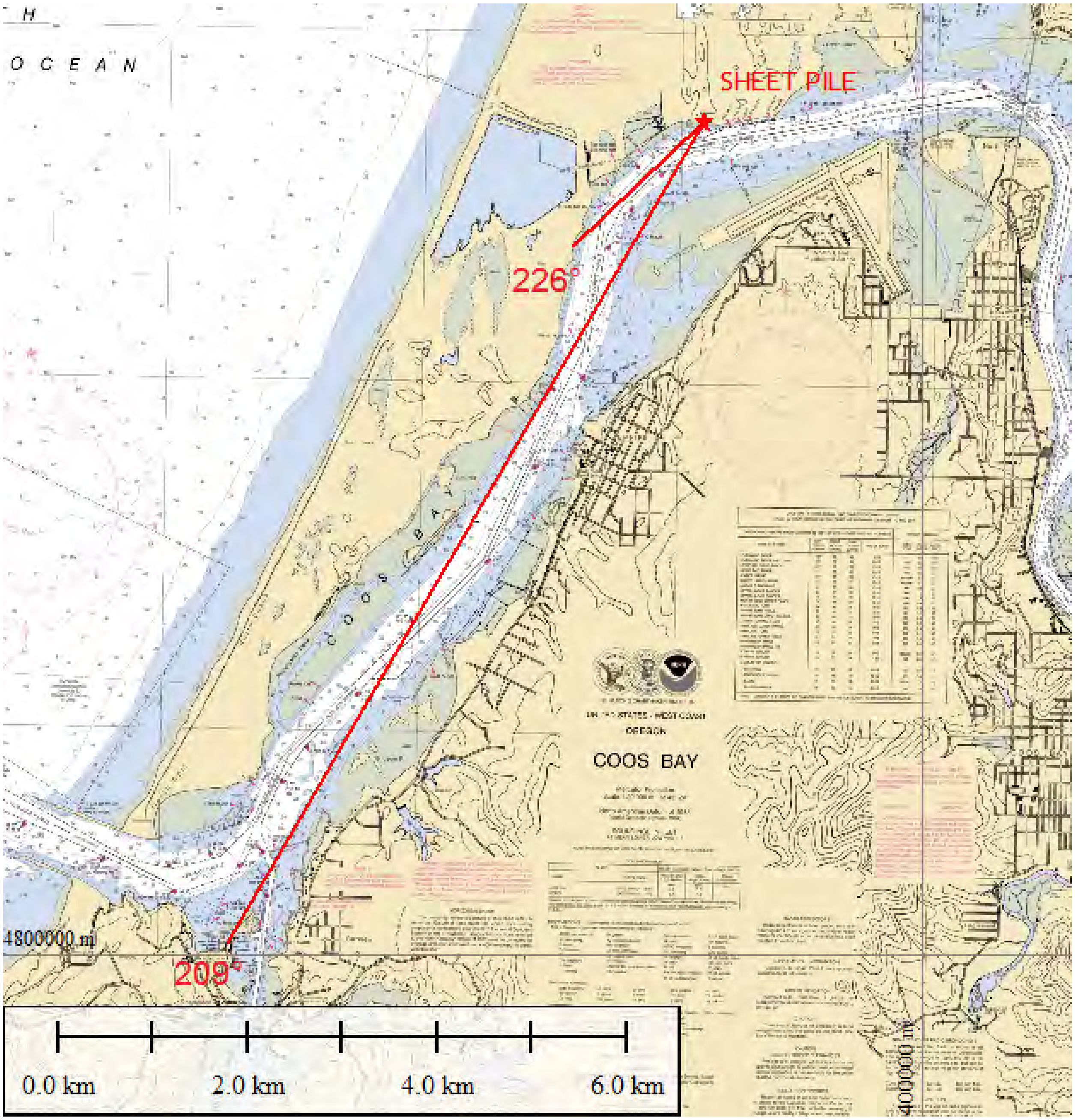


Figure 1. Annotated hydrographic chart of Coos Bay showing the location of the proposed sheet pile driving (red star) and the underwater noise modelling transects (red lines). An expanded distance scale is also provided.

2. Methods

A numerical sound propagation model was used to simulate the transmission of sheet piling noise through water-saturated soils into water. Source levels for this activity were based on published hydrophone measurements of in-water sheet pile driving. To translate the source levels from water into soil, it was assumed that the sheet piles would generate the same magnitude of vibration in soil as in water.

For modeling the sound propagation, JASCO collected environmental data describing the bathymetry, water sound speed, and seabed geoacoustics in Coos Bay. The environmental data and source levels were input to underwater noise modelling software to estimate the underwater noise received levels (RL) that would be present in the water near the pile driving.

2.1. Bathymetry

A bathymetry grid for the acoustic propagation model was constructed based on two datasets:

- U.S. Coastal Relief Model digital elevation model (DEM) with a 3-arc-second resolution (National Centers for Environmental Information, 2017)
- Coos Bay hydrographic chart, no. 18587, at 1:20,000 scale, from the Coast Survey, National Ocean Service, NOAA. (Coast Survey, 2017).

The DEM downloaded from the NCEI website provided only positive elevation values inland of the Pacific Ocean coastline. To accurately represent the bathymetry of the Coos Bay channel, 16433 spot bathymetry values were sampled from the NOAA Bathymetric Chart. These spot bathymetric readings are relative to Mean Lower Low Water (MLLW), while the DEM is relative to the mean high water (MHW) tidal level. Based on the tide information published on the Coos Bay hydrographic chart, an adjustment of 6 feet was made to the spot bathymetry samples from the chart before incorporating them into the revised DEM.

The depth/elevations from the NCEI DEM and the spot bathymetry samples from the NOAA hydrographic chart were combined into a new DEM with a 9-meter horizontal grid spacing. The underwater acoustic noise modelling has been carried-out on the basis of a tidal water level equal to the mean high water (MHW). On the basis of NOAA tidal data, this water level has been taken to be 6 feet higher than the mean lower low water (MLLW) level, which is the basis for the depth soundings and depth contours portrayed on the NOAA hydrographic charts (Coast Survey, 2017).

2.2. Sound Speed Profile

For this particular study, a uniform sound speed of 1500 m/s was assumed for the entire water column. This is a common laboratory reference value for speed of sound in sea-water. Since the water depth in this modelling area is very shallow (less than 14 m), and located in an estuary, it is reasonable to assume that that water column is well mixed and that that the speed of sound is uniform with depth.

2.3. Geoacoustics

In shallow water environments where there is increased interaction with the sea-floor, the properties of the substrate have a large influence over the sound propagation. Information on the composition of the soils at the measurement site was not available at the time of writing, therefore the geoacoustic model used in this work is based on estimated values that are thought to be typical for this environment, consisting of soft silty sand sediments of undetermined depth. The required parameters for modelling sound propagation are the density (ρ), compressional-wave speed, (c_p), shear-wave speed (c_s), compressional-wave attenuation (α_p), and shear-wave attenuation (α_s). A geoacoustic profile, Table 1, has been constructed to represent these geological conditions.

Table 1. Geoacoustic properties as a function of depth, in metres below the seafloor (mbsf). Within an indicated depth range, the parameter varies linearly within the stated range.

Depth (mbsf)	Material	Density (g/cm³)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0–50	Silty sand	1.83	1680–1730	0.5	250	0.1
> 50			1730			

2.4. Source Level

Based on the draft engineering designs, it was assumed that individual sheet piles were 50 feet tall and 18 inches wide, embedded to a maximum penetration depth of 36 feet below MHW. For the purpose of this study, we assumed that the underwater noise of vibratory driving of the pile can be modelled as a point source located at the midpoint of the underground portion of the pile. Therefore, we used a source depth of 5.48 meters (i.e., 18 feet below MHW).

The source level (SL) spectrum of the vibratory driving of this pile for the purpose of this study was assumed to be equivalent to the SL spectrum reported for Berth 23, Port of Oakland (APE 400 3200 kN vibe hammer) vibratory pile driving (Buehler, et al., 2016). The SL, in terms of sound pressure level (SPL) at 1 meter from the source location, in 1/3-octave bands, was taken to be as shown in Table 2.

Table 2. SL of vibratory pile driving, in terms of SPL band-level at 1 meter from the source location, in 1/3-octave bands.

Frequency (Hz)	10	13	16	20	25	32	40	50	63	80	100	125	160	200
SL (dB re 1 µPa)	136.8	138.2	139.6	141.0	149.7	146.4	141.1	140.5	146.1	149.3	146.1	154.2	153.7	157.1

Frequency (Hz)	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
SL (dB re 1 µPa)	158.9	156.1	158.4	160.4	165.3	171.1	174.2	170.8	172.0	170.9	166.9	163.8	162.6

2.5. Underwater Acoustic Propagation Model

The underwater acoustic propagation modeling for this study was performed using a modified version of the RAM parabolic-equation model (Collins 1993, 1996), that has been enhanced by JASCO. RAM was developed at the US Naval Research Laboratory has been extensively benchmarked and is widely used as a reference model in the underwater acoustics community.

3. Results

The modeled received level (RL) of the broadband noise in the water column generated by the vibration sheet pile driving is illustrated in Figure 2 and Figure 3, which show the sound pressure level (SPL) in dB re 1 µPa in areas of different color as a function of the horizontal distance from the source (range) and the depth of the receiver. Each of the figures is for a different azimuthal direction away from the source location (measured in degrees, clockwise from geographic true north).

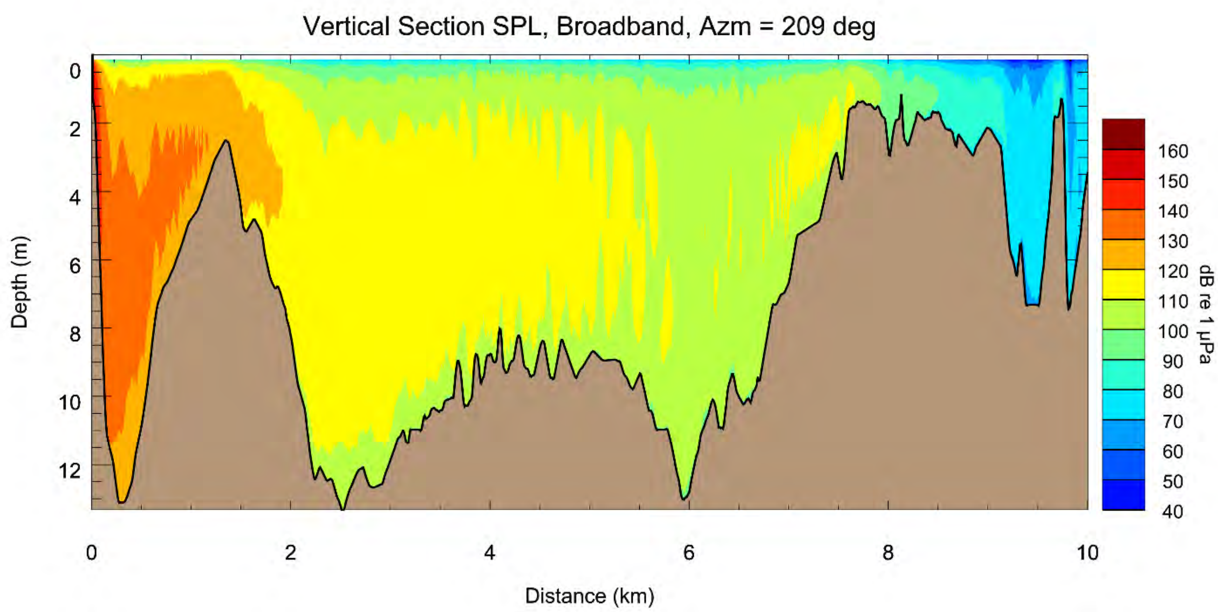


Figure 2. Broadband SPL versus horizontal range from the source and depth below the MHW tidal level for the 209° azimuth.

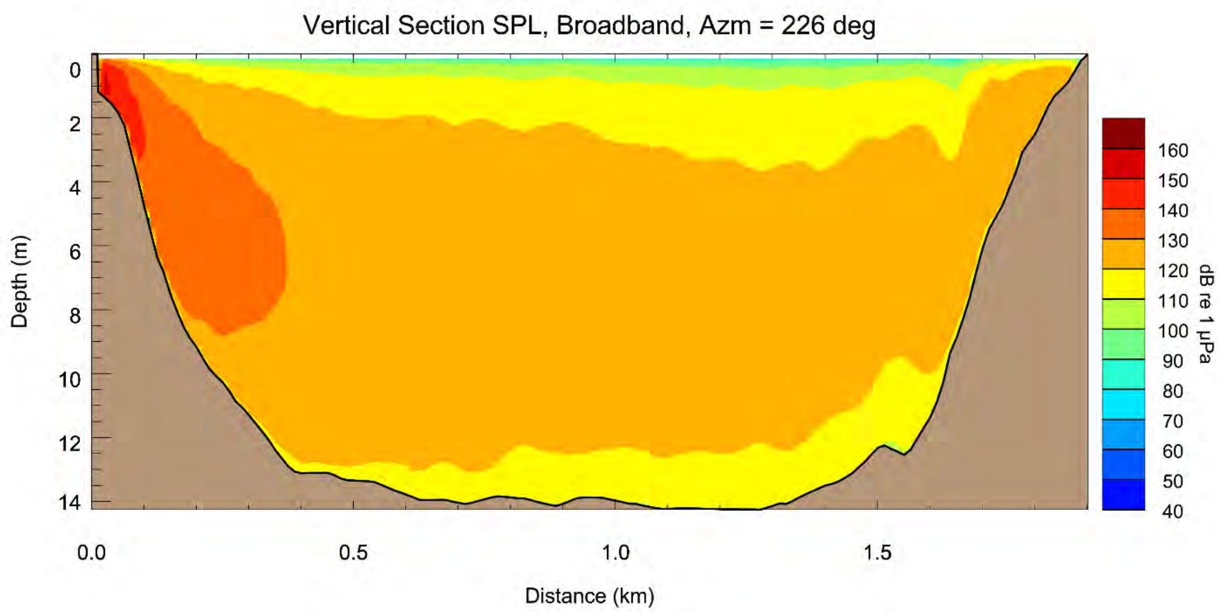


Figure 3. Broadband SPL versus horizontal range from the source and depth below the MHW tidal level for the 226° azimuth.

The 209° azimuthal direction illustrates the longest possible underwater range of noise propagation from the source location, as other directions are blocked at shorter ranges by shoals or the shoreline. The 226° azimuthal direction illustrates the highest underwater RL, at longer ranges, due to the greater water depth in that direction before shoaling is encountered.

The maximum modelled RL (over depth) as a function of range is illustrated in Figure 4 and Figure 5 for the same two azimuthal directions as the previous figures. Inspection of the 1/3-octave band RL shows that highest levels are at frequencies around 1000 Hz (Figure 6).

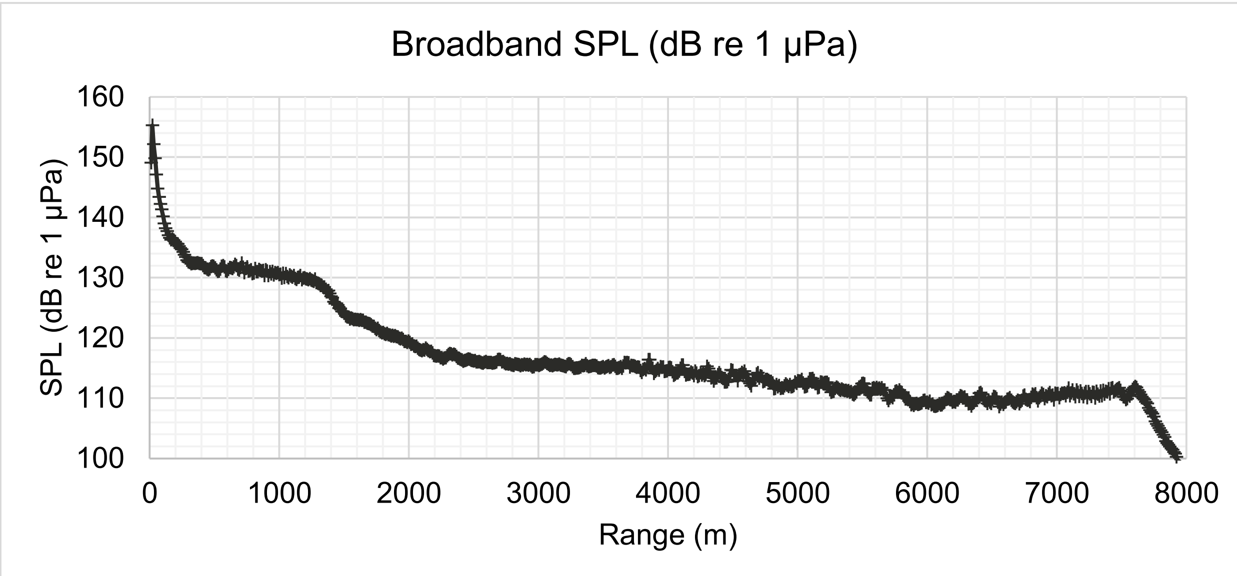


Figure 4. Maximum-over-depth broadband RL versus horizontal range from the source for the 209° azimuth.

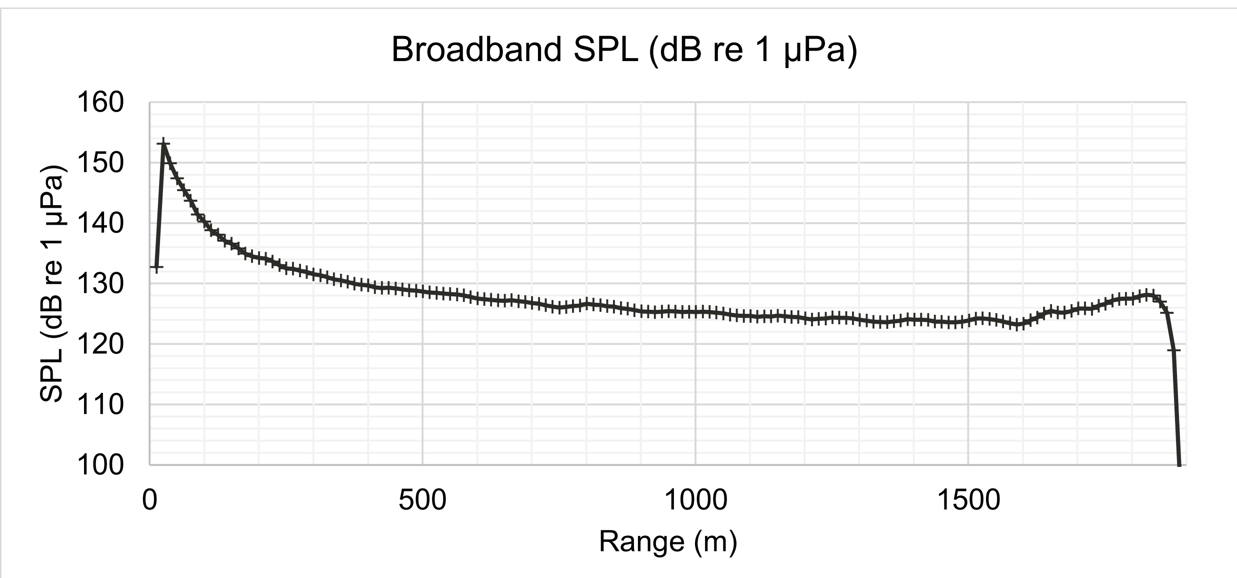


Figure 5. Maximum-over-depth broadband RL versus horizontal range from the source for the 226° azimuth.

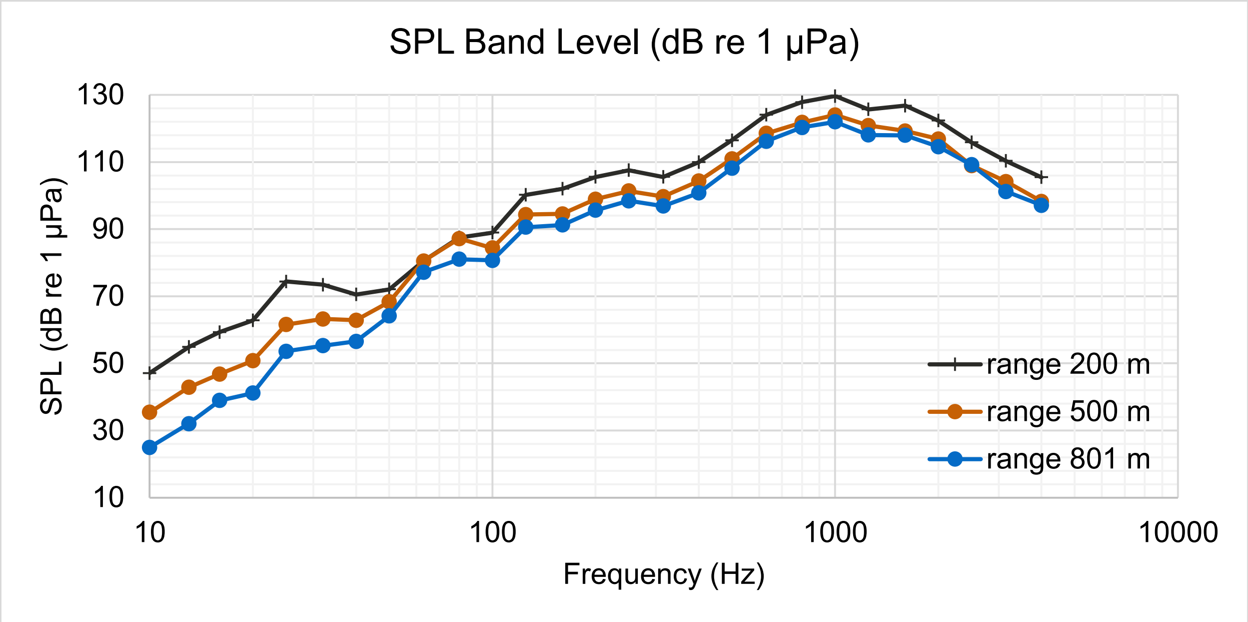


Figure 6. Maximum-over-depth SPL versus frequency in 1/3-octave bands, at three different distances, for the 226° azimuth.

4. Summary

Table 3 shows the maximum distance to the 120 dB re 1 µPa threshold along the two modelling transects considered in the current study. These results show that the highest noise levels from sheet piling at the MOF are to be found where the sound is able to propagate away from the source in deeper water for the furthest distance, before being attenuated by bottom loss in shallower water.

Table 3. Maximum modeled distance to the 120 dB re 1 µPa threshold along two azimuths.

Azimuth (° CW from North)	Maximum range to 120 dB re 1 µPa (m)
209	1914
226	1870

Literature Cited

ANSI S1.1-1994. R2004. *American National Standard Acoustical Terminology*. American National Standards Institute, New York.

ANSI/ASA S1.13-2005. R2010. *American National Standard Measurement of Sound Pressure Levels in Air*. American National Standards Institute and Acoustical Society of America, New York.

ANSI/ASA S3.20-1995. R2008. *American National Standard Bioacoustical Terminology*. American National Standards Institute and Acoustical Society of America, New York.

Buehler, David, Rick Oestman, James Reyff, Keith Pommerenck, and Bill Mitchell. 2015. *Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish*. Report No. CTHWANP-RT-15-306.01.01, Division of Environmental Analysis, California Department of Transportation, Sacramento, Calif.

Collins, M.D. 1993. A split-step Padé solution for the parabolic equation method. *Journal of the Acoustical Society of America* 93: 1736-1742.

Collins, M.D., R.J. Cederberg, D.B. King, and S. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. *Journal of the Acoustical Society of America* 100(1): 178-182.

Coast Survey. 2017. *Coos Bay hydrographic chart.* No. 18587, 1:20,000 scale. National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C.

National Centers for Environmental Information. 2017. *U.S. Coastal Relief Model.* 3-arc-second resolution. National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Retrieved February 2017 from https://maps.ngdc.noaa.gov/viewers/wcs-client/

Glossary

1/3-octave-band
Non-overlapping passbands that are one-third of an octave wide (where an octave is a doubling of frequency). Three adjacent 1/3-octave-bands comprise one octave. One-third-octave-bands become wider with increasing frequency. Also see octave.

attenuation
The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

azimuth
A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

broadband sound level
The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measured frequency range.

compressional wave
A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called primary wave or P-wave.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

digital elevation model (DEM)
A sampled array of elevations (and bathymetric depths in water) for a number of geographical positions at regularly spaced horizontal intervals (i.e., on a horizontal grid).

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

geoacoustic
Relating to the acoustic properties of the seabed.

hertz (Hz)
A unit of frequency defined as one cycle per second.

mbsf
Meters below sea floor

mean high water (MHW)
The arithmetic mean of all the high water heights observed over a period of several years. In the United States this period spans 19 years and is referred to as the National Tidal Datum Epoch.

mean lower low water (MLLW)
The arithmetic mean of the lower of the two low water heights of each tidal day, observed over a period of several years. In the United States this period spans 19 years and is referred to as the National Tidal Datum Epoch.

NCEI
National Centers for Environmental Information (formerly the National Geophysical Data Center).

NGDC
National Geophysical Data Center.

NOAA
National Oceanic and Atmospheric Administration.

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

parabolic equation method
A computationally-efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

point source
A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: *p*.

received level
The sound level measured at a receiver.

rms
root-mean-square.

shear wave
A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 μPa) and the unit for SPL is dB re 1 μPa:

$$\mathrm{SPL} = 10\log_{10}\left(p^2/p_0^2\right) = 20\log_{10}\left(p/p_0\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level. See also 90% sound pressure level and fast-average sound pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound level measured in the far-field and scaled back to a standard reference distance of 1 meter from the acoustic center of the source. Unit: dB re 1 µPa @ 1 m (sound pressure level) or dB re 1 $\mu Pa^2 \cdot s$ (sound exposure level).

APPENDIX C
JASCO Applied Sciences
Technical memorandum on impact pile driving

Jordan Cove LNG - Underwater Noise Impact Assessment

JASCO APPLIED SCIENCES

Jordan Cove Impact Pile Driving Underwater Noise Modeling

Technical Memorandum

Submitted to:
William Gorham, Ph.D.
AECOM Environment
Contract: 86019

Authors:
Caitlin O'Neill
Alexander MacGillivray

25 May 2017

P001353-001
Document 01377
Version 1.0

JASCO Applied Sciences (Canada) Ltd
Suite 2305, 4464 Markham St.
Victoria, BC V8Z 7X8 Canada
Tel: +1-250-483-3300
Fax: +1-250-483-3301
www.jasco.com

Suggested citation:

O'Neill, C., and A. MacGillivray, 2017. Jordan *Cove Impact Pile Driving Underwater Noise Modeling: Technical Memorandum*. Document 01377, Version 1.0. Technical report by JASCO Applied Sciences for AECOM Environment.

Disclaimer:

Contents

Figures

Tables

1. Introduction

This technical memorandum presents results from an underwater noise modeling study undertaken by JASCO on behalf of AECOM to support a Marine Mammal Protection Act Incidental Harassment Authorization application. The planned noise-generating activity is impact hammer pile driving that will be conducted as part of the construction of a Materials Off-loading Facility (MOF) at the proposed Jordon Cove LNG Terminal at Coos Bay, Oregon. The modeling presented in this technical memorandum is based on draft engineering plans for the Jordan Cove facility and is intended to provide a screening-level assessment of potential underwater noise from the construction of 36-inch diameter bollard pipes at the MOF.

The construction plans call for the bollard pipes to be installed in the dry, at a setback distance of 12 feet (ft) (3.65 meters (m)) from the sheet pile wall of the MOF. The purpose of the present study is to model underwater noise that would be transmitted from the pipe piles, through the sediment and sheet pile wall, and into the water, during impact pile driving. Noise from impact pile driving may have the potential to negatively impact nearby marine mammals in Coos Bay. The impacts of underwater noise generated by impact pile driving at the MOF is expected to be mainly limited to seals, eared seals (sea lions), and harbor porpoises that may be foraging near or transiting past the construction site, though other species of marine mammals may occasionally be present.

A hydrographic chart of Coos Bay is shown in Figure 1, with the location of the proposed pipe piles and the two transects used for underwater noise modeling in this study.

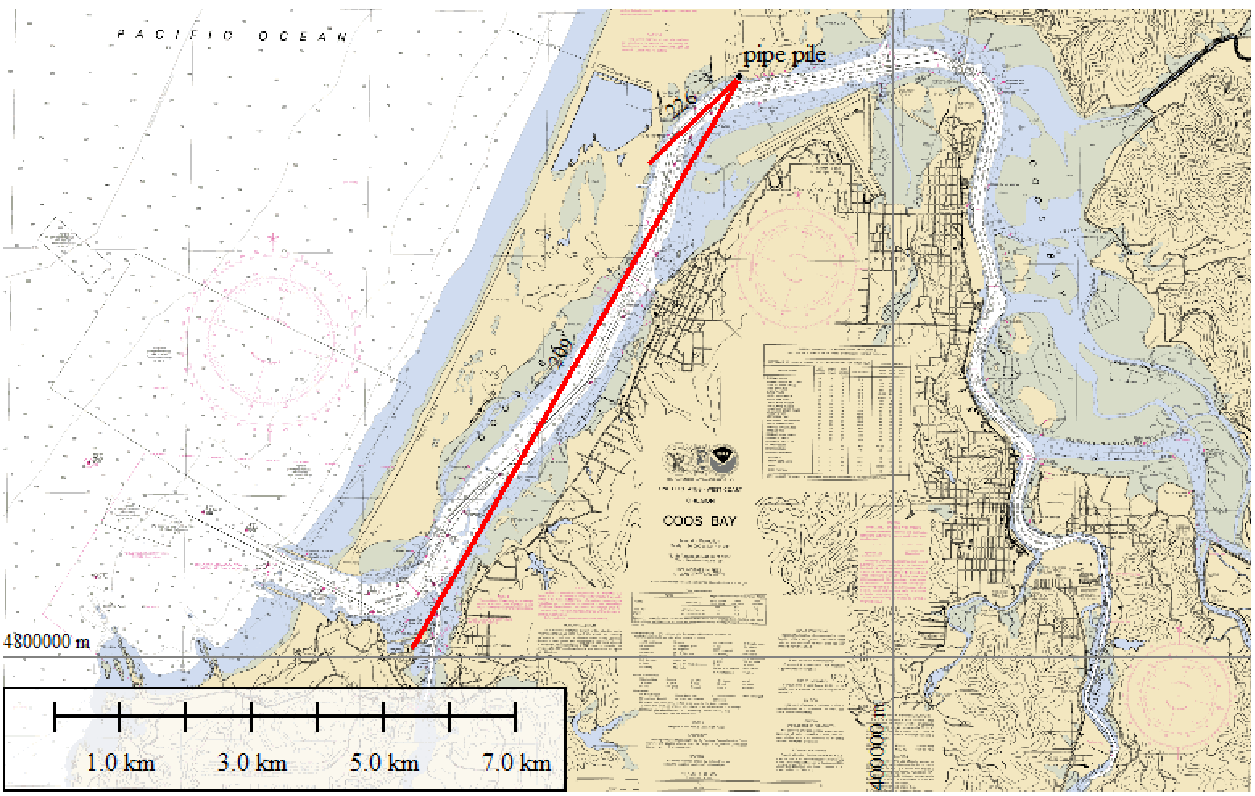


Figure 1. Annotated hydrographic chart of Coos Bay showing the location of the proposed pipe pile driving (black dot) and the underwater noise modeling transects (red lines). An expanded distance scale is also provided.

2. Methods

A full-wave numerical sound propagation model was used to simulate the transmission of impact pile driving noise through water-saturated soils into water. Source levels for impact pile driving were calculated using a thin-shell structural vibration model for cylindrical piles. For modeling the sound propagation, JASCO collected environmental data describing the bathymetry, water sound speed, and seabed geoacoustics in Coos Bay. The environmental data and source levels were input to underwater noise modelling software to estimate the underwater noise received levels (RL) that would be present in the water near the pile driving.

M-weighting was applied for multiple hearing groups, including low-frequency cetaceans, mid-frequency cetaceans, high-frequency cetaceans, phocid pinnipeds in water, and otariid pinnipeds in water, to weight the importance of received sound levels according to marine mammal hearing sensitivity, in accordance with the 2016 NOAA Technical Guidance (NMFS 2016).

2.1. Bathymetry

A bathymetry grid for the acoustic propagation model was constructed based on two datasets:

- U.S. Coastal Relief Model digital elevation model (DEM) with a 3-arc-second resolution ([NGDC] National Geophysical Data Center 2017)
- Coos Bay hydrographic chart, no. 18587, at 1:20,000 scale, from the National Oceanic and Atmospheric Administration (NOAA) Coast Survey, National Ocean Service. (Coast Survey 2017).

The DEM downloaded from the NOAA National Centers for Environmental Information (NCEI) website provided only positive elevation values inland of the Pacific Ocean coastline. To accurately represent the bathymetry of the Coos Bay channel, 16433 spot bathymetry values were sampled from the NOAA Bathymetric Chart. These spot bathymetric readings are relative to Mean Lower Low Water (MLLW), while the DEM is relative to the mean high water (MHW) tidal level. Based on the tide information published on the Coos Bay hydrographic chart, an adjustment of 6 ft was made to the spot bathymetry samples from the chart before incorporating them into the revised DEM with a 9-meter horizontal grid spacing. The underwater acoustic noise modeling was carried-out on the basis of a tidal water level equal to the MHW.

Bathymetry was manually edited to have 12 ft (3.7 m) of land before water starts. For the scenario with dredged bathymetry, water depths were uniformly 45 ft (13.7 m) from the toe of the sheet pile out to the shipping channel.

2.2. Sound Speed Profile

A uniform sound speed of 1500 meters per second (m/s) was assumed for the entire water column. This is a common laboratory reference value for speed of sound in sea-water. Since the water depth in this modeling area is very shallow (less than 46 ft (14 m)), and located in an estuary, it is reasonable to assume that this water column is well mixed and the speed of sound is uniform with depth.

2.3. Geoacoustics

In shallow water environments where there is increased interaction with the sea-floor, the properties of the substrate have a large influence over the sound propagation. Information on the composition of the soils at the measurement site was not available at the time of writing, therefore the geoacoustic model used in this work is based on estimated values that are thought to be typical for this environment, consisting of soft silty sand sediments of undetermined depth. The required parameters for modeling sound propagation are the density (ρ), compressional-wave speed, (c_p), shear-wave speed (c_s), compressional-wave attenuation (α_p), and shear-wave attenuation (α_s). A geoacoustic profile, Table 1, has been constructed to represent these geological conditions.

Table 1. Geoacoustic properties as a function of depth, in meters below the seafloor (mbsf). Within an indicated depth range, the parameter varies linearly within the stated range.

Depth (mbsf)	Material	Density (g/cm^3)	P-wave speed (m/s)	P-wave attenuation **(dB/λ)**	S-wave speed (m/s)	S-wave attenuation **(dB/λ)**
0–50	Silty sand	1.83	1680–1730	0.5	250	0.1
> 50			1730			

2.4. Source Level

Draft engineering designs describe the individual pipe piles for bollard construction: 60 ft long, 36 in diameter, and embedded to a maximum penetration depth of 55 ft. The construction plan calls for the piles to be driven using a Demag D80-23 diesel impact hammer. A forcing function for the hammer was modelled using GRLWEAP 2010 (GRLWEAP, Pile Dynamics 2010) assuming that driving was carried out using the maximum recommended hammer energy (Figure 2). The forcing function was computed assuming direct contact between the hammer and the piles (i.e. no cushion material).

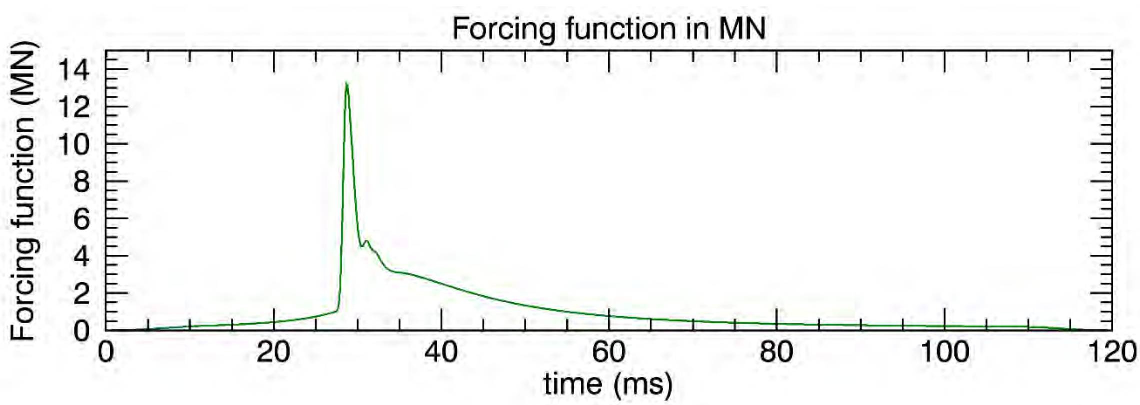


Figure 2. Force (meganewtons (MN)) at the pile tip generated by a Demag D80-23 diesel impact hammer as predicted by GRLWEAP 2010.

A structural acoustic model of pile vibration and near-field sound radiation (MacGillivray 2014) was used to predict the vibration of the struck pile (Figure 3). The sound radiating from the pile itself was simulated using a vertical array of discrete point sources to accurately characterise vertical directivity effects in the near-field zone. An extrapolation method (Zykov et al. 2016) was used to extend the modelled source levels up to 4 kHz, by applying a −2 dB per 1/3-octave-band roll-off coefficient to the source levels starting at 800 Hz.

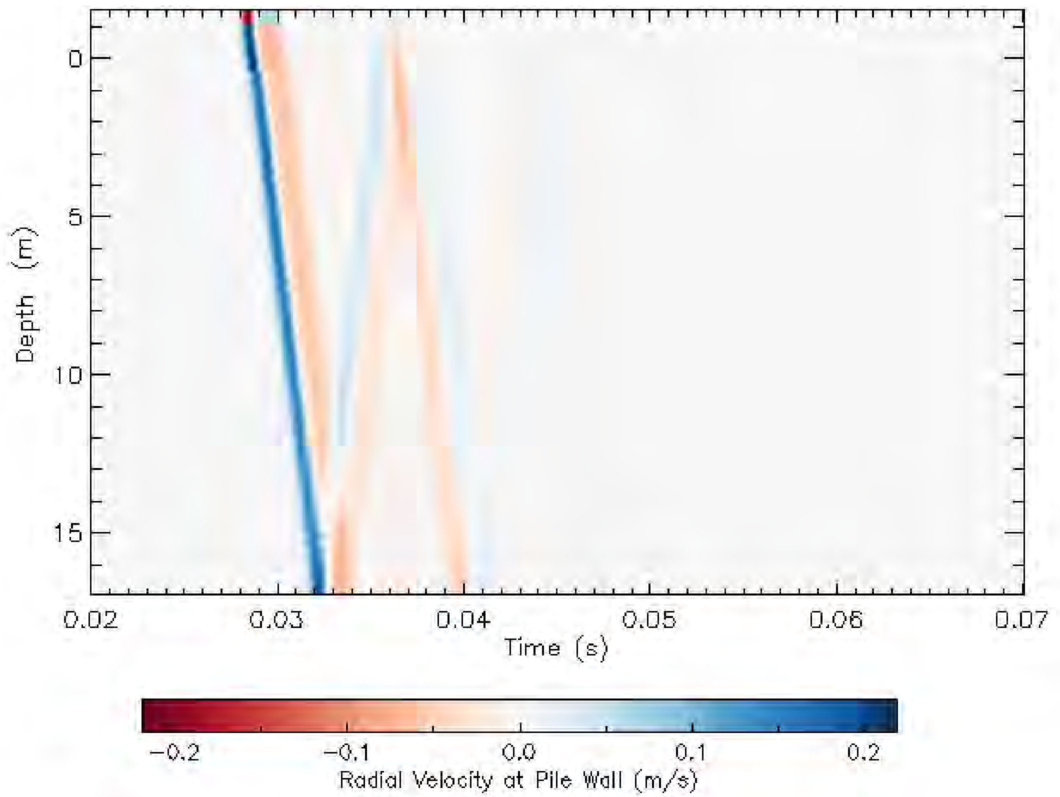


Figure 3. Radial vibration of the pile wall as predicted by the structural acoustic model.

2.5. Underwater Sound Propagation Model

For impulsive sounds from impact pile driving, time-domain representations of the pressure waves generated in the water are required to calculate sound pressure level (SPL), sound exposure level (SEL), and peak pressure level. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic propagation model. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, accounting for bathymetry, water sound speed profile, and seabed geoacoustics. FWRAM computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012).

2.6. Transmission Loss Through Sheet Pile Wall

Frequency-dependent attenuation through the sheet pile wall at the MOF was calculated according a plane wave transmission model (Jensen et al. 2011) from soil through a 0.5 inch steel layer. The frequency-dependent transmission loss (Figure 4) was applied to calculated source pressures of the pipe pile to simulate the attenuation of the pile driving noise due to the sheet pile wall.

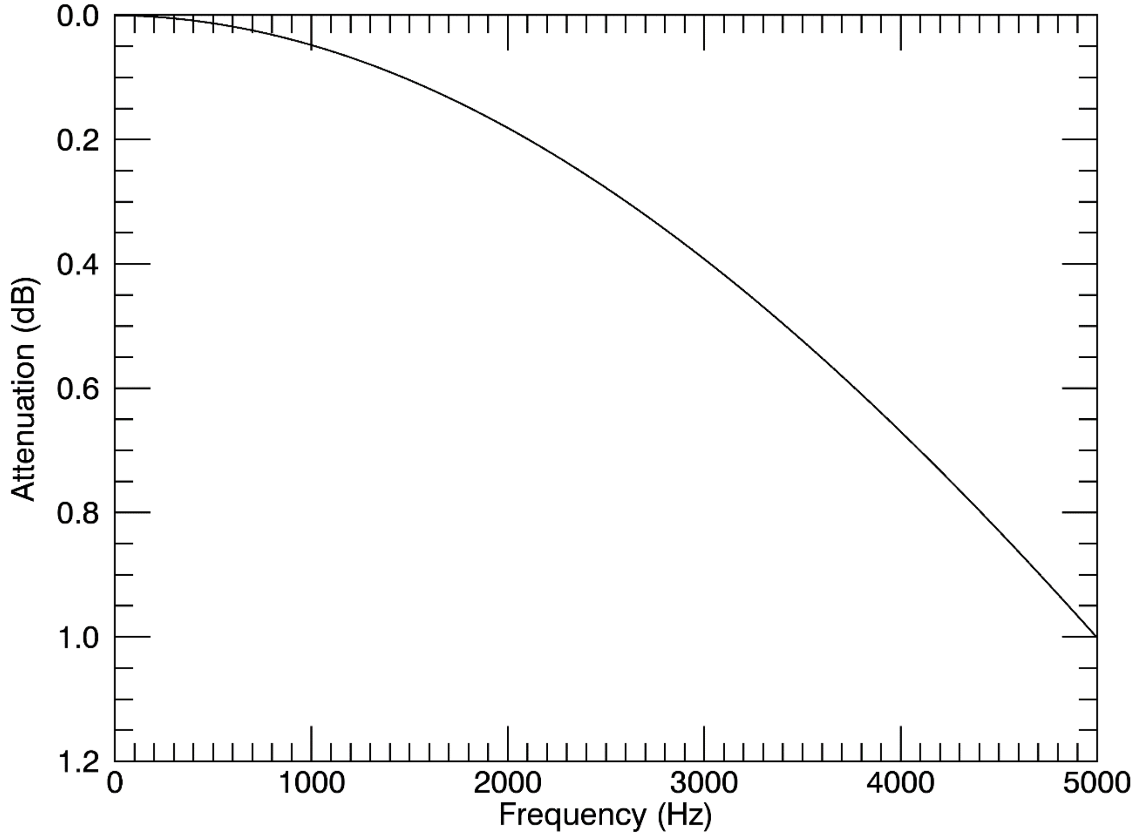


Figure 4. Calculated sound attenuation of the sheet pile wall versus frequency.

2.7. Marine Mammal Frequency Weighting Functions

In 2015, a U.S. Navy technical report recommended new auditory weighting functions for marine mammals (Finneran 2016). The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The report proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year and were adopted in NOAA's technical guidance that assesses noise impacts on marine mammals (NMFS 2016). Figure 5 shows the recommended frequency-weighting curves.

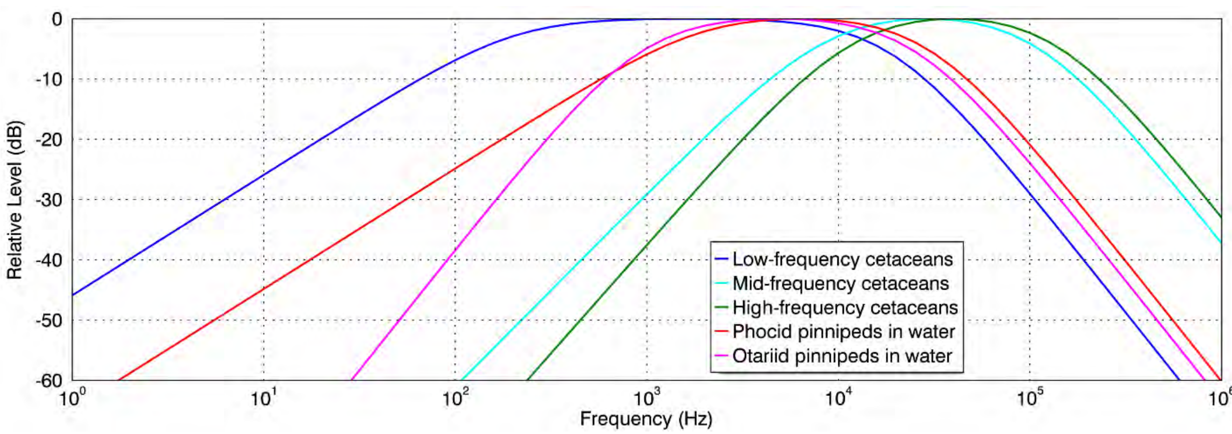


Figure 5. Auditory weighting functions for functional marine mammal hearing groups as recommended by NOAA (2016).

3. Results

The modeled received levels (RL) of the broadband noise in the water column generated by the impact pipe pile driving are illustrated in Figure 7 and Figure 7, which show unweighted, per-pulse SEL (dB re 1 µPa²s) as a function of the horizontal distance from the source and the depth of the receiver. Each of the figures is for a different azimuthal direction away from the source location (measured in degrees, clockwise from geographic true north).

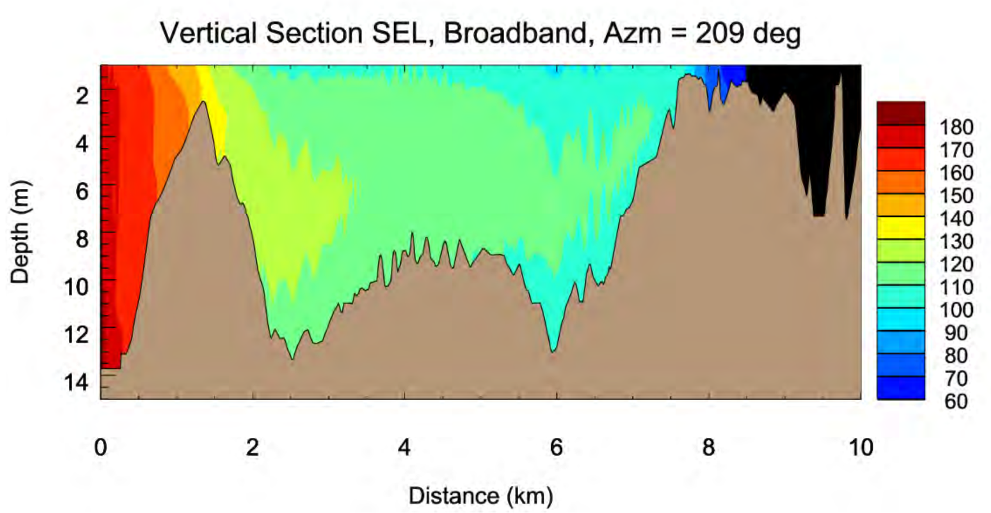


Figure 6. Per-pulse SEL (unweighted) versus horizontal range from the source and depth below the MHW tidal level for the 209° azimuth.

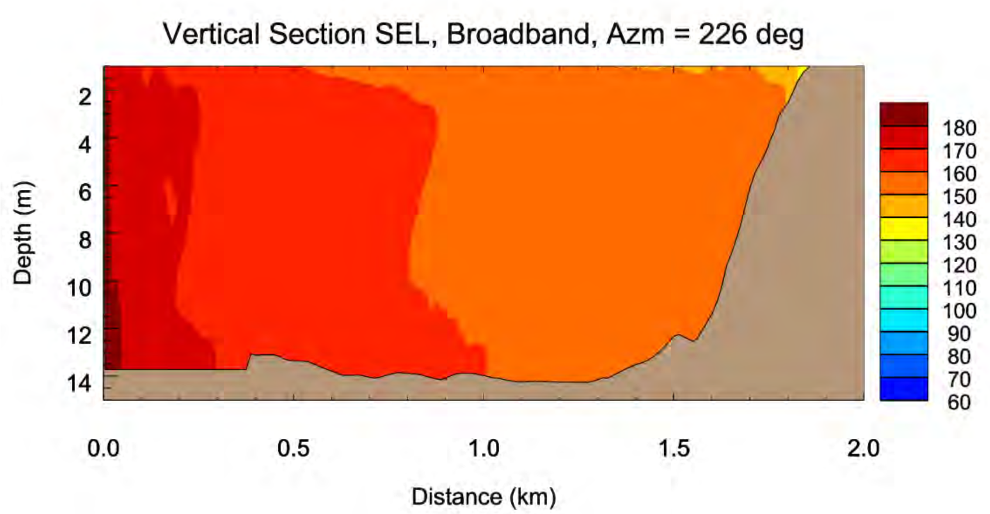


Figure 7. Per-pulse SEL (unweighted) versus horizontal range from the source and depth below the MHW tidal level for the 226° azimuth.

The 209° azimuthal direction illustrates the longest possible underwater range of noise propagation from the source, as other directions are blocked at shorter ranges by shoals or the shoreline. The 226° azimuthal direction illustrates the highest underwater RL, at longer ranges, due to the greater water depth in that direction before shoaling is encountered.

The maximum modelled RL (over depth) as a function of range is illustrated in Figure 8 and Figure 9 for the same two azimuthal directions as the previous figures. Inspection of the 1/3-octave band RL shows that highest levels are at frequencies around 300 to 500 Hz (Figure 10). These frequencies are within the hearing ranges of all marine mammal hearing groups, although killer whales (mid-frequency cetaceans) and harbor porpoises (high-frequency cetaceans) would not hear these frequencies as well as seals (phocid pinnipeds) and sea lions (otariid pinnipeds) (NMFS 2016).

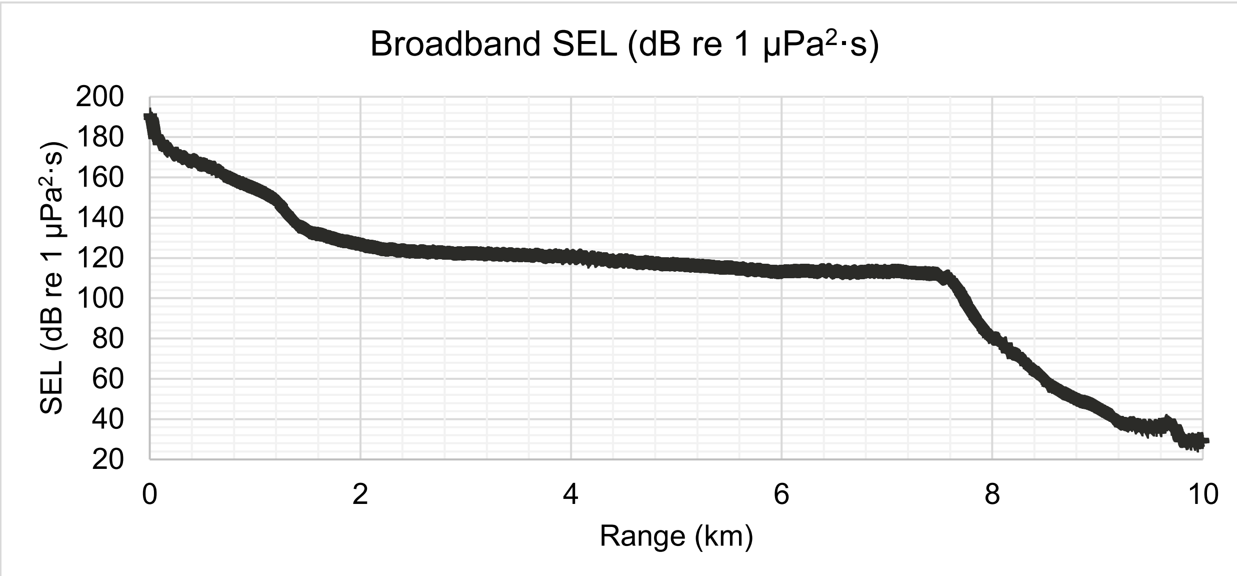


Figure 8. Maximum-over-depth per-pulse SEL (unweighted) versus horizontal range from the source for the 209° azimuth.

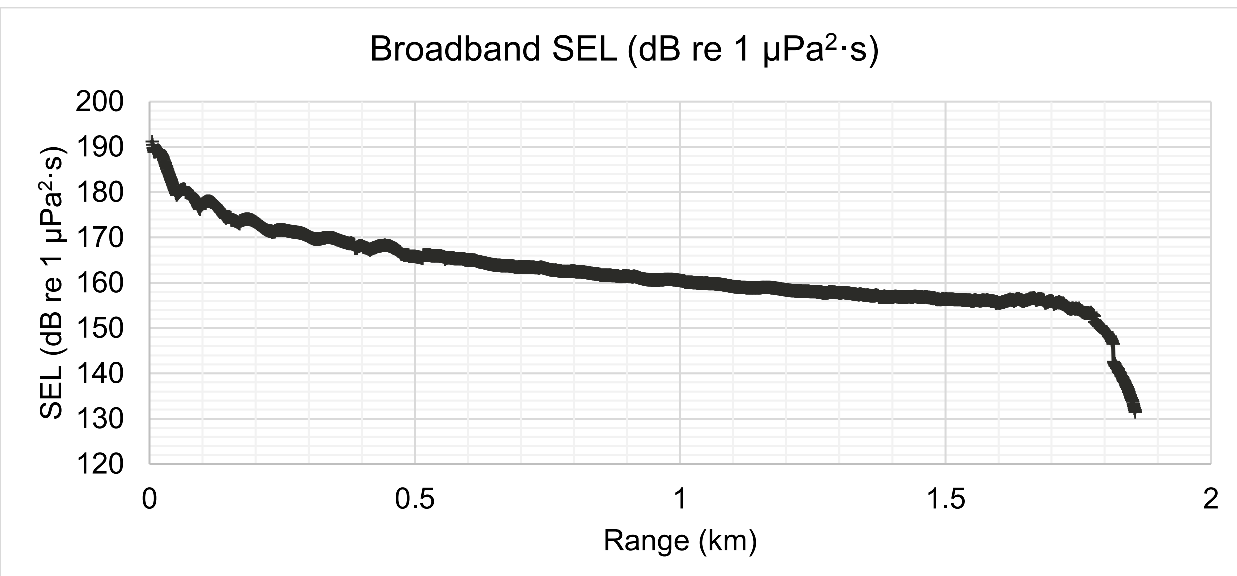


Figure 9. Maximum-over-depth per-pulse SEL (unweighted) versus horizontal range from the source for the 226° azimuth.

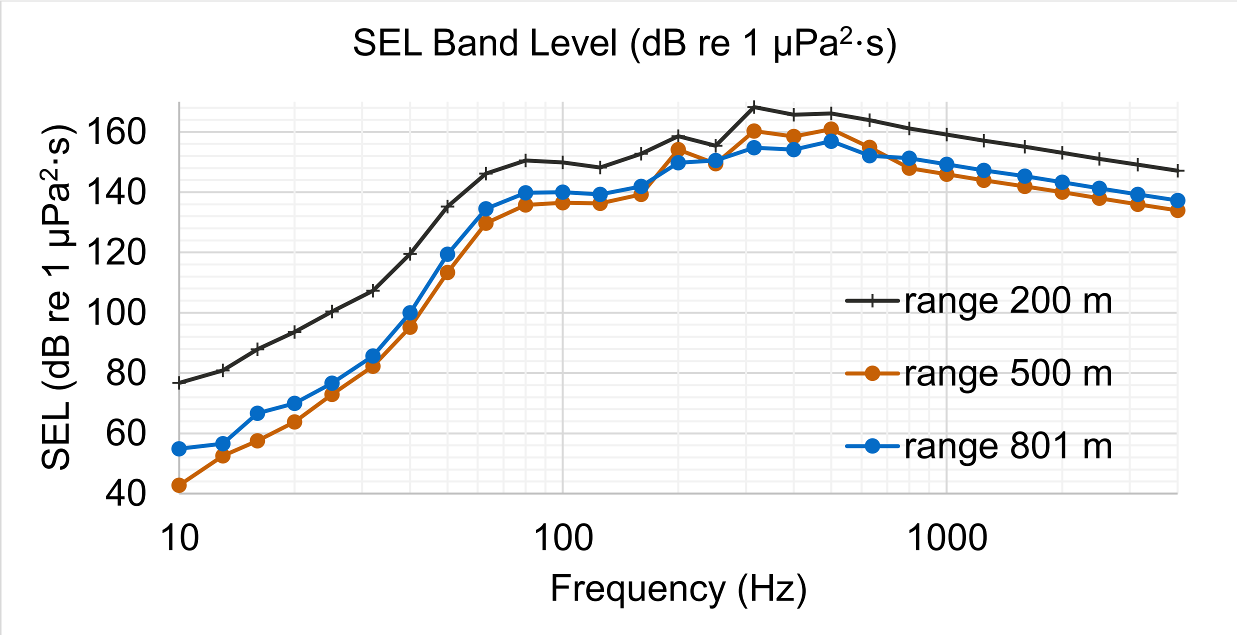


Figure 10. Maximum-over-depth per-pulse SEL versus frequency in 1/3-octave bands, at three different ranges, for the 226° azimuth.

4. Summary

NMFS criteria (NMFS 2016) define a 160 dB re 1 µPa SPL (rms) behavioral threshold for marine mammals for impulsive sound sources. Table 2 shows the maximum distance to 160 dB re 1 µPa SPL along the two modelled transects considered in the current study. The results show that bathymetry plays a strong role in sound propagation conditions in Coos Bay. Received sound levels along the 209° azimuth decrease at a greater rate within 1.8 km of the source than the received levels along the 226° azimuth. Table 3 and Table 4 show the maximum ranges to the Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) criteria along the two modeling transects. Because cumulative SEL depends on the total number of hammer strikes over a 24-hour period, distances were calculated for three different possible conditions: 100 strikes, 1000 strikes, and 10000 strikes. Assuming a blow rate of 40 strikes/second, these correspond to 2.5 minutes, 25 minutes, and 250 minutes of continuous pile driving during a 24-hour period.

Table 2. Maximum modeled distance to 160 dB re 1 µPa threshold along two azimuths.

Azimuth (° from North)	Maximum range to 160 dB re 1 µPa (m)
209	1299
226	1817

Table 3 Maximum range from the pipe pile to modelled peak pressure level TTS and PTS thresholds based on the NOAA Technical Guidance (NMFS 2016) A dash indicates that the threshold was not reached.

Hearing group	Peak SPL (dB re 1 µPa)			
	PTS Threshold	Range (m)	TTS Threshold	Range (m)
Low-frequency cetaceans	219	20	213	35
Mid-frequency cetaceans	230	-	224	-
High-frequency cetaceans	202	199	196	337
Phocid pinnipeds in water	218	21	212	43
Otariid pinnipeds in water	232	-	226	-

Table 4. Maximum range from the pipe pile to modelled 24h SEL thresholds based on the NOAA Technical Guidance (NMFS 2016).

Hearing Group	Weighted SEL_{24h} (dB re 1 µPa²·s)			
	PTS Threshold	Range (m)	TTS Threshold	Range (m)
100 strikes (2.5 minutes)				
Low-frequency cetaceans	183	669	168	1806
Mid-frequency cetaceans	185	613	170	1796
High-frequency cetaceans	155	1849	140	4223
Phocid pinnipeds in water	185	605	170	1795
Otariid pinnipeds in water	203	40	188	455
1000 strikes (25 minutes)				
Low-frequency cetaceans	183	1758	168	1835
Mid-frequency cetaceans	185	1726	170	1830
High-frequency cetaceans	155	2160	140	7592
Phocid pinnipeds in water	185	1726	170	1829
Otariid pinnipeds in water	203	204	188	1253
10000 strikes (250 minutes)				
Low-frequency cetaceans	183	1817	168	1860
Mid-frequency cetaceans	185	1817	170	1860
High-frequency cetaceans	155	5549	140	7732
Phocid pinnipeds in water	185	1817	170	1860
Otariid pinnipeds in water	203	750	188	1811

Literature Cited

[NGDC] National Geophysical Data Center. 2017. U.S. Coastal Relief Model, 3-arc-second resolution. National Geophysical Data Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.ngdc.noaa.gov/mgg/coastal/crm.html (Accessed February 2017).

[NMFS] National Marine Fisheries Service. 2016. *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 pp. http://www.nmfs.noaa.gov/pr/acoustics/Acoustic%20Guidance%20Files/opr-55_acoustic_guidance_tech_memo.pdf.

ANSI S1.1-1994. R2004. *American National Standard Acoustical Terminology*. American National Standards Institute, New York.

Coast Survey. 2017. *Coos Bay Hydrographic Chart No. 18587*. National Ocean Service, National Oceanic and Atmospheric Administration, US Department of Commerce, Washington, DC.

Collins, M.D. 1993. A split-step Padé solution for the parabolic equation method. *Journal of the Acoustical Society of America* 93(4): 1736-1742.

Collins, M.D., R.J. Cederberg, D.B. King, and S. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. *Journal of the Acoustical Society of America* 100(1): 178-182.

Jensen, F.B., W.A. Kuperman, M.B. Porter, and H. Schmidt. 2011. *Computational Ocean Acoustics*. 2nd edition. AIP Series in Modern Acourics and Signal Processing. AIP Press - Springer, New York. 794 pp.

MacGillivray, A. 2014. A model for underwater sound levels generated by marine impact pile driving. *Proceedings of Meetings on Acoustics* 20(1): 045008. http://scitation.aip.org/content/asa/journal/poma/20/1/10.1121/2.0000030.

Pile Dynamics, Inc. 2010. GRLWEAP.

Zykov, M.M., T.J. Deveau, and D. Zeddies. 2016. *Modeling Underwater Sound Associated with Constructing Canaport Energy East Marine Terminal: Impact and Vibratory Pile Driving Noise*. Document Number 01161, Version 3.0. Technical report by JASCO Applied Sciences for Stantec Consulting Ltd.

Glossary

1/3-octave-band
Non-overlapping passbands that are one-third of an octave wide (where an octave is a doubling of frequency). Three adjacent 1/3-octave-bands comprise one octave. One-third-octave-bands become wider with increasing frequency. Also see octave.

attenuation
The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

azimuth
A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

broadband sound level
The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measured frequency range.

compressional wave
A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called primary wave or P-wave.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

digital elevation model (DEM)
A sampled array of elevations (and bathymetric depths in water) for a number of geographical positions at regularly spaced horizontal intervals (i.e., on a horizontal grid).

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

geoacoustic
Relating to the acoustic properties of the seabed.

hertz (Hz)
A unit of frequency defined as one cycle per second.

mbsf
Meters below sea floor

mean high water (MHW)
The arithmetic mean of all the high water heights observed over a period of several years. In the United States this period spans 19 years and is referred to as the National Tidal Datum Epoch.

mean lower low water (MLLW)
The arithmetic mean of the lower of the two low water heights of each tidal day, observed over a period of several years. In the United States this period spans 19 years and is referred to as the National Tidal Datum Epoch.

NCEI
National Centers for Environmental Information (formerly the National Geophysical Data Center).

NGDC
National Geophysical Data Center.

NOAA
National Oceanic and Atmospheric Administration.

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

parabolic equation method
A computationally-efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

point source
A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: *p*.

received level
The sound level measured at a receiver.

rms
root-mean-square.

shear wave
A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 µPa) and the unit for SPL is dB re 1 µPa:

$$\mathrm{SPL} = 10\log_{10}\left(p^2/p_0^2\right) = 20\log_{10}\left(p/p_0\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level. See also 90% sound pressure level and fast-average sound pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound level measured in the far-field and scaled back to a standard reference distance of 1 meter from the acoustic center of the source. Unit: dB re 1 µPa @ 1 m (sound pressure level) or dB re 1 $\mu Pa^2 \cdot s$ (sound exposure level).